Department for Transport

Union Connectivity Review

Analytical Report

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Contents

Appendices

Appendix A

Policy Review

Appendix B

Review of Geographic Corridor

Appendix C

Review by Mode

Appendix D

RAG Rankings Rationale

Appendix E

Environmental Review

1 Executive Summary

Arup was commissioned by the Department for Transport (DfT) to provide transport and economic analysis to inform the considerations and conclusions of the Union Connectivity Review (UCR). This report summarises our work on the development of a potential Strategic Transport Network for the whole United Kingdom, including the assessment framework, a review of the current network, and the prioritisation of interventions to address challenges to, and opportunities for, improved Union Connectivity.

The Union Connectivity Review was initiated at the request of the Prime Minister. It is guided by Terms of Reference (ToR)[1] that are focussed on how the quality and availability of transport infrastructure across the UK can support economic growth, and quality of life across the whole of the UK.

Five transport-related challenges

This study responds to five strategic-level transport-related challenges that are faced by the United Kingdom:

- supporting **economic growth and recovery** across the UK following the Covid-19 pandemic in a way that contributes to the *Build Back Better* [2] principles for the UK as a whole;
- supporting policies that contribute to **levelling up** across the whole of the UK;
- consideration of the merits of establishing an equivalent network to the EU **Trans European Transport Network** (TEN-T), now that the UK's membership of that network has ceased;
- transport's contribution towards **sustainable development** and the UK Government's commitment to becoming carbon neutral by 2050; and
- having regard to **changes in technology and lifestyle** that might lead to changes in travel demand and travel choices.

These five challenges, and the timeliness of this report, present an opportunity to address future strategic transport infrastructure needs for the whole of the UK. A UK-wide response that recognises the challenges and opportunities of a transport network that is not limited to individual nations, regions, or modes, could be more effective than looking at this from a devolved nation and individual mode perspective. The challenges and opportunities to enhance the transport network will also be determined by the fiscal measures that the UK Government and devolved administrations set out in their budgets and investment programmes.

[1] https://www.gov.uk/government/publications/union-connectivity-review-terms-of-reference/union-connectivity-review-terms-of-reference
[2] Build Back Better: our plan for growth, HM Treasury (March 2021)

Study Objectives

This study is focused on how to improve transport connectivity within the UK and its constituent nations of England, Scotland, Wales and Northern Ireland via road, rail and air, and across the Irish Sea.

Transport connectivity between the nations of the UK operates on a number of different levels. At the Union level, this means connections between nations by road, rail, sea and air, particularly between major cities and along major freight corridors, for example, between Great Britain and Northern Ireland. The need for enhancement may be contained to one nation but the benefits spread to a number. For example, many freight movements between England and Northern Ireland pass through southern Scotland on their way to Cairnryan using sections of the A75. Whilst this road is part of the strategic road network in Scotland, it also forms part of a more strategic route connecting three nations of the UK.

There is also a more localised level of connectivity where the economic geography of regions within the UK spans multiple nations. For example, North West England and North East Wales operate as part of a single economic region and labour market, as does the South Wales and Bristol area. In these locations the need for enhanced connectivity between two nations may be more localised in nature, but significant in terms of the potential impact it will have on meeting objectives in those economic regions.

Recognising that Union connectivity works at these different levels is an important aspect of this review. In response to the Terms of Reference for the Review and the challenges described above, seven specific objectives for this study have been identified.

- **Objective 1 – To improve transport provision across the Union** - make recommendations as to whether and how to improve connectivity across the UK in the long-term, including how to bolster existing connections as well as creating new links
- **Objective 2 – To support economic growth and recovery across the whole of the UK –** how recommendations contribute to economic growth and recovery across the whole of the UK and identify where targeted interventions can unlock or stimulate further growth.
- **Objective 3 – To help address economic and social inequalities across the whole of the UK -** identify those proposals which help address economic and social inequalities within the UK. Enhancing transport connectivity has been identified by the Government as one of the primary means to address regional inequality and deliver the Government's levelling up ambition.
- **Objective 4 – To support quality of life across the whole of the UK –** support enhancements in quality of life across the whole of the UK. Transport infrastructure links people to one another, to jobs, to housing and to leisure opportunities.

- **Objective 5 – To support the UK's commitment to be net zero by 2050 –** ensure that any future Strategic Transport Network, and any specific schemes recommended, together best support the pathway to decarbonisation and complement the government's wider environmental strategy.
- **Objective 6 – To get the best out of technological innovation** – assess, based on the best evidence currently available, the extent to which future technological change affects the case for transport investment in the present, both broadly and in relation to specific proposed schemes.
- **Objective 7 – To be consistent with the UK Government's overall fiscal strategy** – how governments nationally, regionally and locally best prioritise the use of existing funds to deliver the greatest benefit locally and, critically for this review, nationally in an efficient manner which reflects the strategic aims of the UK.

These objectives have been used to develop a set of criteria that have been used as part of an assessment and sifting process of potential opportunities for strengthening the proposed Strategic Transport Network.

Defining a proposed Strategic Transport Network for the whole UK (UKNET)

Before considering gaps in the existing strategic network, and how the network needs to adapt to meet the challenges posed by future trends, an understanding of how the strategic transport network currently exists today was assessed.

The UK already has a strategic transport network that provides connectivity across the UK. This includes transport connections that provide a combination of some or all of the following four key features.

1. **Direct linkages between major cities and economic regions in the UK**
   By road, rail and air – for passengers and freight – supporting greater economic activity/agglomeration and enhanced productivity.
2. **Connections to major sea and airports**
   Including the location of the 8 new potential UK freeports.
3. **Cross-border connections between single economic regions**
   Supporting regions which span two nations and provide critical access to shared labour markets and jobs.
4. **Essential connections to regional networks**
   Ensuring all parts of the UK can better access the strategic network.

To enable strong economic connectivity across the country it is essential that all of these major cities and economic regions are better connected to one another through road, rail and air links. It is not realistic to assume all parts of city regions are directly connected into the strategic transport network, with the role of local and regional transport networks providing feeder connections into the more strategic network.

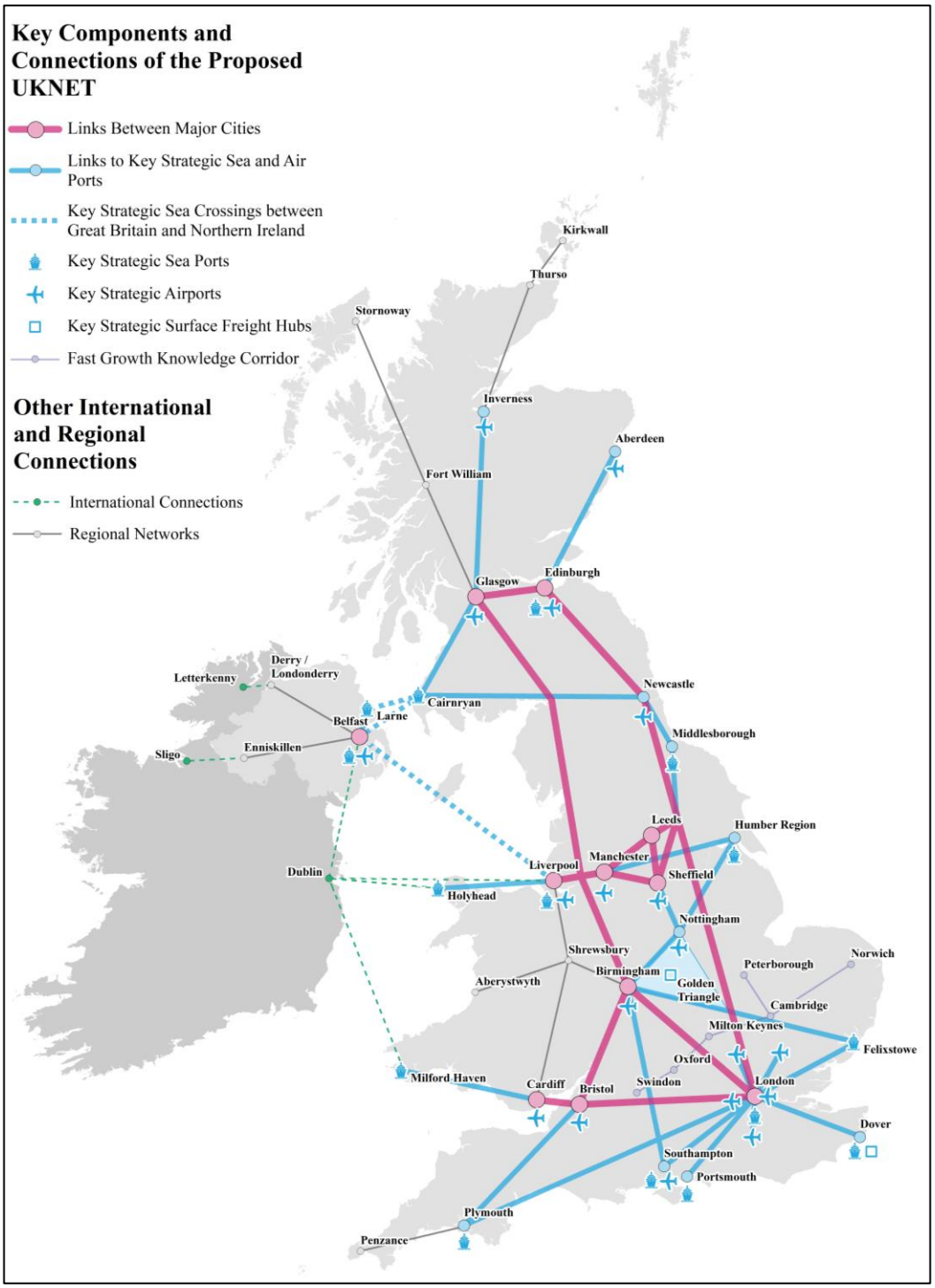
The UK has always been defined by its geography as an island nation and ports (both international and domestic, air and sea), have always played a critical role in the connectivity, economic security, and prosperity of the UK. Fast and reliable access to major ports is crucial for both the domestic economy and international trade.

While the population and economic activity of the UK is concentrated in major cities and towns across the country, there remain several regions that are more geographically isolated from the rest of the UK either by land or by sea. To ensure a future UKNET is able to meet the objectives of this review, including the need to address social and economic inequalities across the UK with no area 'left-behind', the geographically remote areas of the country must be connected into the UKNET via road, rail, air or sea.

Another feature of the UK strategic transport network is the role it plays in connecting cross-border areas where the local economies of areas either side of the border are both significant at a UK scale with a high degree of interdependency. These areas have close geographical proximity and the economic geography of regions, including journey to work and labour market catchments, span the border.

Based on these features, a schematic has been developed of the proposed UKNET as shown in Figure 1.

Figure 1 – A schematic representation of the proposed UKNET

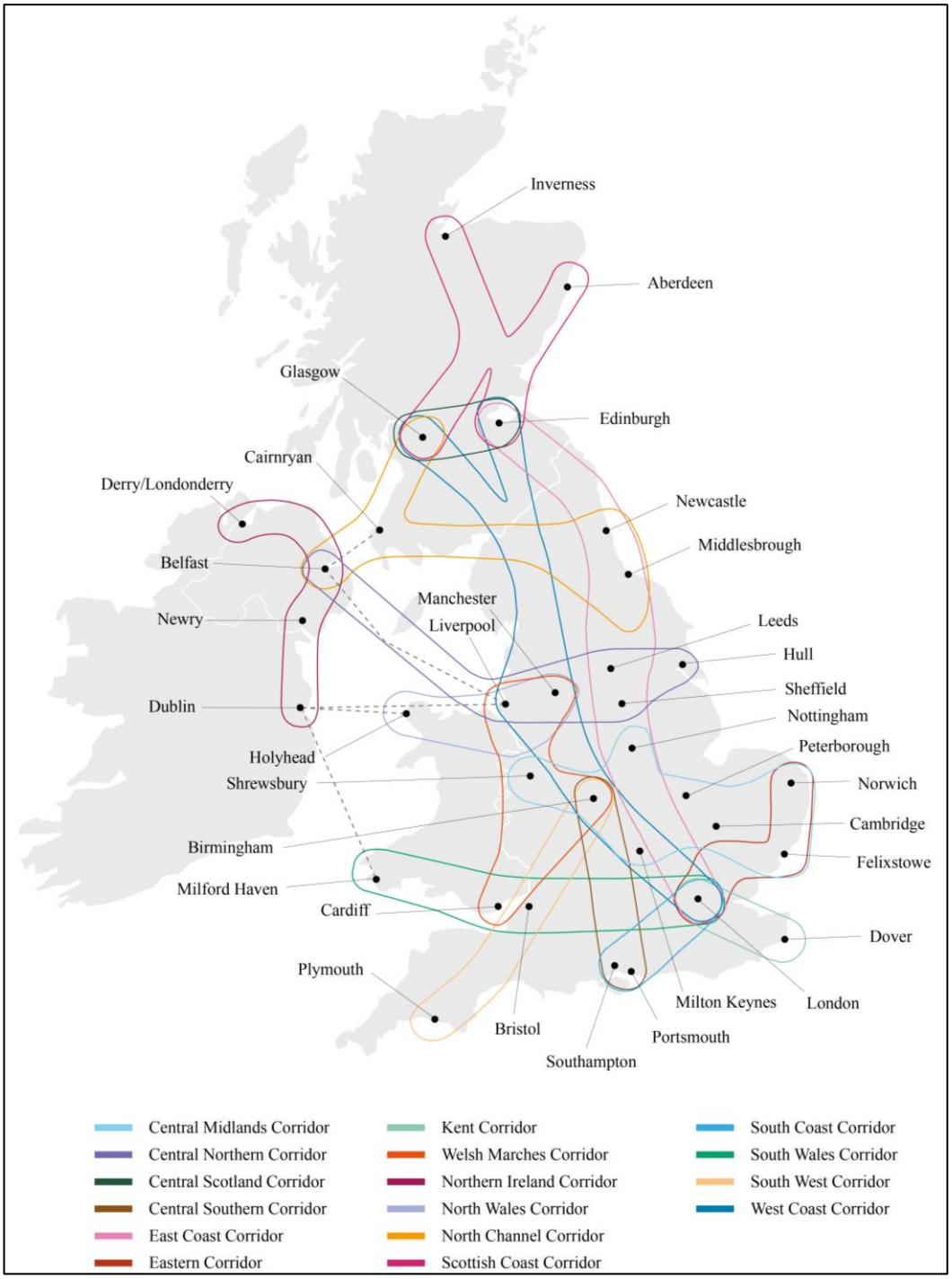


Source – Arup analysis

A more detailed understanding of how movements take place across the Union has been further explored. Connectivity corridors have been developed, to assess the multi-modal transport connectivity that takes place by people and freight to, from and within the corridors. This also allows a focus on how the economic geographies of these corridors work, and where they may cross boundaries. The analysis of baseline data, and the call for evidence responses has supported the development and understanding of movements within these corridors.

Many of these corridors are also 'enabling corridors' and form part of a much broader corridor of movement. For example, the West Coast Corridor plays an important connecting role for movements between the Central Midlands, the North Channel corridor, and onwards to the Northern Ireland corridor.

Figure 2 – The geographic corridors of the proposed UKNET



Source – Arup analysis

Policy Review

The responsibility of transport policies and projects vary by mode and geography across the UK. Some areas of responsibility have been devolved to individual nations whilst others remain the responsibility of the UK Government. In many cases, responsibilities are broken down further, into executive agencies, including Transport Scotland, Transport for Wales, and Highways England. In Northern Ireland many public transport services are operated directly by the government-owned company Translink. A review of UK Government, Devolved Administrations and English Sub-National policies and strategies has been undertaken to support this report. This clearly demonstrates there is a strong policy and strategy drive for investment in transport infrastructure across the Union to support sustainable economic growth.

Future Changes

There have been many technological advances in transport in recent years. Some of these have focused on the technology of the transport service, including advances in automation, vehicle emissions and new methods of propulsion such as electric vehicles and hydrogen technology. There have also been enhancements in technology that have improved the experience of transport from a user perspective, giving more information and choice to travellers and enabling them to be more informed about their travel choices. The availability of data has also improved the efficiency and operations of transport, including enhancements in freight and logistics, allowing for more efficient operations. Many of these technology changes will directly support the decarbonisation of transport. Some aspects of the transport network such as aviation and shipping are at an earlier stage of technological change, particularly from a carbon emissions perspective, with further research into new fuels and the electrification of flight/shipping underway.

The COVID-19 pandemic has impacted on the demand for travel across the UK in different ways. Some work-related travel associated with commuting to offices has reduced significantly as employees have followed Government advice to work from home. This has fuelled developments in technology and new models of employment and attitudes towards remote working that will lead to longer term changes in working patterns. Other aspects of the labour market have not been affected at all as working from home has not been an option.

Business related travel has reduced significantly (particularly by rail) whereas some freight movements have increased as the demand for online retail has grown. Travel to and from airports has reduced significantly but some domestic tourism related trips have increased. It is also possible that if people are commuting less, they will be more willing to travel more and further for recreation and leisure. If employees are spending some or all of their working week at home, the attractiveness of going away at the weekend could grow. These longer distance leisure trips are important on many of the important links on the proposed UKNET. It may be a number of years before the true long-term mobility impacts of the pandemic become clear.

The new trading relationship between the UK and the EU has also changed the pattern of travel demand across the UK, particularly for freight movements. This

includes the reduction in the use of Great Britain as a 'land bridge', between mainland Europe and the Republic of Ireland for freight movements. Whilst some of these changes have been associated with transition and are relatively short-term and temporary in nature, the long-term impact of this new relationship between the UK and the EU on cross-border UK travel may take a number of years to settle.

The UK's population is also growing. It is therefore important to understand how population distribution and growth patterns may vary in the coming years, and how this will transform the shape of demand on the UKNET. However, the UK also has an ageing population, with life expectancy rising and birth rates reducing. The latest ONS projections suggest that in 50 years' time, there will be an additional 8.6 million people aged 65 years and over. This will place different mobility requirements on the UKNET.

There are many uncertainties in the future, both behavioural and technological, that the UKNET will need to respond to and consider when planning future investment.

Network Improvements

The Terms of Reference direct that the Review make recommendations as to whether and how best to improve transport connectivity across the UK in the long term, including how to bolster existing connections.

Drawing upon the suggestions made by key industry bodies in the Call for Evidence (for example Network Rail and Highways England), and the analysis of the performance of the existing UK strategic transport network by mode and by corridor, a longlist of areas for infrastructure improvement has been defined. This longlist has been refined to ensure no important areas are omitted. For each area identified in the longlist, the key aspects of the transport system in need of improvement have been highlighted; whether the alleviation of congestion and improvement of resilience (amongst others) for roads, or the improving of journey times and increasing of capacity (amongst others) for rail links.

The longlist of infrastructure improvements has been assessed using a red / amber / green (RAG) assessment framework, which determines the extent to which each of the longlisted improvements fulfils the objectives of the review. This enables the ranking and prioritisation of the longlist to form a shortlist of improvements.

The priorities in the table below have been highlighted in the shortlist for road and rail.

Infrastructure	
Road	**Rail**
• Improvements to capacity on the A75 • Improvements to capacity on the A77 • Severn Resilience package to the east of the Severn Crossings • Improvements to the A1 (north of Ellingham to Edinburgh)	• Improvements to track capacity and journey times on the West Coast Mainline north of Crewe • Improvements to track capacity on the East Coast Mainline north of Northallerton • Rail-led 'network of alternatives' to alleviate M4 congestion • Improvements to line speeds on the North Wales Coast Line • Improvements to direct connections between Cardiff and the Midlands, north-east England, and Scotland • Re-opening and upgrading of the line between Dumfries and Stranraer[3]

For air and sea connections, improvements are focused on policy since these modes are less dependent on public sector infrastructure.

Documents published by the UK Government and by industry bodies have been reviewed, and suggested areas for policy improvement identified. These have been tested with internal experts to determine which are most aligned with the objectives of this review.

The policy priorities in the following table have been highlighted for each of the modes.

Policy	
Road	**Rail**
• Continue to encourage shift to electric vehicles and more sustainable modes of transport • Consider road pricing to account for loss of excise duty on petrol and diesel • Decarbonisation of freight	• Rail industry changes underway with release of the 'Williams-Shapps Plan for Rail: Great British Railways' • Golden opportunity for fares reform
Aviation	**Maritime**
• Safeguard sufficient airport capacity for domestic connections, particularly in south-east England • Ensure a price competitive market on key domestic routes • Ensure affordable, competitive, and accessible connectivity, through the use of support mechanisms as needed • Encourage modal shift to rail where possible • Accelerate the decarbonisation of flights • Improve surface access to airports	• Resilience, reliability, and flexibility of strategic routes • Improve surface access to seaports • Ensure customs and taxation policy aids competitiveness

[3] *Only recommended if a rail fixed link is constructed between Stranraer and Northern Ireland*

2 Introduction

Arup was commissioned by the Department for Transport (DfT) to provide transport and economic analysis to inform the considerations and conclusions of the Union Connectivity Review[4] (UCR).

This report summarises the assessment framework and the development of a proposed Strategic Transport Network for the whole United Kingdom, termed UKNET, as well as identifying future 'network improvements'. The report is structured in the following chapters:

- Assessment Framework (Chapter 3);
- Defining the Proposed UKNET (Chapter 4);
- Review of Geographical Corridors (Chapter 5);
- Future Changes (Chapter 6);
- Network Improvements (Chapter 7); and
- Summary (Chapter 8).

2.1 Terms of Reference

The Union Connectivity Review was initiated on the request of the Prime Minister. The Terms of Reference[5] for the Union Connectivity Review are reproduced below.

We translate these terms of reference into an assessment framework for our report in the next chapter.

[4] https://www.gov.uk/government/publications/union-connectivity-review-terms-of-reference/union-connectivity-review-terms-of-reference (retrieved 16th November 2020)
[5] Ibid

Union Connectivity Review: Terms of Reference

Context

The UK government is building a stronger and fairer economy for the future.

To support this aim, the government is keen to understand whether and how connectivity across the UK can support economic growth and quality of life, particularly as the country recovers from the COVID-19 pandemic.

This will be an independent review led by Sir Peter Hendy.

Scope

The government has asked Sir Peter to undertake a detailed review of how the quality and availability of transport infrastructure across the UK can support economic growth and quality of life across the whole of the UK.

As part of this review, Sir Peter should consider:

- the quality and reliability of major connections across the UK
- likely current and future demand for transport links
- the environmental impact of policy options (including with regard to climate change)
- existing work completed by the government on cross-UK connectivity

The review should consider the work across modes to restart and recover from the COVID-19 pandemic, including the Aviation Recovery Plan.

Sir Peter should make recommendations as to whether and how best to improve transport connectivity across the UK in the long term, including how to bolster existing connections. This work should cover transport connectivity between England, Scotland, Wales and Northern Ireland via road, rail and air, and across the Irish Sea.

Any recommendations made by Sir Peter should be consistent with the UK's wider fiscal strategy and underpinned by detailed, published economic analysis. Sir Peter should ensure that any recommendations he makes have significant benefits to either economic growth or quality of life in the UK.

Sir Peter should also consider in detail:

- cost
- feasibility
- value for money
- delivery arrangements and the time that recommendations may take to deliver
- how any projects he proposes should be sequenced

This analysis should be published.

In carrying out his study, the government asks Sir Peter to:

- consider likely future transport need and technological development in the long-term, which the government defines as the next 20 to 30 years
- consult widely with relevant government agencies, including the Department for Transport, including its modal teams, Scotland Office, Wales Office, Northern Ireland Office, National Infrastructure Commission, alongside the devolved administrations, local authorities and their infrastructure commissions
- consult widely with industry, academics, engineering experts and the general public

Timing

Sir Peter will report his findings to the Prime Minister, the Secretary of State for Transport and the Chancellor, and publish his interim report in January 2021 and final recommendations in summer 2021.

Review team

The review will be led by Sir Peter Hendy CBE.

He will be supported by a panel consisting of:

- Michèle Dix CBE
- Elaine Seagriff
- Neale Coleman CBE
- Professor David Begg

Secretariat support will be provided by the Department for Transport.

Undertakings of confidentiality will be entered into with the Chair and panel as necessary.

3 Assessment Framework

This chapter translates the Terms of Reference into an assessment framework for the UKNET. It sets out the problem statement, the study objectives, and the appraisal methodology for the study. We elaborate on the case for connectivity, the case for a network, and the economic approach utilised, as previously outlined in our December 2020 report.

3.1 Defining the 'Problem Statement'

The evaluation process for the Union Connectivity Review is guided by a 'problem statement' which responds to the question of *'why as a nation are we better off connected and what problems are we trying to solve*?'

To answer this question, we highlight five strategic-level transport-related challenges that are faced by the United Kingdom, that improved transport may be able to help with.

- Support **economic growth and recovery** across the UK following the Covid-19 pandemic in a way that contributes to the *Build Back Better* [6] plan for the UK as a whole.
- Support for policies that contribute to **'levelling up'**[7] across the whole of the UK.
- Consideration of transport's contribution towards **sustainable development** and the UK Government's commitment to becoming carbon neutral by 2050.[8]
- Having regard to **changes in technology and lifestyle** that might lead to changes in travel demand and travel choices.
- Consideration of the merits of establishing an equivalent network to the EU **Trans European Transport Network** (TEN-T) now that the UK's membership of that network has ceased.

These five challenges, together with the timeliness of this report, present an opportunity to address future strategic transport infrastructure needs for the whole of the UK. The current way we plan for transport priorities across the UK – often holistically, but sometimes by individual mode or by devolved nation – can make it more difficult to respond to these challenges comprehensively. A UK-wide response that recognises these challenges are not limited to individual nations, regions, or modes, has the capacity to be more effective.

This chapter focuses on the role of connectivity strategically; that is the benefits of a completed network – which can be more than the component parts – and the contribution of these strategic benefits to other government aims. It is after this point that we move to the investigation of the merits and opportunities presented

[6] Build Back Better: our plan for growth, HM Treasury (March 2021)
[7] Build Back Better: our plan for growth, HM Treasury (March 2021), p.69
[8] UK enshrines new target in law to slash emissions by 78% by 2035, BEIS (April 2021)

by individual schemes, through use of a more traditional scheme appraisal method to assess their standalone contribution (discussed in Section 3.4 and carried out in Chapter 7).

Below, we describe each of the five strategic-level challenges in more detail.

3.1.1 Economic Growth and Recovery

In March 2021, the Chancellor of the Exchequer presented *Build Back Better: Our plan for growth* to Parliament[9]. The plan outlines the importance of stimulating and driving economic growth as we begin our Covid-19 recovery.

> *"This plan for growth is a call to arms to put this right. Our mission is to unleash the potential of our whole country and restore the energy and confidence of the Victorians themselves. Just as the government has done whatever it takes to support lives and livelihoods throughout the Covid crisis, so we will turn that same ambition and resolve to the task of our recovery. We will level up our country, so the map of our whole United Kingdom is lit up with competitive cities and vibrant towns that are centres of life – places people are proud to call home, with access to the services and the jobs they need to thrive."*[10]

The *Build Back Better* plan identifies infrastructure, skills, and innovation as the three core pillars of growth. Transport has a central role to play supporting these pillars of growth, both as a form of infrastructure, and by providing the UK wide connectivity across the UK that allows for people to access opportunities to develop skills, and for businesses to innovate together. While devolved administrations have a role to play in delivering the transportation infrastructure needed to support economic recovery, the *Build Back Better* plan demands a national 'call to action' to unite efforts across the whole of the country: *"It is human genius and ingenuity that is beating Covid and it is by unlocking that genius and ingenuity across our whole county that we will build back better."*[11]

Why are we better off connected?

At a basic level, connectivity, in terms of the ability of firms and individuals to access suppliers, markets and other opportunities, is vitally important to our economy. Business, capital and labour is now more mobile than it has ever been, across regions, borders, and around the globe. Transport connectivity should not serve as a constraint on developing the UK's internal market, ensuring future growth can reach all corners of the UK.

The UK is, broadly speaking, a well-connected nation but some links are congested, and others are comparatively slow in terms of journey time. Congested links can cause significant economic harm to the UK, through their impact upon business, quality of life, and the UK's reputation abroad for inward investment.

[9] Build Back Better: our plan for growth, HM Treasury (March 2021)https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/968403/PfG_Final_Web_Accessible_Version.pdf
[10] Build Back Better: our plan for growth, HM Treasury (March 2021)
[11] Build Back Better: our plan for growth, HM Treasury (March 2021)

Britain was ranked in the top 10 of 38 countries surveyed for traffic congestion in 2017, ahead of the EU nations in the survey, and the UK's transport infrastructure is deemed the least attractive element of its criteria for FDI (Foreign Direct Investment), with almost two-thirds of investors identifying transport infrastructure as a priority for investment. Likewise, the United Kingdom's motorway and major rail network is smaller than most other European countries on a per capita basis, ranking 23rd of 28 European countries on both motorways and major rail infrastructure kilometres per capita.[12]

Failing to keep up with future economic growth and address congestion could result in the United Kingdom losing out to its international rivals when being considered for inward investment. This would impact negatively on economic growth and quality of life.

An effective transport network can also act as a facilitator and impetus for future growth and help drive other policy aims. The UK's population is growing – it is currently 67 million and anticipated to grow to above 72 million by 2041.[13] The economy depends upon capacity being available for additional movements of people and goods, and we must consider the future connectivity requirements demands and capacity required in order to allow future growth to occur. This needs to reflect changes in drivers of demand – including reflecting the long-term changes in travel demand emerging from the pandemic – and the ongoing requirement to move travel demand towards more sustainable modes and methods of transport.

However, because of the long lead time for transport projects, and the frequent practical difficulties in expanding capacity once built (for example, adding another lane to a road, widening a bridge, or four-tracking a two-track railway), decisions on provision of that capacity are often 'lumpy' and must be made several years in advance. There is also an opportunity with transport investment to align investment decisions with the implementation of non-transport policy aims, such as the delivery of housing growth or economic development and regeneration.

The transformational benefits of transport investment arise from increases in the connectivity between places, which often includes benefits that are not picked up in the direct journey time valuations in traditional transport appraisal. Current DfT Transport Analysis Guidance (TAG) acknowledges the significance of the agglomeration benefits and wider economic impacts of transport investments and the importance of incorporating them through the business case and decision-making process. This agglomeration can occur between regions as well as within them, with the most significant benefits often occurring between cities that are larger, include high numbers of skilled workers and can be brought significantly closer together, in terms of travel times. The scope for significant agglomeration benefits would include, for example, improved connections between the city economies of Cardiff, Bristol and Bath in south Wales and south-west England.

[12] NationMaster Transport Network per capita
[13] Overview of the UK Population: ONS (January 2021)

However, it is important to reinforce that while transport investment has an essential role to play in delivering connectivity and facilitating economic growth, it is rarely the single limiting factor, and more often one of a number of critical ingredients for enabling success. Complimentary investments, especially in skills, digital connectivity and housing remain vitally important to realising an area's, and the United Kingdom's, full potential. Transport connectivity across the Union thus provides a stable platform for growth that can achieve more when integrated with other investments.

3.1.2 Levelling up

Government has placed the importance of 'levelling up' at the heart of its policy agenda for this parliament.[14] The drive to 'level up' embodies a recognition that significant economic differences remain between certain parts of the UK, including our cities, ex-industrial towns, and rural and coastal communities. These differences have real-world implications for the people who live there in terms of their income, their access to work opportunities, and their health and wellbeing.[15] Addressing these inequalities is a priority of the Government and improving infrastructure, including transport connectivity, is identified as one of the primary measures for addressing this challenge.[16]

The role of transport in delivering the 'levelling up' agenda

The UK Government has set out its intention to address geographical inequality, and to 'level up' underperforming and left-behind parts of the UK through a programme of long-term investment in infrastructure, skills, and research and development. Understanding, measuring and maximising the role a future UKNET can play in delivering this strategic outcome is one of the aims of the UCR.

The proposed Strategic Transport Network for the whole United Kingdom would be expected to contribute to mitigating disparities in prosperity between and within regions. In some cases, the level of prosperity across the borders of UK nations can change significantly (such as the move from Cheshire in England to Flintshire in Wales). The Review will consider the impacts transport networks have on marginalised communities through our assessment of opportunities for network improvement, and how mitigating disparities in access to quality transport infrastructure may help to address this inequality and improve quality of life.

While transport is a key facilitator of economic improvement and levelling up, it cannot deliver this outcome without being integrated into a holistic strategy. A Local Institutions, Productivity, Sustainability & Inclusivity Trade-Offs (LPSIT) report identifies five components to a strategy to address levelling up: identify firms and sectors with the potential to create good jobs; conduct focused inward investment activities based on this analysis; partner with firms to boost demand for skills in those firms and in the local economy; tailor skills strategies to the

[14] Build Back Better: our plan for growth, HM Treasury (March 2021)
[15] Levelling up: where and how?, Institute for Fiscal Studies (October 2020)
[16] Build Back Better: our plan for growth, HM Treasury (March 2021)

resulting demand; and *adopt spatial and transport policies so that people can get to these jobs*. [17]

Furthermore, transport investment to support levelling up is broader than major road, rail or air projects. For example, the National Infrastructure Commission's Rail Needs Assessment for the Midlands and the North states that rail alone may not be sufficient to drive transformation. A wider set of complementary policies is necessary for economic transformation. Urban transport and local connections, including first and last mile connections to longer distance transport routes, are also important.

Transport connectivity and social cohesion

Whilst many different definitions of social cohesion exist, there is broad consensus that it plays a positive and important role in both shaping society and growing the economy. Fonseca et al (2019) review different interpretations of social cohesion used in academia since 1897 and put forward the following definition.

> *"The ongoing process of developing well-being, sense of belonging, and voluntary social participation of the members of society, while developing communities that tolerate and promote a multiplicity of values and cultures and granting at the same time equal rights and opportunities in society."*

Ultimately, social cohesion increases social capital which is defined by the OECD as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups."[18] There is a growing consensus that social capital has an economic payoff for communities that invest in it fostering entrepreneurial activity[19], improving job prospects[20], and supporting the development of human capital.[21]

Social cohesion on a pan-Union basis can be assisted by transport links that make it easier for businesses to interact with one-another, for people to visit a place of work or leisure in another UK nation, to foster a joint sense of place and identity, and for personal relationships to be developed, maintained and nurtured. Already there are significant personal and family ties that exist across the Union. For example, large numbers of students from one part of the union go to another in order to study and over half of migrants to Scotland are from England. Improving transport links will allow these ties between the UK nations to be better served, our existing pan-Union relationships to be better nurtured and for new ones to be formed.

Compared with projects solely within a particular nation, cross-border transport projects or projects that enable improved cross-border connectivity (those that better connect transport users to an existing cross-border link), have the greatest

[17] Achieving Levelling-Up: The structures and processes needed, LPSIT (November 2020)
[18] OECD Insights: Human Capital, Chapter 6. A Bigger Picture (2007)
[19] Kim & Aldrich, 2005
[20] Erickson, 2001
[21] Croninger & Lee, 2001

potential to increase integration and social cohesion between the nations of the UK. An integrated and well-planned transport network can foster long-term social cohesion between, nations, regions, and communities, ultimately delivering greater economic benefits across the Union.

3.1.3 Sustainable Development

With the UK's declaration of a national climate emergency, and the spring 2019 passing of legislation to achieve net zero carbon emissions by 2050[22], sustainable development and addressing the climate crisis has become a key focus for all parts of government, industry, and society. In the UK Government report *Leading on Clean Growth*[23] there is a specific focus on the role of transport in enabling sustainable growth. Transport is currently the largest emitting sector in the UK and is responsible for 27% of national emissions and the *Clean Growth* report speaks directly to the need for a "single concerted approach to dramatically reduce emissions from our road, rail, maritime and aviation networks as we move people and goods more sustainably".[24] National government has a clear role to play directly, and in fostering a concerted effort across all parts of government and industry, to ensure that the UK achieves its net-zero requirement. New and/or upgraded infrastructure is part of this.

3.1.4 Changes in Technology and Lifestyle

The Covid-19 pandemic has impacted travel behaviour across the UK from both a demand and supply perspective. Drivers of demand have changed with a significant proportion of the labour market being advised to work from home, which is embedding a longer-term change in behaviour, particularly for those people who work in offices. New models of transport operation have also been developed, accelerating trends we have been seeing for some time and triggered by developments in technology. This includes new models of delivery for goods and services and a rising awareness and willingness of the public to procure goods and services in new ways.

Most organisations are planning to allow white-collar employees greater flexibility on when and where they work, with two-thirds of employers developing a hybrid work model where people spend only part of the time in the office.[25] Most employees similarly appear to favour a hybrid working model going forward.[26] Beyond the next few years, changes in work/life arrangements, the continued growth of e-commerce, and access to more digital services at home, will all impact on the demand for travel in the future, and will affect the volume and pattern of personal travel and movement of goods.

Whilst it is too early to predict with certainty what the long-term effects will be on travel demand (particularly for longer distance demand), emerging patterns of

[22] UK becomes first major economy to pass net zero emissions law, Dep. BEIS (June 2019)
[23] Leading on Clean Growth, Dep. BEIS (October 2019)
[24] Leading on Clean Growth, Dep. BEIS (October 2019)
[25] CIPD Research (April 2021)
[26] Arup (2021) The economic future of the Central Activities Zone (CAZ) Phase 2 report

travel as we 'unlock' from the pandemic, are already different to how they were pre-pandemic.

3.1.5 Trans-European Transport Network (TEN-T)

The UK was until recently part of the EU TEN-T network, a formal network of strategic transport routes across the EU that was originally established in 1996. TEN-T was designed to ensure that member states prioritised cross-continent connectivity, rather than solely focusing on national transport priorities.

Corridors linking London to north west England and the Scottish central belt, joining with links to channel ports and those across the Irish Sea, were part of the TEN-T network. Now that the UK has left the EU, there is the opportunity to review the case for a Strategic Transport Network for the whole UK that is tailored to the UK's needs across all four nations, and the strategic priorities of government.

3.2 The need for a Strategic Transport Network

The constitutional make-up of the United Kingdom with four nations and a range of national transport agencies covering different modes of transport and nations, such as Highways England and Transport Scotland, means the planning and consideration of future challenges of the transport network of the whole of the UK, are not always considered. Whilst many transport challenges are best addressed at the devolved nation level, there is a need to consider future transport needs from a whole UK perspective. Through the development of a UKNET, there is the opportunity to better integrate planning and investment across different modal transport delivery bodies and all four nations.

3.2.1 Devolution and the need to plan for cross-border travel

Transport policies and projects are the responsibility of the relevant administrations in each UK nation, with the exception of England, whose domestic transport policy is overseen by the UK Department for Transport. In almost all cases, responsibilities are broken down further, into executive agencies, including Transport Scotland, Transport for Wales, and Highways England, which have responsibility within different jurisdictions, often for individual modes. In Northern Ireland many public transport services are operated directly by the government-owned company Translink. In some cases, English Mayoral authorities also have responsibility for transport strategy and policy through agencies such as Transport for London and Transport for Greater Manchester. All over the United Kingdom, local authorities have responsibility for many local transport issues, including roads and bus subsidy arrangements. The relevant executive agencies are responsible for producing plans for long term transport investments and enhancements, which are approved by the appropriate devolved administration.

There is thus less *political* incentive for devolved administrations to invest in cross-border transport, when considering the alternatives wholly within their own constituency, and the allocation of a finite pot of money. Further, any investments

in cross-border transport to promote local *economic* growth risk 'leakage' of the benefits to neighbouring jurisdictions, such that the economic return on the investment, from a devolved administration's perspective, may be lower for cross-border links than it would be for entirely domestic ones.

Conversely, administrations might be incentivised to invest in radial links to their own major work and leisure sites, that reorientate economic activity away from similar opportunities over the border. On a year-by-year, or scheme-by-scheme basis, this difference may not be noticeable, but over time, this creates patterns of investment and economic activity that could mean that the UK nations become more insular. This unintended consequence of devolution suggests that there is a role for the UK government to take a broader view of growth and to take responsibility for connectivity across the UK and the creation of a UKNET, in the same way that the European Union takes responsibility for TEN-T and the federal highway administration in the United States takes responsibility for defining and setting the standards for the Interstate Highway Network. This is not an argument against devolution, but rather in favour of providing devolved authorities with certainty of the requirements and responsibilities at the UK level that are identified within the UKNET, so they can best plan and deliver regional networks.

Through employing a higher scale of appraisal, the UKNET will emphasise the strategic case for projects and routes which create specific value at the UK-wide level, and which stimulate economic growth in other regions and nations than in the nation where the project is realised.

3.2.2 Enabling better planning

A UKNET would give devolved administrations the ability to plan their own regional networks in a complementary way. The UKNET would serve as the multi-modal top tier in the hierarchy of the UK's transport networks. This is a principle that is already being enacted, albeit unevenly, in other aspects of transport planning, such as the way that the plans for HS2 are being used as the basis for national strategic railway planning, with regional rail strategies being orientated around the national investment, so that they make the best of the opportunities that arise.

A UKNET could formalise this approach, and develop it on a multi-modal basis, such that there is better planning, more local investment, and therefore better transport overall. For example, a multi-modal UKNET can lead to the consideration of planning of transport corridors where international, regional and local transport networks converge, allowing for improved connectivity of both people and freight, and avoiding instances in the past where a proposed road scheme has rivalled a proposed rail scheme in the same corridor.

As part of the brief, a multi-modal UKNET could also consider the resilience both within and across modes, which is likely to become even more important as we feel the impacts of climate change and there is an increasing desire to shift movements to more sustainable modes.

The establishment of a UKNET would provide a degree of certainty across sectors on the connectivity of the Union over the coming decades, allowing the private

sector to better plan its own complementary investments. Increased certainty about the UKNET will allow businesses that rely heavily on physical transport of goods or of people to invest in specific sites. It will also allow the supply chain involved in design, build and maintenance of the UKNET to better invest in its own growth, such as capital and people. In some cases, this could result in increased research and development spend, and innovation – a co-ordinated UK-wide infrastructure plan provides a certainty mechanism for driving through innovation in construction techniques.

In this way, clearly defining a UKNET and articulating the case for transport connectivity can help create local as well as national and trans-union benefits. A UKNET would assist devolved administrations, and those planning detailed networks around our towns and cities, in planning their own local networks in a complementary way. In the same way as HS2 is considered to be the future backbone of the rail network, and future regional rail strategies are being planned around it, UKNET could give rise to better, more integrated planning, and therefore better transport overall.

3.2.3 Supporting a more environmentally friendly transport future

The UK's commitment to net zero by 2050 demands action from all levels of government and all sectors to reduce emissions of greenhouse gases (GHG) through effective planning and innovative solutions. By taking a multi-modal approach, a UKNET could encourage the use of less carbon intensive modes of travel, such as electric railways, along certain corridors. While a UKNET will not decarbonise the transport sector on its own, it can be a contributing factor in the environmental transition through encouraging investment in more carbon-friendly modes and creating a critical mass and a pipeline of funding for those enablers for net zero that require extensive networks in order to function effectively, such as electric vehicle charging points, hydrogen refuelling locations, and rail network electrification.

3.2.4 Linking the strategic and economic cases

Considering transport in this more strategic manner builds on the recent emphasis of the importance of a robust Strategic Case outlined in the Green Book Review 2020.

> *"A central finding of the review is that some business cases do not have a strong strategic case. They may lack a strong rationale for intervention, a clear objective aligned to government priorities, or robust evidence and analysis for how different options for delivering that intervention will advance that objective (a 'logical process of change'). Partly as a consequence of this, appraisal advice – and decisions – can rely heavily on a Benefit Cost Ratio (BCR) that is unrelated to a compelling strategic case, in order to justify the project."*

3.2.5 Local, regional, and UK-wide economic benefits

The different modes of transport within the UKNET bring different travel characteristics. With the exception of some flows between Scottish islands, the UK's air travel network is used almost exclusively for long distance journeys. Other transport links perform both a regional, domestic and union-wide role. Our motorway network caters for both strategic, long distance trips, and short, local hops, sometimes across a border, such as northern England – Scotland. Our intercity rail lines perform a similar role, often catering for commuter journeys around large cities, providing key rural links elsewhere, and facilitating significant long-distance flows on a single train service. Many parts of the network perform a key role in the context of their individual nation, whilst also retaining a role in the connectivity of the UK as a whole, such as the A74, A75 & A77 linking Dumfries & Galloway with Scotland's central belt, and at the same time, the rest of Great Britain with Northern Ireland via Cairnryan.

The purpose of the network can also change throughout the week and the year, with many trans-union journeys being made for business and leisure purposes during weekdays and weekends respectively.

3.2.6 Summary

Based on the evidence presented above to ensure the UK is effectively planning for the future of cross-border and cross-region transport there is a strategic and economic rationale for the development of a UKNET. A UKNET will deliver economic benefits locally, regionally, and nationally, while allowing for improved multi-modal planning and a stronger approach to tackling the climate emergency. A proposed UKNET is defined in Chapter 4.

3.3 Objectives for the proposed UKNET

In response to the Terms of the Reference for the review and the challenges described above (Section 3.1), seven specific objectives for the review of a proposed UKNET have been identified.

Later (Section 3.4.3), these objectives are used to derive assessment criteria for the initial sift of opportunities to strengthen the proposed UKNET for the future.

Objective 1 – Improve transport provision across the union

The fundamental objective of the study is the improvement of connectivity across the UK in the long-term. This is facilitated by the identification and development of a Strategic Transport Network for the whole UK (UKNET), and recommendations as to how to strengthen existing connections and, potentially, to create new links. This includes consideration of the existing plans and strategies in place in the UK nations, which often encompass plans for individual transport modes through their respective agencies.

This requires a multi-modal, UK-wide review of the transport connectivity within the UK, and consideration of the transport provision requirements to ensure that strategic UK-wide challenges are being fully considered and any gaps in meeting

these challenges or harnessing opportunities can be addressed. This should include the consideration of proposed transport schemes, their funding, and their integration into a broader network.

Objective 2 – To support economic growth and recovery across the whole of the UK

Proposals identified in this study should contribute to economic recovery across the whole of the UK. We will identify where targeted interventions can unlock or stimulate further growth. The Covid-19 pandemic has prompted the greatest UK economic contraction in a generation, and in response, central government has presented to Parliament their plan to Build Back Better.[27] This review reflects on how transport connectivity can best support the objectives of the Build Back Better plan and demonstrate if and how, a national approach to transport connectivity could help further unlock economic growth.[28]

In doing so, our Review reflects on complementary recovery work underway by central government (for example the DfT's Aviation Recovery Plan)[29] to form an approach to delivering improved transport connectivity and economic growth across the UK.

Objective 3 – To help address economic and social inequalities across the whole of the UK

This study will identify those proposals which help address economic and social inequalities within the UK. Enhancing transport connectivity has been identified as one of the primary means to address regional inequality and deliver on the government's 'levelling up' ambition.[30]

This may focus on specific areas of the UK where economic regions span the border between nations. For example, in North East Wales, enhanced access to employment opportunities in Merseyside and Greater Manchester, and vice versa, may benefit both local residents and businesses, and help to address some of the inequalities that exist.

Objective 4 – To support quality of life across the whole of the UK

Proposals identified in this study for enhanced connectivity will support enhancements in quality of life across the whole of the UK. Transport infrastructure links people to one another, jobs, housing, education, healthcare and other essential services, and leisure opportunities. The recent Transport, health, and wellbeing[31] review found that transport is intrinsically linked to health and wellbeing in three key ways.

1. By providing access to health and recreation services.

[27] Build Back Better: our plan for growth (March 2021)
[28] Build Back Better: our plan for growth (March 2021)
[29] "Beyond the crisis" - speech to the aviation industry, DfT (October 2020)
[30] Build Back Better: our plan for growth (March 2021)
[31] Transport, health and wellbeing: An evidence review for the Department for Transport (July 2019)

2. By mode choice – physical and mental wellbeing is correlated to key aspects of transport including the associated level of physical activity.
3. Through its ability to facilitate and promote social and family interactions, connections and inclusion.

Families, friends, and communities depend on the transport network to maintain physical connections that support physical and mental health, wellbeing, and (across the UK) an overall sense of social cohesion. Loneliness continues to be a key cross-government department priority that has only been heightened in importance and severity over the course of the Covid-19 pandemic.[32,33]

A robust transport network post-Covid-19 should have at its heart the value of face-to-face human interactions, in order to reduce community severance, limit social exclusion and improve access to services and activities. Our review will investigate the extent to which targeted transport interventions could enhance quality of life, including our health and wellbeing, and social cohesion within and across regions of the UK.

Objective 5 – To support the UK's commitment to be net zero by 2050

The UK Government has declared a national climate emergency and committed in law to achieve net-zero carbon emissions by 2050. While significant investment has been made in promoting more sustainable transport connectivity (for example through the push to electrify road and rail networks including over 23,000 publicly accessible EV charge points)[34], the transport sector remains the largest carbon emitting sector[35] and transformational work will be required over the coming decades for the UK to achieve its net zero requirements.

The national transport decarbonisation plan is currently under development by the DfT and is expected later this year. The initial *Decarbonising transport* [36] report outlined six strategic priorities.

1) Accelerating modal shift to public and active travel.
2) Decarbonisation of road vehicles.
3) Decarbonising how we get our goods.
4) Place based solutions.
5) The UK as a hub for green transport technology and innovation.
6) Reducing carbon in a global economy.

Our review will consider how a national approach to improving transport connectivity can best support these strategic priorities and how our transport network, infrastructure and services will be shaped to best enable a decarbonised future for the transport sector. For example, the government also recently

[32] A Connected Society: A strategy for tackling loneliness, Dep. DCMS (October 2018)
[33] Loneliness, social isolation and COVID-19, Local Government Association (Dec 2020)
[34] Zap-Map Statistics
[35] Decarbonising transport: setting the challenge
[36] Decarbonising transport: setting the challenge

published its Ten Point Plan for a Green Industrial Revolution[37], including bringing forward the ban on new sales of petrol and diesel vehicles to 2030 and committing £1.3bn to accelerate the roll out of electric vehicle charging infrastructure.

This review will ensure that any future strategic transport network, and any specific schemes recommended, consider the pathway to decarbonisation and complement the government's wider environmental strategy including the recently published UK climate target of a 78% reduction in greenhouse gas emissions by 2035, compared to 1990 levels.[38]

Objective 6 – To get the best out of technological innovation

The emergence and maturing of innovative technologies could have major implications for the supply of and demand for transport systems in the future. Our work will assess, based on the best evidence currently available, the extent to which future technological change affects the case for transport investment in the present, both broadly and in relation to specific proposed schemes. This includes the types of services provided, the infrastructure needed to support them, as well as the potential capacity requirements of a future network given the impacts of technological change on travel habits.

Objective 7 – To be consistent with the UK Government's overall fiscal strategy

The Covid-19 pandemic has forced the government to spend and invest huge sums to support the economy (over £280bn in 2020-21) and to mitigate impacts of business closures and job losses.[39] This increased spending has raised national borrowing to levels not experienced since the world wars[40] and suggests that there will be increased scrutiny on public spending in coming years. Our work considers the need to spend money wisely; by focussing on confirming proposed transport interventions that reflect the strategic objectives of government, influencing existing and future funding programmes that can deliver significant economic benefit.

3.4 Assessment methodology for improvements

3.4.1 An evidence-based, objective and proportionate approach

In order to identify which transport intervention, if any, is most appropriate and can maximise the benefits and opportunities created for the future of the UK economy and the people and businesses that rely on its success, it is important that we use a clear methodological approach that fulfils two requirements.

[37] The ten point plan for a green industrial revolution, Dep. BEIS (November 2020)
[38] UK enshrines new target in law to slash emissions by 78% by 2035, Dep. BEIS (April 2021)
[39] UK Government Spending Review (December 2020)
[40] How much is Covid costing the UK and how will we pay?, BBC News (June 2021)

- It must be evidence based, objective and promote the potential impacts of schemes in delivering benefits and outcomes desired by this review.
- The methodology must be proportionate, recognising the wide-reaching scale of this review and the need to be able to assess a large number of modes, corridors, and schemes quickly and efficiently. Given the timescales of this review, it would not be feasible or appropriate use of public funds to undertake detailed quantitative transport, economic and financial modelling analysis for each scheme.

An evidence-based proportionate approach reflects the most recent Green Book Review[41], which emphasises the importance of schemes that come forward being underpinned by a strong strategic case that demonstrates they can deliver against key government objectives.

3.4.2 The challenges of a traditional cost benefit approach

Traditionally, transport projects are appraised through the Green Book business case process and heavily rely on an economic cost benefit analysis (CBA). The DfT's TAG framework provides advice and guidance on how to conduct cost benefit analysis for transport projects.

Given this review spans across multiple modes and nations, undertaking detailed CBAs for all of the identified potential investments does not fulfil the proportionate requirements identified for this assessment. Some schemes brought forward through this review may have already undertaken detailed CBAs and in this case these results will be taken into consideration.

This review is an initial stage in a longer process for identifying and evaluating potential network improvements. Areas identified for improvement will continue, in the next stage, through a more detailed stage-gate process involving the sifting, modelling and cost benefit appraisal to determine the specifics of the appropriate improvement to deliver.

3.4.3 A Multi-Criteria Analysis Based Approach

We use a multi-criteria-analysis-based approach in our assessment. This allows us to assess the contribution of each option to the objectives identified earlier. Through doing this, we can take forward those schemes that have the greatest overall impact on the stated policy objectives. We suggest a red / amber / green (RAG) approach for criteria that correspond to each objective. In this study, the economic assessment takes two forms as follows.

- As part of the methodology, we identify opportunities for network improvement using information from the Call for Evidence and other studies. These areas for improvement are identified by looking at measures such as journey times and crowding / congestion.

[41] Green Book Review 2020: Findings and response, HM Treasury (November 2020)

- We undertake a sift of the network opportunities for improvement using multi-criteria analysis, based on the assessment criteria outlined below. Note that these criteria are derived from the scheme objectives.

We include our proposed criteria, together with a RAG mark scheme, in the table below. Note that improvements focused on freight rather than passengers will score less well against some objectives such as improvements to quality of life.

Figure 3 –Assessment criteria and red / amber / green mark scheme

Objective	Criteria	Consideration for scoring	Red	Amber	Green
Transport provision across Union	Corridor plays a significant role in connecting people and/or goods in the Union	Improvement in connectivity between two (or more) nations of the Union, whether short distance cross-border trips or longer distance through trips.	The intervention does not connect people / goods between the four nations (i.e., benefits are overwhelmingly within a single nation of the Union)	The intervention is located within a single nation, but has secondary benefits for cross-border journeys	The intervention brings direct improvement for people and goods across more than one nation
	Extent of improvement to transport connections	Extent to which journey times / resilience / congestion will be improved by intervention	The intervention brings small connectivity improvements (e.g., less than 5% improvement to journey times / congestion etc.) or benefits only a small number of people/businesses	The intervention brings considerable connectivity improvements (e.g., 5-10% improvement to journey times / congestion etc.) and benefits significant population centres (e.g., large towns)	The intervention brings major connectivity improvements (e.g., more than 10% improvement to journey times / congestion etc.) for key economic centres (e.g., major cities, major ports and airports)
Economic growth and recovery	Increase productivity	Extent to which business or freight trips specifically will benefit from the intervention and agglomeration benefits will be realised	Negligible business or freight trips on the route, and no agglomeration benefits likely to be realised.	Significant volume of business or freight trips on the route which will benefit from the intervention, or minor agglomeration benefits	Large volume of business or freight trips between key economic centres will benefit from the intervention, or considerable agglomeration benefits
	Secure inward investment	Extent to which connectivity to international gateways is improved	The intervention does not improve connectivity to international gateways	The intervention brings some connectivity improvement to international gateways (e.g., relieve congestion on part of a route to a port for a small number of vehicles)	The intervention brings major connectivity improvement to international gateways (e.g., relieve congestion on a major portion of a route to a port for a large number of vehicles)
Economic and social inequalities	Deliver inclusive growth	Extent to which connectivity improvements benefit areas with above average deprivation, to help 'level-up' left-behind regions	The intervention does not improve connectivity for people in areas with above average deprivation, or contributes to an increase in deprivation	Areas with above average deprivation are among the beneficiaries of the improvement, but are not the primary beneficiaries	Areas with above average deprivation are among the primary beneficiaries of the improvement
Quality of life	Enhance accessibility and connectivity through reduced journey times	Extent to which accessibility to employment and leisure opportunities are improved	No increase or a reduction in the catchment of urban centres and their employment and leisure opportunities	A minor increase in the catchment of urban centres and their employment and leisure opportunities	Significant increase in the catchment of urban centres and their employment and leisure opportunities
	Enhance connectivity to separated and isolated areas, to promote community and combat loneliness	Extent to which connectivity improvements benefit separated or isolated areas	The intervention does not improve connectivity for people in isolated areas, or further isolates these communities	Separated or isolated areas are among the beneficiaries of the improvement, but are not the primary beneficiaries	Separated or isolated areas are among the primary beneficiaries of the improvement
Environment	Separate Environmental Assessment (see Appendix E)				
Technological innovation	Embraces emerging transport technologies	The extent of opportunities to embrace innovative technology or methods as part of the intervention	No opportunity to adopt/embrace new technology as part of the intervention. No ability to adopt new transport technologies later.	Minor opportunities to adopt/embrace new technology as part of the intervention. Potential to incorporate new transport technologies later.	New technology or innovation will be a central part of the intervention. Potential to incorporate further transport technologies later.
	Flexible to reflect the shifts in travel demand that may arise from future technological change	Enables flexibility for future shifts in demand	The intervention negatively impacts the flexibility of the transport network to adapt to future changes in demand	The intervention slightly increases the flexibility of the network to adapt to future changes in demand	The intervention brings major benefits for the flexibility of the network to adapt to future changes in demand
Fiscal strategy	Delivers good value for money	Ability to demonstrate through an identified BCR or a benchmark estimate from similar projects that the benefits of the project deliver good value for money relative to the investment required.	Low value for money expected	Medium value for money expected	High value for money expected

3.5 Policy Review

This section sets out the policy and strategy drivers for investment in transport infrastructure across the Union. This includes the UK Government's current and emerging policy, as well as those of the nations and sub-national transport bodies (who have cross-border nation connections). This is important context for the future drivers of changes (see Chapter 6) and the network gaps and opportunities.

The policy review demonstrates there is a strategic case for investment in connectivity across all parts of the Union to support sustainable economic growth across the proposed UKNET.

The policy drivers are also not just pure transport ones, but approaches that will support the transition to clean and green trips across all nations, along with a greater focus on how people in all communities can use the network to access opportunities.

Many policies and strategies have been updated to address the role that the transport network can play in supporting economic growth following Covid-19 (see Figure 4). What these policies show is that there are clear economic and connectivity drivers for investment in transport infrastructure that connects the nations internally, but also with each other.

A summary of each of the policies and/or strategies listed can be found in Appendix A.

Figure 4 – Summary of Key Relevant Policies by Jurisdiction

UK Government	
Build Back Better: our plan for growth (2021)	'Build Back Better: our plan for growth' sets out the Government's plans to support growth through significant investment in infrastructure, skills and innovation, and to pursue growth that levels up every part of the UK, enables the transition to net zero, and supports the vision for Global Britain.
National Infrastructure Strategy (2020)	The Strategy brings together the government's long-term infrastructure priorities with the short-term imperative to build back fairer, faster and greener following the Covid-19 pandemic
10 Point Plan for Decarbonisation (2020)	The Plan seeks to ensure that the recovery from Covid-19 will be green, generate jobs and bolster the economy, whilst continuing to drive down emissions both now and in the future. Specifically, on transport, the Plan states that as well as decarbonising private vehicles, there must be an increase the share of journeys taken by public transport, cycling and walking.
Transport Investment Strategy (2017)	The Strategy states that by maintaining and upgrading transport infrastructure communities and businesses can be better connected and can deliver balanced growth across the country. The Transport Investment Strategy set out how the Government will respond realistically and pragmatically to today's challenges and put the travelling public at the heart of the choices we make.
Williams-Shapps Plan for Rail (2021)	The Plan sets out how the Government intends to deliver wider changes to the railway network, including the establishment of Great British Rail.
Integrated Rail Plan for the North and Midlands (forthcoming in 2021)	The Government is developing an Integrated Rail Plan for the Midlands and the North which is framed by the Government's commitment to bring forward transformational rail improvements along the HS2 route as quickly as possible. This work will be informed by an assessment from the National Infrastructure Commission (NIC)**.**
National Infrastructure Commission – Rail needs for the Midlands and the North (2020)	As mentioned above, the NIC's Rail Needs Assessment will inform the outcomes of the Integrated Rail Plan. It assessed current and future travel demand needs and made a series of recommendations for infrastructure improvements. These were grouped into packages which provided government with a series of strategic options. It recommends that the government consider regional links as well as identifying that transport alone cannot solve the economic problems faced by these regions.
National Policy Planning Framework (2019)	The Framework states that the purpose of the planning system is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs.
Scottish Government	
Transport Scotland – National Transport Strategy (2020)	The strategy's vision is for a sustainable, inclusive, safe and accessible transport system helping deliver a healthier, fairer and more prosperous Scotland for communities, businesses and visitors. NTS2 sets out an ambitious and compelling vision for Scotland's transport system for the next 20 years. There are four priority areas are to reduce inequalities, take climate action, help deliver inclusive economic growth, and improve our health and wellbeing.
Welsh Government	
Welsh Government - Llwybr Newydd: A New Wales Transport Strategy (2021)[42]	The Strategy sets out the Welsh Government's plan for the transport system over the next 20 years. The vision for an accessible, sustainable and efficient transport system. These are our three headline priorities for the next five years. There is more detail about these priorities in the 'mini plans'. The Welsh Government will review these priorities as circumstances and technology change.

[42] https://gov.wales/llwybr-newydd-wales-transport-strategy-2021

Northern Ireland Government	
Regional Development Strategy and Regional Transportation Strategy (2002 and 2011)	The RDS 2025 guides the development of Northern Ireland up to 2025 and beyond. The RDS sets out important gateways and corridors. These gateways are strategically important transport interchanges which are important for economic development, freight distribution activities and additional employment generation. A new Northern Ireland Investment Strategy is expected to be published in 2021.
Sub-national Transport Bodies	
Transport for the North – Strategic Transport Plan (2019)	Building on the outcomes of the Northern Powerhouse Independent Economic Review, the North could increase its GVA by an extra £100 billion by 2050 through investment in infrastructure and other areas of the economy. TfN has developed seven Strategic Development Corridors. Each corridor represents an area where evidence suggests investment in transport infrastructure will enable transformational economic growth.
Midlands Connect Transport Strategy (2017)	Midlands Connect published its first transport strategy in 2017, and since then has made progress researching, developing and progressing schemes that will bring the biggest social, economic and environmental benefits to the Midlands. They are currently in the process of refreshing our strategy to ensure we overcome these unprecedented challenges. This updated strategy will be published in late 2021. The existing strategy established a spatial framework for investment based on four strategic economic hubs and six intensive growth corridors which are critical to both the Midlands and the UK as a whole.
Western Gateway Strategic Transport Plan (2020)	The Plan sets out the short‑term plan covers the period from 2020 to 2025. It lays the ground for a long-term strategic plan to be produced covering the 25-year period through to 2050. The Plan identifies four key strategic corridors, considers the main transport issues for each and how they will contribute towards the long-term strategic plan. The strategic corridors are South East to South Wales, South East to South West, Midlands to the South West and Midlands to the South Coast. The production of a multi-modal corridor plan which, once completed, will form part of the Western Gateway's long-term Strategic Transport Plan. The aim is to agree the plan by March 2023.

4 Defining the Proposed Strategic Transport Network for the Whole United Kingdom

Transport connectivity between the UK nations operates on a number of different levels by road, rail, sea and air. Connections between major cities and along major freight corridors are particularly busy. The need for enhancement may be contained to one nation but the benefits spread to a number. For example, many freight movements between England and Northern Ireland pass through southern Scotland on their way to Stranraer using sections of the A75. Whilst this road is part of the strategic road network in Scotland, it also forms part of a more strategic route connecting three nations of the UK.

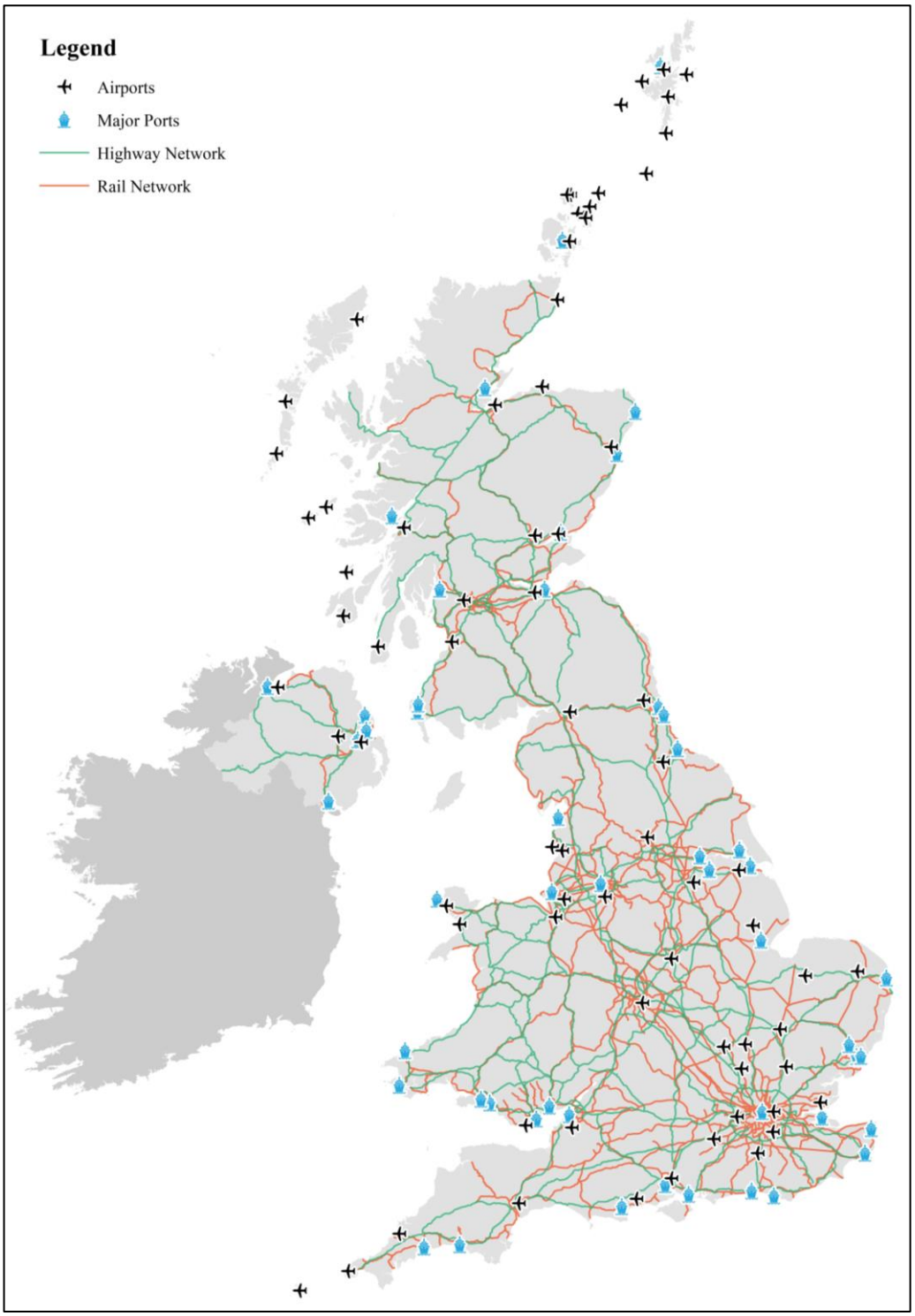
There is also a more localised level of connectivity where the economic geography of regions within the UK spans a number of nations. For example, North West England and North East Wales operate as part of a single economic region and labour market as does the South Wales and Bristol area. In these locations the need for enhanced connectivity between two nations may be more localised in nature but significant in terms of the potential impact it will have on meeting objectives in those economic regions. Recognising that connectivity within the UK works at these different levels is an important part of this review.

There is also a recognition that much of the planning around future transport networks takes place either at a modal transport agency level or by devolved administrations and there is consequently a need to look strategically across the whole of the UK and all modes of transport if the objectives outlined above are to be realised.

The UK has a dense and complex transport network made up of different modes of transport that perform at different levels ranging from very local linkages to strategic long-distance connections. The journeys that are made on the network also vary from work and education-based trips to leisure and family related journeys, with a mix of passenger and freight/servicing movements. The demand for travel on the network is influenced by a number of factors (with economic activity being the most significant). There are many existing national and modal networks which together comprise the overall UK transport network – a review of existing networks by mode in detail can be found in Appendix C. The shape of the overall transport network is outlined in Figure 5.

These multiple uses of the system make defining a strategic network, within this overall network, somewhat challenging. This section of the review attempts to do this by defining the aspects of the network that perform at the strategic UK level, and can therefore be justified as forming part of a Strategic Transport Network for the whole UK (UKNET).

Figure 5 – A map showing the modal constituents of the UK's overall transport network



Source – DfT (Highways England Strategic Road Network, Scotland Trunk Road Network, Wales Trunk Road Network, NI Key Road Corridors, GB Rail Network), Open Data NI (NI Rail Network), Arup Analysis (UK Airports, UK Major Sea Ports)

NB: All UK airports shown. Only Major Ports shown, as defined by DfT (handle at least 1 million tonnes of cargo annually). Some original shapefiles have been edited by Arup eg. the comprehensive NI road network shapefile provided was edited to show only the Key Road Corridors.

What constitutes 'strategic'?

In the assessment framework (Section 3), we outlined a series of objectives and an analytical framework for assessing options that can improve and facilitate a UKNET. Before considering gaps in the existing strategic network, and how the network needs to adapt to meet the challenges posed by future trends, we must identify the strategic transport network as it exists across the UK today.

The UK already has a strategic transport network that provides connectivity across the whole of the UK. This includes transport connections that provide a combination of some or all the following four key features.

1. **Direct linkages between major cities and economic regions in the UK**
   By road, rail and air – for passengers and freight – supporting greater economic activity.
2. **Connections to major sea and airports**
   Including the proposed UK freeports.
3. **Cross-border connections between single economic regions**
   Supporting regions which span two UK nations and provide critical access to shared labour markets and jobs.
4. **Essential connections to Irish and regional networks**
   Ensuring no region is 'left behind' and that the network connects into regional network across all four nations of the union as well as connecting the Island of Ireland to Great Britain.

The following sections consider analysis on each of the key features presented above to layer together the proposed existing UKNET based on current evidence.

4.1 Layer 1 – Links between major cities and economic regions

Links between major cities

Major cities and economic regions are hubs for business, employment & housing. Effective transport connections between these centres serve both passenger and freight flows: facilitating greater trade, enabling spill-overs of knowledge and skills, and enhancing productivity.

Figure 6 below outlines the UK urban areas with a population above 500,000 and over 250,000 employees according to 2019 statistics. An exception has been made to ensure all 4 capital cities of UK nations are included in the list of major cities. Together these major cities include a population of approximately 15 million—over 20% of the total UK population.

To enable strong economic connectivity across the country, it is essential that all of these major cities and economic regions are directly connected to one another through road, rail, and/or air links. Local and regional transport networks then provide feeder connections so that everyone in city regions can conveniently access the more strategic network.

Connections between the 11 largest UK cities listed in Figure 6 form the first of four layers of the current UKNET (shown in Figure 10).

Figure 6 – Major UK Cities[43]

Major Cities	Population Estimate (2019)	Employees Estimate (2019)
London	8,920,000	5,345,000
Birmingham	1,160,000	543,000
Glasgow	633,000	653,000
Liverpool	587,000	300,000
Bristol	577,000	317,000
Manchester	563,000	390,000
Sheffield	552,000	261,000
Edinburgh	525,000	405,000
Leeds	511,000	348,000
Cardiff* (11)	354,000	354,000
Belfast* (13)	289,000	230,000
		Indicates a capital city of a UK nation

Source – Arup Analysis, ONS, NISRA, NRS Data, 2019

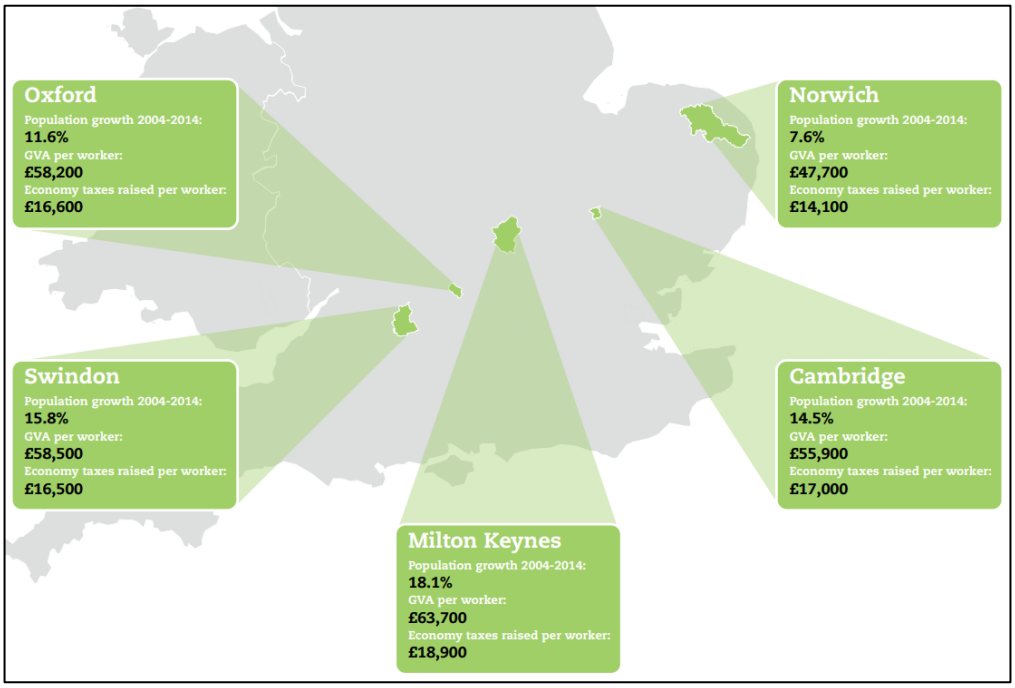
[43] Note: Population figures for UK cities are notoriously difficult to define and are often show with different local authority, combined authority, or regional boundaries. For the purposes of this report we have relied on the ONS classification of Major Towns and Cities (ONS Methodological Note and User Guidance)

Links between fast-growing cities

Outside of these major cities, the Centre for Cities has conducted extensive research and in 2016 identified a group of other 'Fast Growth UK Cities', including Norwich, Cambridge, Milton Keynes, Oxford and Swindon.

The cities, shown in Figure 7, are smaller in terms of population than the major cities but contribute significantly to overall UK economic performance. This is because of the nature of their local economies, the industries they attract and the broader role this has on UK economic output and inward investment.

Figure 7 – UK Fast Growth Cities



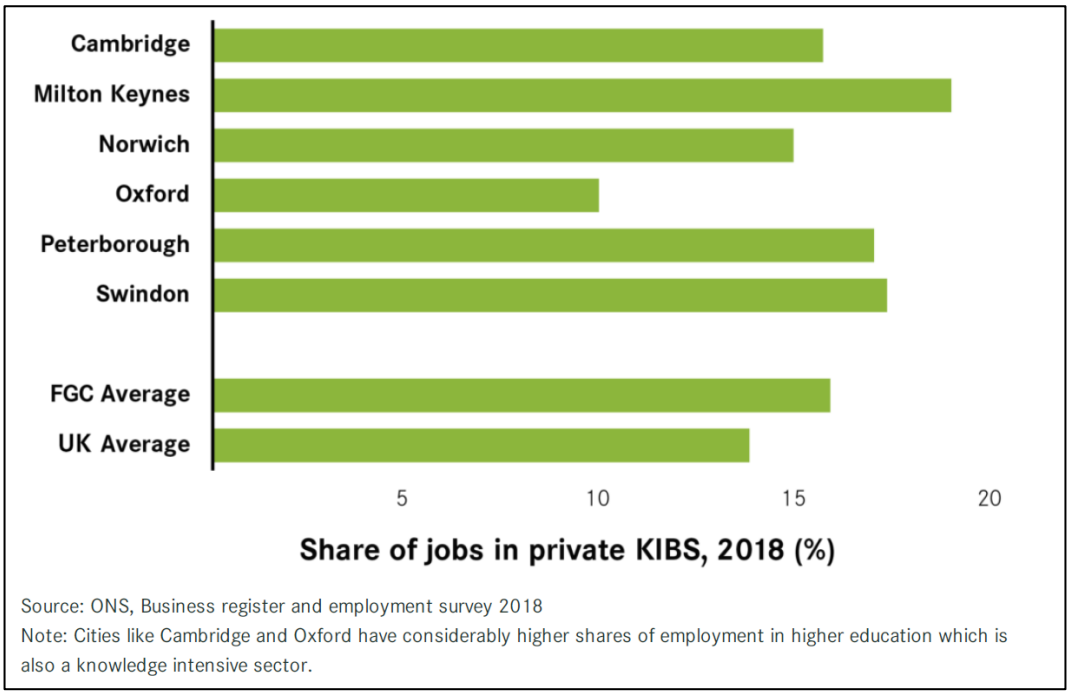
Source – Fast Growth Cities: The Opportunities and Challenges Ahead, Centre for Cities, 2016

In 2021, the Centre for Cities published an updated report, analysing the progress made and the challenges facing these Fast Growth Cities. Peterborough was added to the group of cities, having 'emerged as a city with increasing innovation dynamics and now among the 15 cities with the highest number of business start-ups and patents in the UK'.

The latest report further emphasises the strategic importance of these cities:

- In 2018 the Fast Growth Cities collectively accounted for 2.6% of national GDP despite being home to just 2% of national jobs.
- The Fast Growth Cities have high shares of jobs in private Knowledge Intensive Business Services (KIBS), as shown in Figure 8. These jobs are often in growing industries such as software engineering or research. Note that while the share of knowledge intensive jobs looks low in Oxford and (to a lesser extent) Cambridge, these figures exclude employment in higher education which is also a knowledge intensive sector.

Figure 8 – Share of jobs in private knowledge intensive business services (KIBS)

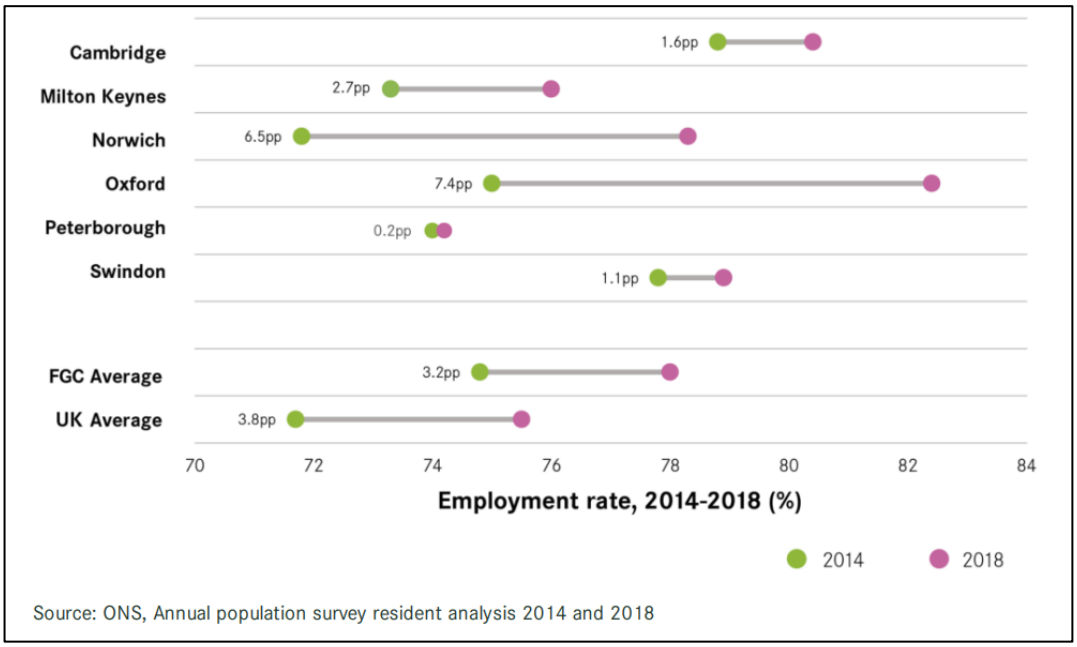


Source: ONS, Business register and employment survey 2018
Note: Cities like Cambridge and Oxford have considerably higher shares of employment in higher education which is also a knowledge intensive sector.

Source – Fast Growth Cities - 2021 and Beyond, 2021

- Nearly all of the Fast Growth Cities have very high (and fast growing) rates of employment, as shown in Figure 9. The growth in employment rate in Oxford and Norwich almost doubled the UK average from 2014 to 2018

Figure 9 – Percentage point change in the employment rate



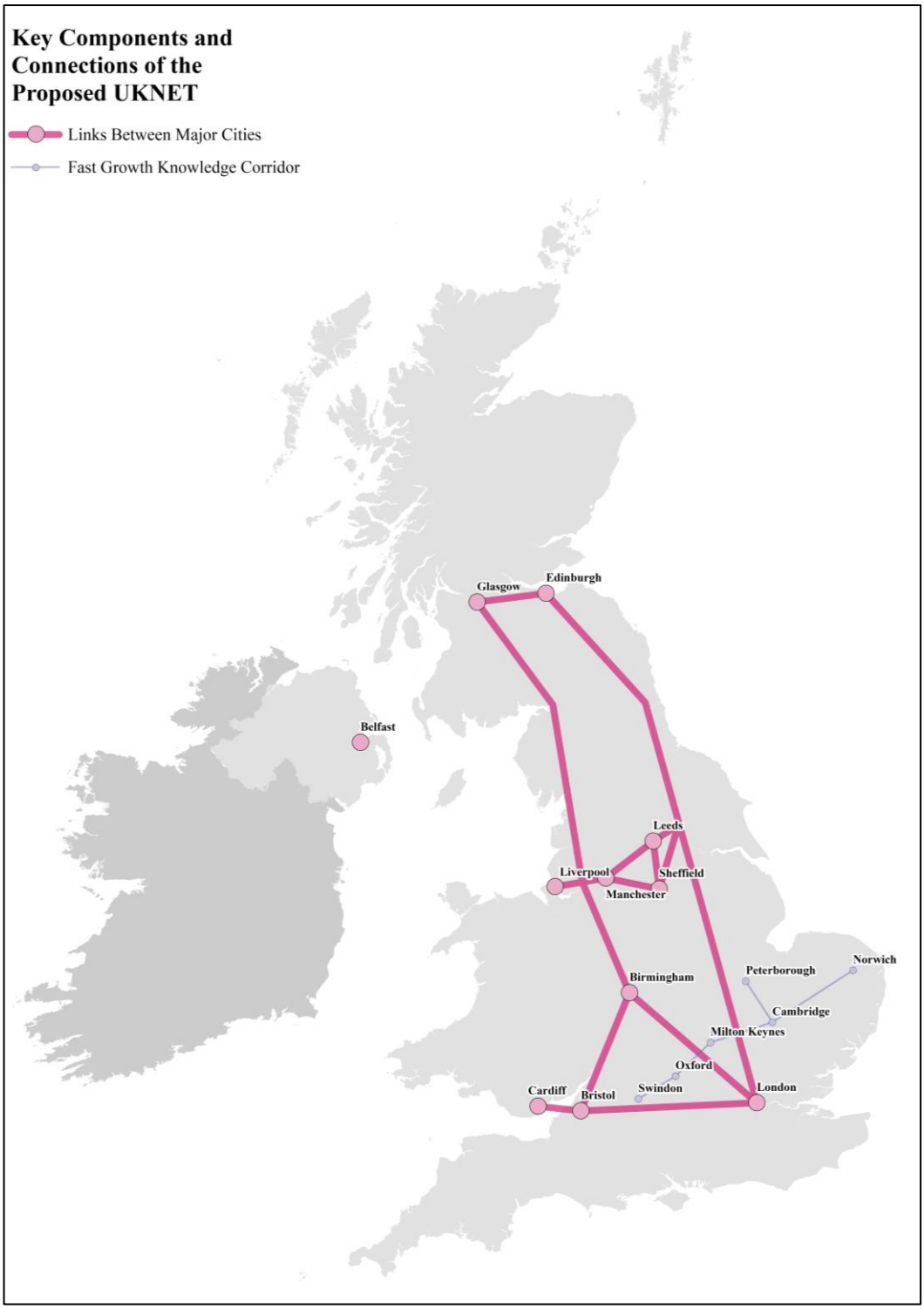
Source: ONS, Annual population survey resident analysis 2014 and 2018

Source – Fast Growth Cities - 2021 and Beyond, 2021

These cities form a corridor between Swindon and Norwich which we are terming the Fast Growth Knowledge Corridor. While not of strategic importance for cross-border connectivity, it is recognised as an increasingly important strategic corridor for the UK.

The map below begins to build up the UKNET by linking together the major cities of the UK, together with the Fast Growth Knowledge Corridor.

Figure 10 – Proposed UKNET Layer 1: Direct linkages between major cities and fast growth knowledge corridor



Source – Arup Analysis

4.2 Layer 2 – Connections to major air and seaports

4.2.1 Air

We suggest a definition of strategic airports that would include:

- major domestic and international passenger airports;
- major domestic and international freight airports; and
- airports serving capital cities of UK nations.

Major airports

2019 annual data indicates 13 UK airports with above 5 million passengers (10 in England, 2 in Scotland, and 1 in Northern Ireland). Together these airports account for over 90% of all UK passenger air traffic (international and domestic). These airports are listed in Figure 11. Cardiff Airport has also been added to this list to ensure airports serving the capital cities of all UK nations are represented.

Ten UK airports are responsible for 98% of all air freight volumes. There is significant crossover between the freight and passenger intensive airports (shown in Figure 11), with East Midlands International and Doncaster Sheffield airports featuring in the former but not the latter. In total the table below identifies 16 strategic airports across the UK.

Figure 11 – Strategic UK Airports based on passenger and freight volumes, 2019

Top 13 UK Passenger Airports + Cardiff		Top 10 UK Freight Airports + Cardiff	
Airport	**Annual pax (millions)**	**Airport**	**Annual freight (Tonnage 000s)**
Heathrow	80.9	**Heathrow**	1,587
Gatwick	46.6	**East Midlands**	336
Manchester	29.4	**Stansted**	224
Stansted	28.1	**Gatwick**	110
Luton	18.2	**Manchester**	108
Edinburgh	14.7	**Luton**	36
Birmingham	12.6	**Birmingham**	30
Bristol	9	**Belfast International**	25
Glasgow	8.8	**Edinburgh**	19
Belfast International	6.3	**Doncaster Sheffield**	18
Newcastle	5.2	**Cardiff**	2
London City	5.1		
Liverpool (John Lennon)	5		
Cardiff	1.6		

Highlighted box indicates an airport serving the capital city of the UK or a UK nation

Source – CAA Airport Data 2019, Table 01 and Table 13

While Figure 11 shows the key strategic airports from an overall (international and domestic) perspective, it is also important to consider the strategic

connections between regional UK airports and major global hubs such as Heathrow. Connections from regional airports into Heathrow (and to a lesser extent Manchester, Birmingham, Edinburgh, Glasgow and Gatwick) provide smaller airports with single-change connectivity to a range of international destinations.

The strategic airports listed in Figure 12 below are each responsible for transporting over 500,000 domestic passengers per year and have regular direct connections to major hub airports including Heathrow. Each of these airports provides direct connections within the UK that are not currently competitive in terms of journey time by other modes.

Figure 12 – Key domestic airports not included in the top airports listed in Figure 11 but which provide intra UK connections

Airport	Annual domestic passengers, 2019 (millions)
Belfast City	2.3
Aberdeen	1.5
Southampton	1.1
Inverness	0.8

Source – CAA Airport Data, Table 10.2, 2019

Together the major international and domestic airports combine to form a list of 20 strategic airports which have been included on the proposed UKNET.

Figure 13 – Summary of all airports included in the proposed UKNET

Airport	Nation	Airport	Nation
Aberdeen	Scotland	**Glasgow**	Scotland
Belfast City	Northern Ireland	**Heathrow**	England
Belfast International	Northern Ireland	**Inverness**	Scotland
Birmingham	England	**Liverpool (John Lennon)**	England
Bristol	England	**London City**	England
Cardiff	England	**Luton**	England
Doncaster Sheffield	England	**Manchester**	England
East Midlands	England	**Newcastle**	England
Edinburgh	Scotland	**Southampton**	England
Gatwick	England	**Stansted**	England

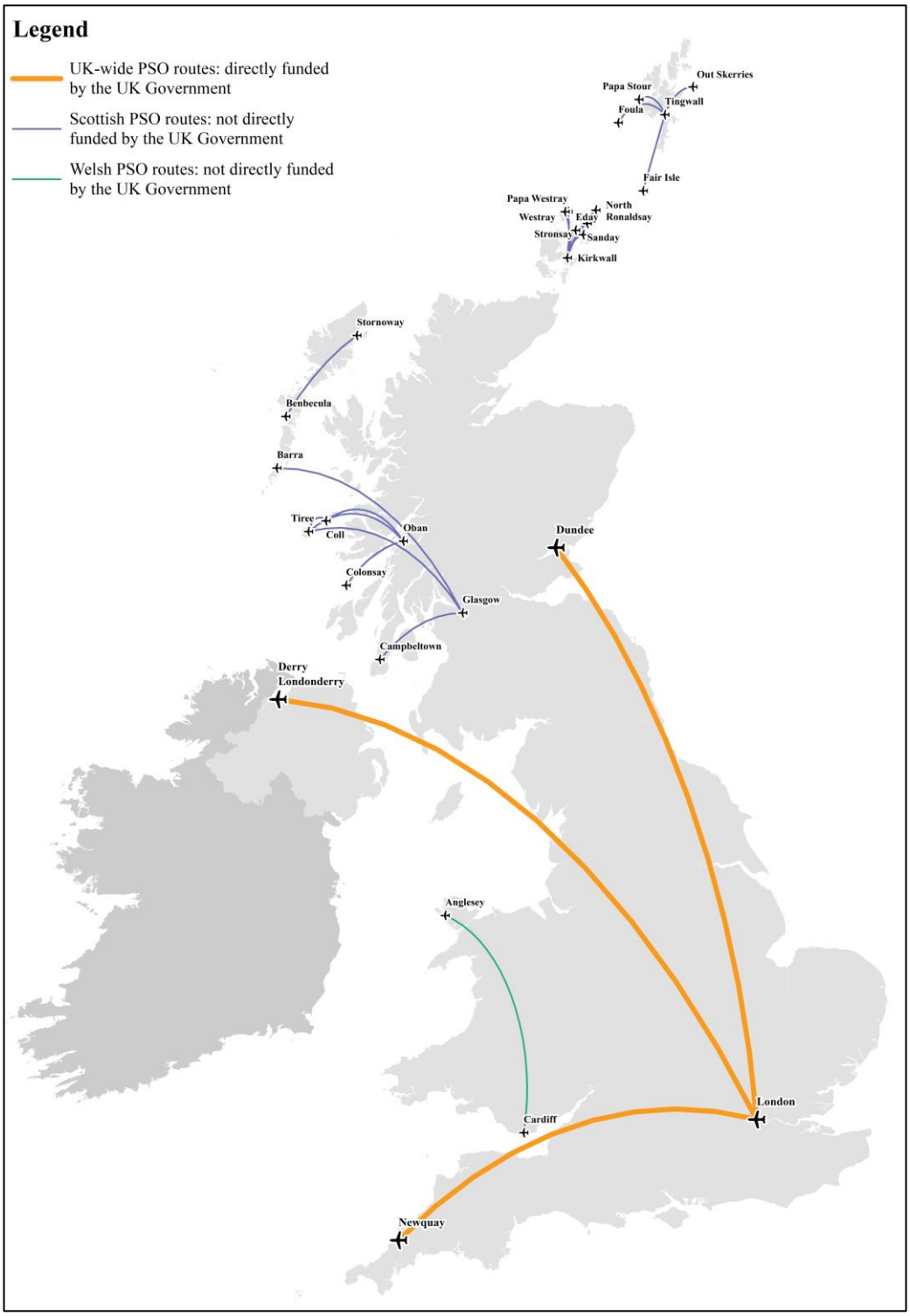
Source – Arup analysis

In the aviation sector the UK Government also directly subsidises three Public Service Obligation (PSO) routes. PSOs ensure that essential routes are served, where those routes are not commercially viable for private airlines, owing to low passenger volumes. Each of these three PSO routes connects to London (though the specific London airport is not specified), with the contract usually competitively tendered to airlines on a rolling basis.

There are a number of further regional PSO routes within Wales and Scotland which do not receive funding directly from the UK Government – they are funded and overseen by devolved administrations and/or local authorities. For instance, in Scotland, these include routes connecting the Scottish Islands to the Mainland of Scotland.

While these PSO routes are not proposed to be part of the UKNET, they are important for ensuring connectivity to the farthest reaches of the UK and are shown for completeness in Figure 14.

Figure 14 – PSO routes across the UK as of September 2019



Source – PSO Inventory table list of routes concerned, European Commission

Major air routes

Having defined the airports that are strategic to UK connectivity, it is important to assess the specific route flows between these strategic airports and their volumes. High volume routes tend to be associated with one or more of the following:

- the route connects two major cities;
- the route connects to/from a hub airport such as Heathrow, enabling interlining passengers to access international flights; and
- the route is not competitively served by other modes, owing either to physical barriers (eg. Great Britain - Northern Ireland routes) or very long distances (eg. Aberdeen/Inverness - London).

As in the previous tables, 2019 volume statistics from the Civil Aviation Authority have been used in the following table and maps since this is the most recent full year data unaffected by the Covid-19 pandemic. It therefore presents the best representation of the 'base-case'. However, there have been important developments since 2019 which must be borne in mind before drawing conclusions from the 2019 data, notably:

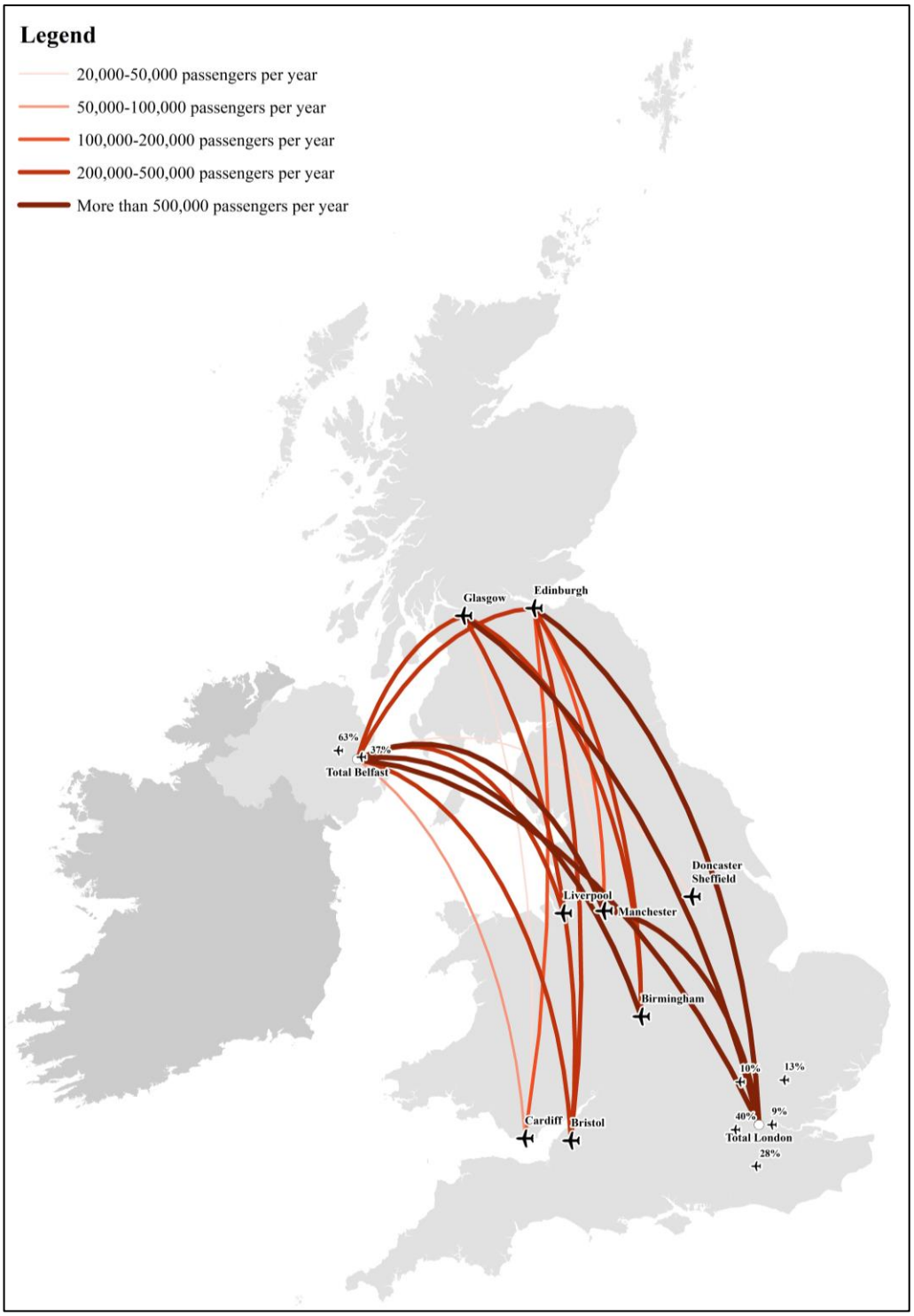
1. It is unclear when or if aviation demand will return to 2019 levels as the UK emerges from the Covid-19 pandemic.
2. Following the collapse of Flybe in 2020, there are several routes that operated in 2019 which are currently unfilled. The future of these routes, including Edinburgh - Manchester and Edinburgh - Cardiff, is unclear.

Figure 15 – Top fifteen domestic passenger air routes in 2019

	Airport 1	Airport 2	Total 2019 Passengers
1	Heathrow	Edinburgh	1,196,921
2	Heathrow	Glasgow	865,008
3	Gatwick	Edinburgh	731,793
4	Heathrow	Aberdeen	692,289
5	Heathrow	Belfast City (George Best)	668,575
6	Gatwick	Glasgow	641,566
7	Stansted	Edinburgh	618,628
8	Gatwick	Belfast International	581,909
9	Stansted	Belfast International	572,832
10	Heathrow	Manchester	554,201
11	London City	Edinburgh	513,360
12	Belfast International	Liverpool (John Lennon)	492,312
13	Belfast International	Manchester	470,260
14	Heathrow	Newcastle	461,804
15	Bristol	Edinburgh	396,911

Source – CAA Airport Data, Table 12.2, 2019

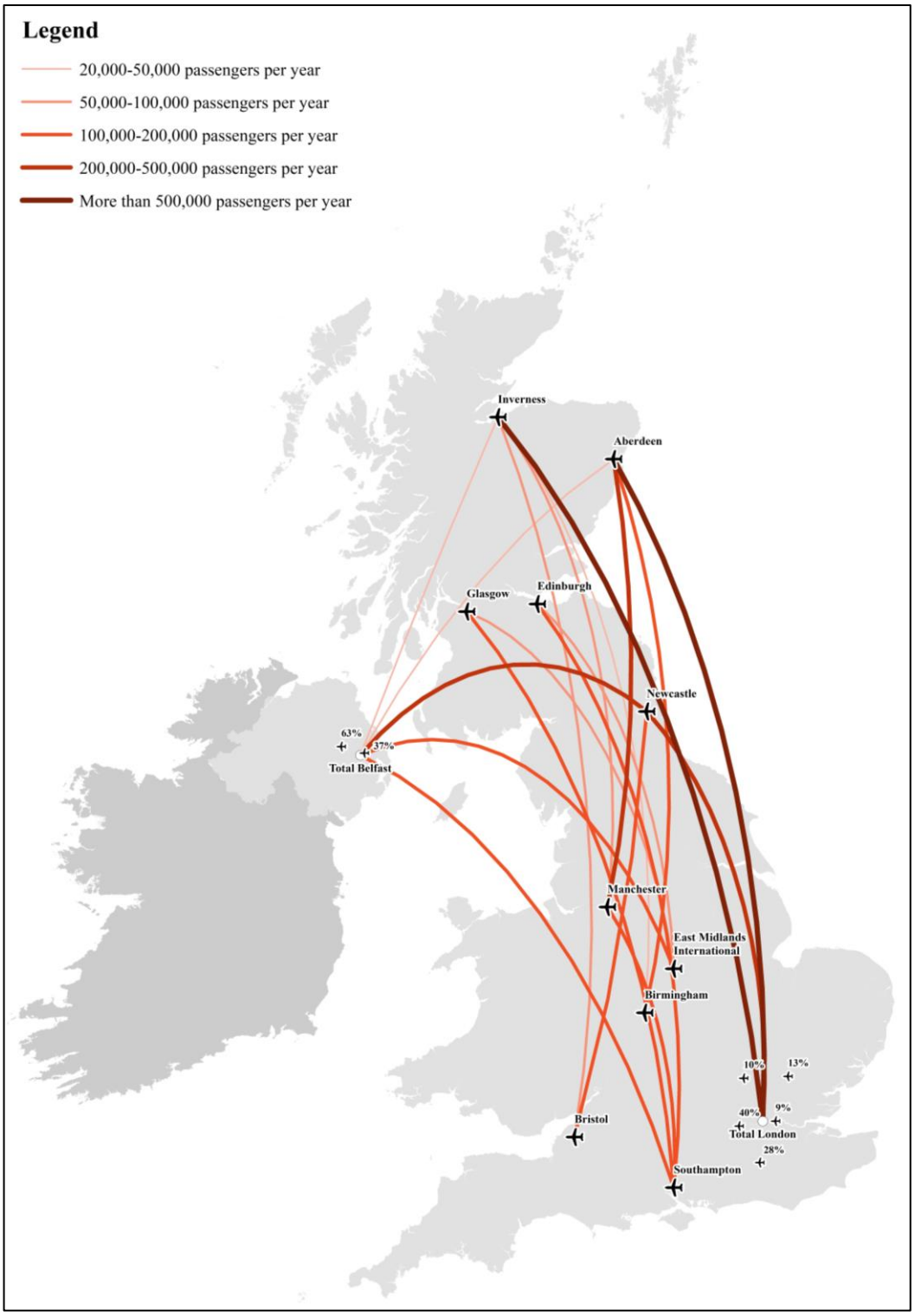
Figure 16 – Air passenger flows between airports that serve cities major cities (Layer 1 of the proposed UKNET)



Source – CAA Airport Data, Table 12.2, 2019

** London and Belfast demand is aggregated across the multiple strategic airports in those cities, with the percent overall distribution of domestic demand between airports shown on the map*

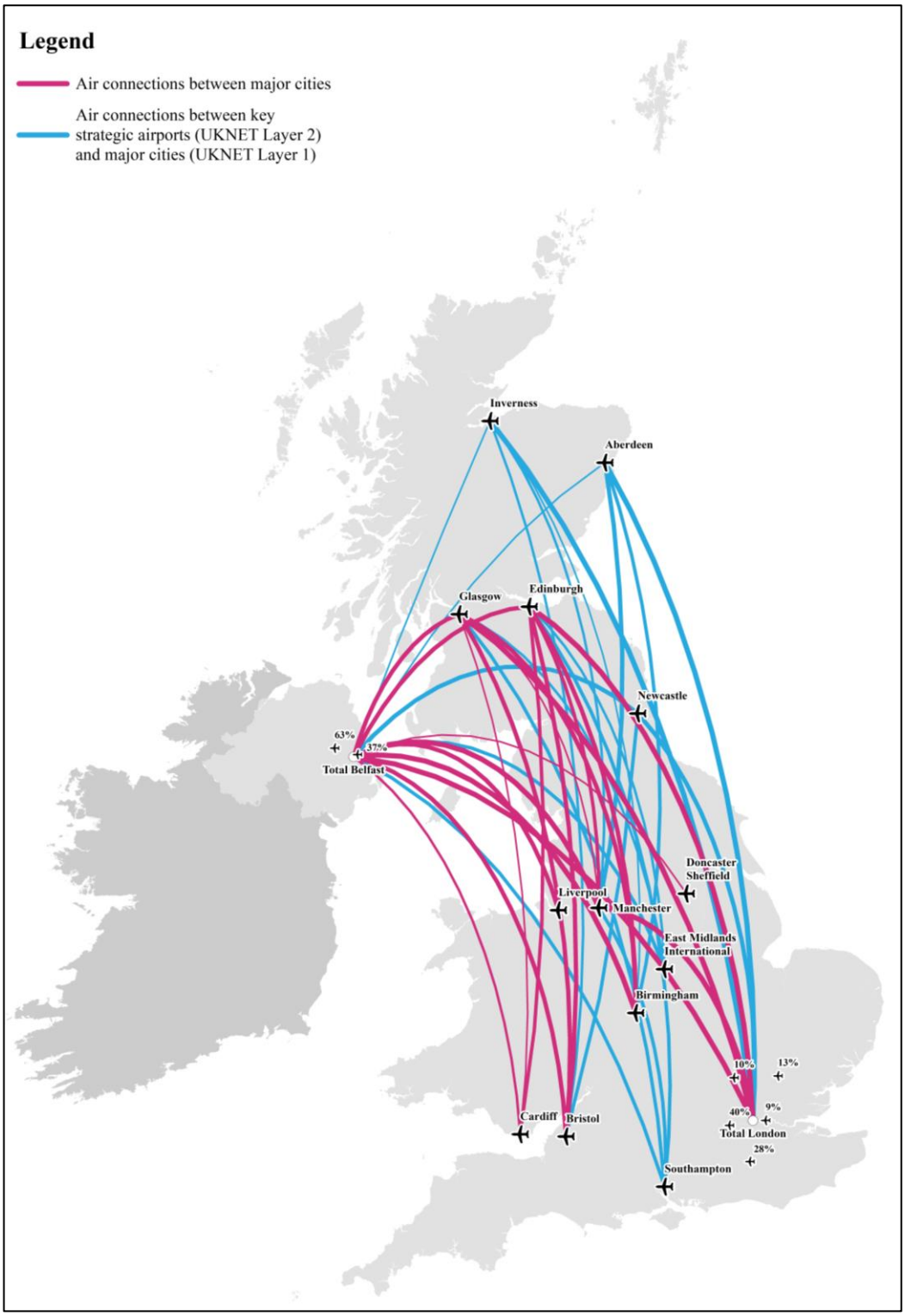
Figure 17 – Air passenger flows between key strategic airports (in Layer 2 of the proposed UKNET, not in major cities) and airports in major cities



Source – CAA Airport Data, Table 12.2, 2019

** London and Belfast demand is aggregated across the multiple strategic airports in those cities, with the percent overall distribution of domestic demand between airports shown on the map*

Figure 18 – Routes between strategic airports by category



Source – Arup Analysis, CAA Airport Data, Table 12.2, 2019

** London and Belfast demand is aggregated across the multiple strategic airports, with the overall distribution of domestic demand between airports shown on the map*

4.2.2 Sea

As an island nation, ports have always played a critical role in the connectivity, economic security, and prosperity of the UK. Fast and reliable access to major ports is crucial for both the domestic economy and international trade.

We suggest a definition of strategic sea ports that would include:

- major domestic and international passenger ports;
- major domestic and international freight ports; and
- freeports.

Major Sea Ports for Passengers and Freight

Maritime ports are essential for the transport of passengers and freight within the UK, and internationally. Similarly to airports, there is a concentration of activity in a key subset of UK seaports. There are 10 seaports which handle over 15 million tonnes of freight annually and together they account for approximately 70% of all maritime freight movements in the UK. These ports are listed in Figure 19, which also includes the top 5 international passenger sea routes. The top 5 international sea routes accounted for 14.4 million passengers in 2019 (78% of all UK international sea passengers).

Figure 19 – Strategic UK Seaports based on passenger and freight volumes

Top 5 Int'l Passenger Sea Routes		Top 10 UK Freight Seaports	
Seaport	**Annual passengers (millions)**	**Seaport**	**Annual freight (Tonnage millions)**
Dover - Calais	8.6	**Grimsby & Immingham**	54.1
Dover - Dunkirk	2.3	**London**	54
Holyhead - Dublin	1.9	**Milford Haven**	35
Portsmouth - Caen	0.9	**Liverpool**	34.3
Harwich - Hook of Holland	0.7	**Southampton**	33.2
		Tees and Hartlepool	28.2
		Felixstowe	25.3
		Forth (Edinburgh)	25.2
		Dover	23.4
		Belfast	18.5
		Indicates a seaport serving a capital city of a UK nation	

Source – DfT Data 2019, SPAS0101 and PORT0101

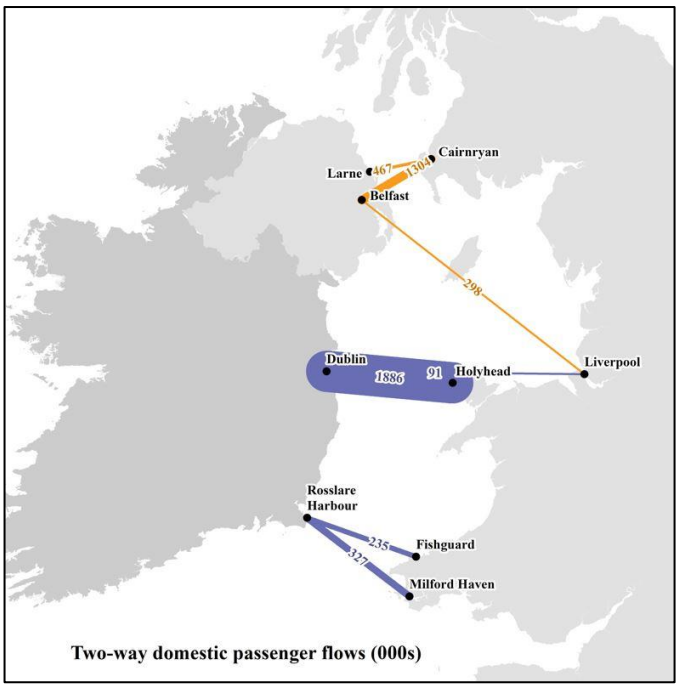
Major Sea Routes for Passengers and Freight

Domestic sea connections are of strategic importance for connecting Northern Ireland with the rest of the UK. As shown in Figure 20, there are three domestic Irish Sea routes that carry passengers between Great Britain and Northern Ireland:

between Cairnryan (Loch Ryan Port) and Belfast, between Cairnryan (Cainryan Port) and Larne, and between Liverpool and Belfast. The route between Cairnryan (Loch Ryan Port) and Belfast dominates with more than double the passenger numbers of any other domestic Irish Sea route.

We have also reviewed and analysed confidential data on freight volumes for maritime routes across the Irish Sea. While this data cannot be reproduced here, this data confirms that the same three routes are also the key domestic routes across the Irish Sea for freight, further emphasising their strategic importance.

Figure 20 – Domestic passenger flows using routes across the Irish Sea



Source – DfT data tables SPAS0102 and SPAS0201

Government Freeports Commitment

Further emphasising the important role of UK ports, in the March 2021 Budget, the Chancellor announced the locations of eight new freeports in England. Common features of freeports include various concessions on customs, other tax and planning advantages and reduced bureaucracy—together these features help support the growth of maritime trade, but also local, regional, and national economies.[44]

The eight identified freeports include:

- Felixstowe and Harwich;
- Humber region;
- Liverpool City region;
- Plymouth;

[44] https://commonslibrary.parliament.uk/research-briefings/cbp-8823/

- Solent;
- Thames;
- Teesside; and
- East Midlands Airport .

Of these freeports, only Plymouth qualifies as a strategic port on the basis of its freeport status alone. Each of the others would be included as strategic regardless of freeport status by virtue of the volumes of freight handled.

4.2.3 Surface Freight Hubs

In addition to sea ports and airports, surface freight hubs are also important strategic centres which must be included within the UKNET. Connectivity of surface freight is increasingly important to UK productivity; efficient supply chains are crucial in delivering economic growth and attracting investment to the UK.

The 'Golden Triangle' of national distribution centres spans between Nottingham, Bedford and Birmingham. Located in the geographical heart of Great Britain, RCS logistics indicate that distributors can access over 90% of the UK population within a 4-hour drive, and that the Midlands has more than twice the combined warehousing activity of London, Scotland and Wales[45]. Excellent road and rail links, both to the remainder of the UK and to international gateways, is directly linked to the thriving of distributors in the 'Golden Triangle'.

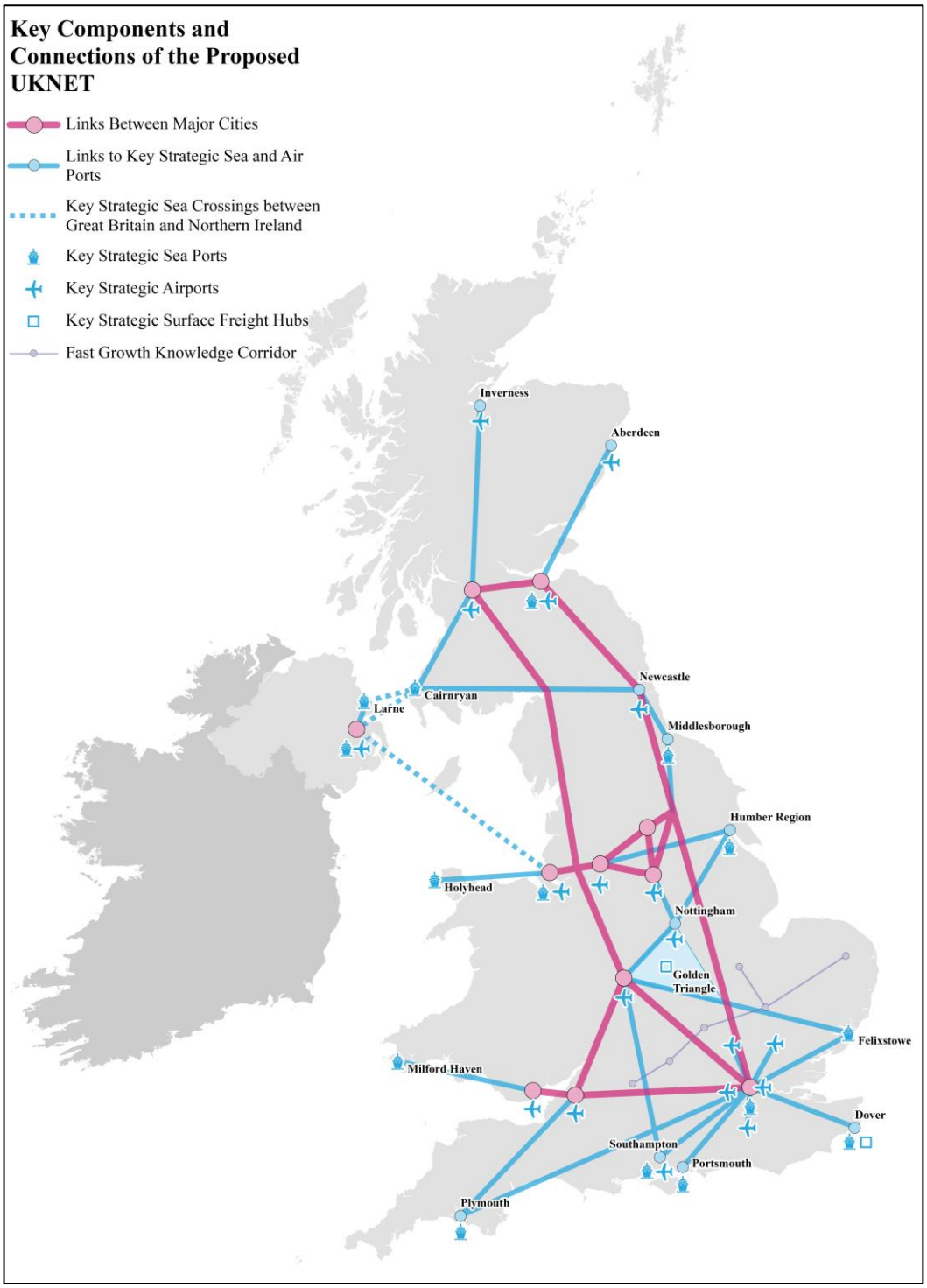
The Channel Tunnel is another particularly important surface freight hub. Almost 1.6 million freight vehicles used this link to cross between Folkestone and Calais in 2019[46], forming an essential international freight path. Dover is already included in the UKNET owing to the volume of maritime freight and passengers which it handles, but its additional significance as a strategic surface freight hub should be recognised.

4.2.4 Summary

Having defined which UK sea and airports are strategic to connectivity of the UK through this section, connections to these ports are added as the second layer of the current UKNET. These links to key strategic sea and airports are shown in blue in Figure 21.

[45] The Golden Triangle of Logistics, RCS Logistics, http://www.rcslogistics.co.uk/blog-and-news/golden-triangle/2935
[46] Table TSGB0607 (RAI0108) *Channel Tunnel: traffic to and from Europe, annual from 1994*, Department for Transport, 2020

Figure 21 – Proposed UKNET Layer 2: Connections to strategic sea and airports



Source – Arup Analysis

**Belfast City (George Best) Airport and Belfast International Airport are not both shown, to avoid overcrowding this schematic map*

4.3 Layer 3 – Cross-border connections

For our definition of the UKNET we consider cross-border areas where the local economies of areas either side of the border are

- significant at a UK scale; and
- connected with a high degree of interdependency.

This is often because of (relatively) large populations, geographical proximity and existing transport links that facilitate journey to work catchments across the border. It is important to consider the connectivity of these regions from a UK perspective to ensure the borders between UK nations do not create any undue artificial restrictions or limitations on connectivity that could limit economic growth and productivity in these areas.

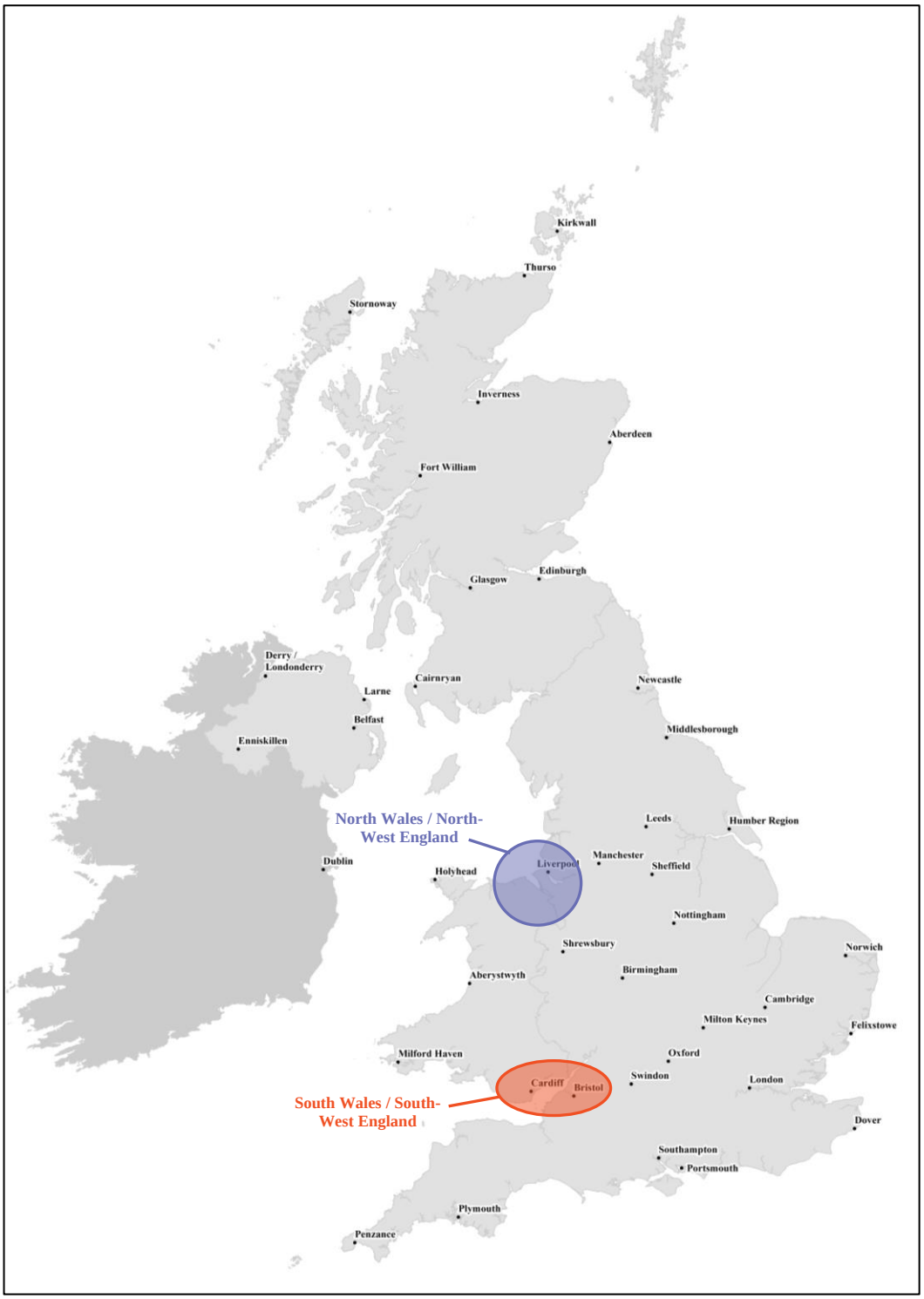
Two areas have been identified that meet these criteria for strategic cross-border economic regions within the UK:

- North Wales and North-West England; and
- South Wales and South-West England

While cross-border travel between Scotland and England is of critical strategic importance for the connectivity of the UK, the Scottish/English Borderlands region does not have the density of economic activity or quantity of local cross-border commuting flows to be considered a strategic cross-border economic region.

The strategic cross-border economic regions are shown in Figure 22 overleaf and each discussed in more detail on the pages that follow.

Figure 22 – UK Cross-Border Economic Regions



Source – Arup Analysis

4.3.1 North Wales / North-West England

There is significant economic interaction across the border in terms of commuting and labour market catchments. For example, 25% of employees in this region cross the England-Wales border for work according to data from the 2011 census.[47]

The following maps illustrate the area of North West England and North Wales in terms of population density (Figure 24) and transport accessibility (Figure 25). The key centres of population in this area are Liverpool and Chester in England and Wrexham in Wales.

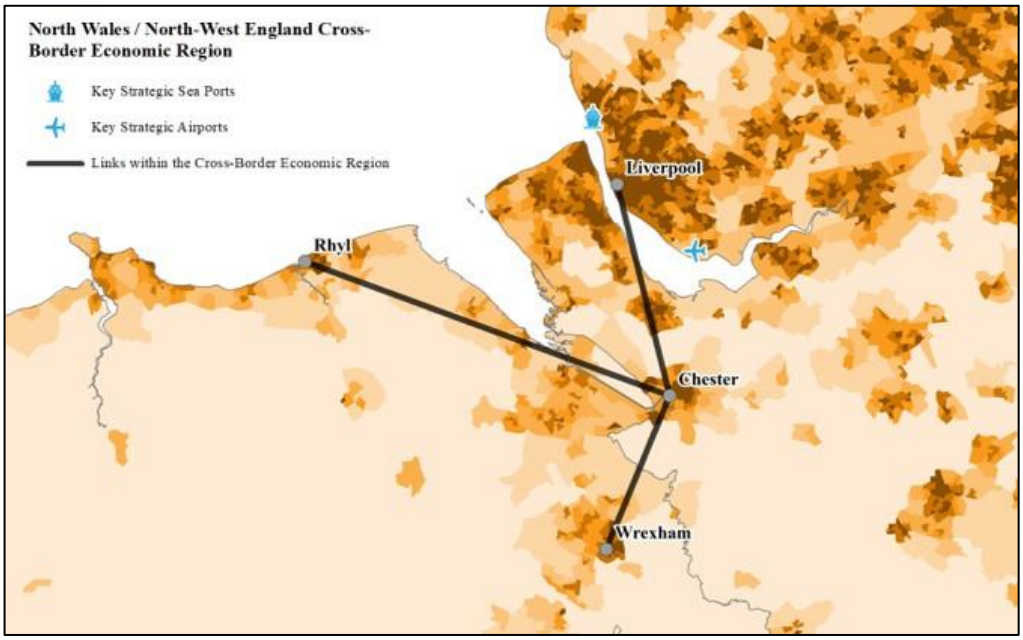
The table below highlights the expected peak-hour typical travel time between key centres of population in this region by both private vehicle and public transport.

Figure 23 – Travel time estimates between key population centres in North Wales and North-West England

Key population centres	Private Vehicle Travel Time	Public Transport Travel Time
Liverpool - Wrexham	51 - 60 mins	69 - 93 mins
Liverpool - Chester	39 - 41 mins	51 mins
Chester - Wrexham	25-30 mins	18 mins

Source – Travel Time API, Arup Analysis 2021

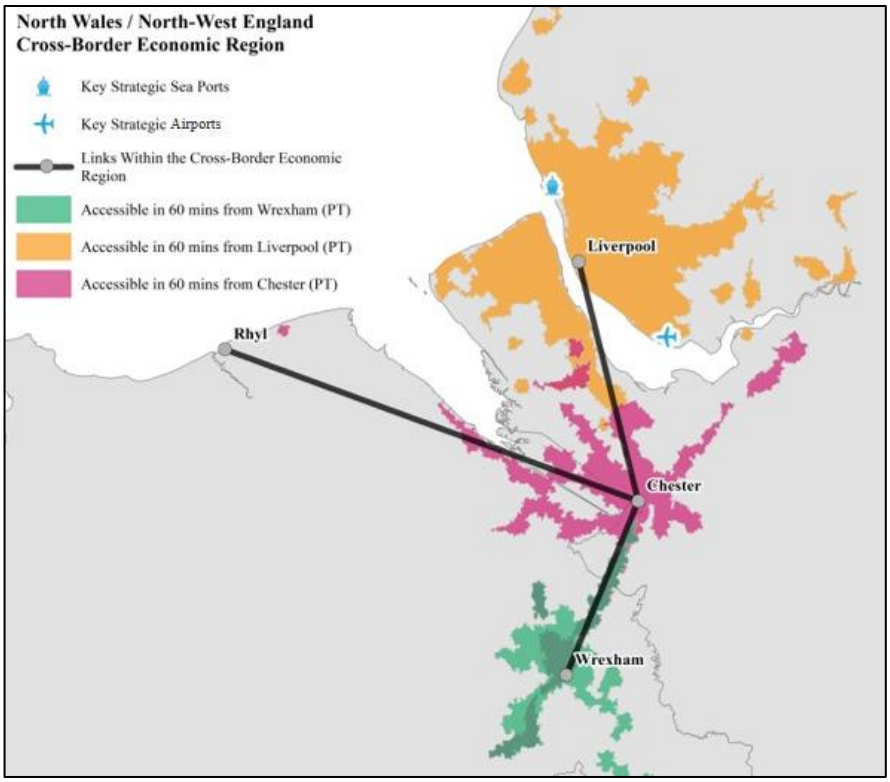
Figure 24 – Schematic links in the North Wales / North-West England cross-border region on population density, 2019



Source – Annual Population Survey, 2019

[47] WU01UK Table Census, 2011 (Local Authorities included: Liverpool, Cheshire West and Chester, Wirral, Flintshire, Wrexham)

Figure 25 – Public transport accessibility in the North Wales / North-West England cross-border region



Source – Travel Time API, Arup Analysis

Access from North Wales to international gateways is economically important for people and businesses, in particular Manchester Airport. However, western access to Manchester Airport is limited by public transport, with better car journey time comparisons. As the maps below show, by public transport it is not possible to reach North Wales from Manchester Airport within 1.5 hours, a distance of 40 miles. Below journey time and distance comparisons have been highlighted for both Manchester and Liverpool airports from economic centres in North Wales. This clearly shows a large variation in journey times by public transport than by private vehicle.

Figure 26 – Distances and journey times by private and public transport to Manchester airport

To Manchester Airport			
From economic centre	Private Vehicle Travel Time (hrs)	Public Transport Travel Time (hrs)	Distance
Holyhead	1:50 – 2:20	3:08 – 3:18	112 miles
Llandudno Junction	1:10 – 1:30	2:45 – 2:54	73 miles
Wrexham	0:45 – 1:00	2:16 – 2:37	46 miles
Chester	0:35 – 0:45	1:37 – 1:58	33 miles

Figure 27 – Distances and journey times by private and public transport to Liverpool Airport

To Liverpool Airport			
From economic centre	Private Vehicle Travel Time (hrs)	Public Transport Travel Time (hrs)	Distance
Holyhead	1:50 – 2:20	3:09 – 3:42	103 miles
Llandudno Junction	1:05 – 1:30	2:49 - 2:51	65 miles
Wrexham	0:40 – 1:00	2:02 – 2:04	37 miles
Chester	0:30 – 0:45	1:10 – 1:33	24 miles

**assumes leaving at 12:00 on Monday – Source – Google*

Journey times from North Wales to Liverpool Airport, and Liverpool by rail have been improved through the re-opening of the Halton Curve, currently allowing an hourly service from Chester – Liverpool, with plans to extend this beyond Chester to North Wales. For rail journeys from North Wales to Manchester Airport, there is an hourly service, however it fails to compete with private vehicles. In the future, a mobility option such as coach from Chester to Manchester Airport could be considered.

4.3.2 South Wales / South-West England

The following maps illustrate the area of South West England and South Wales in terms of population density (Figure 29), and transport accessibility (Figure 30). The key centres of population in this area are Cardiff and Newport in Wales and Bristol in England.

There is a relatively large population on both sides of the border with the Welsh side of the border including the capital, Cardiff. There is significant interaction across the border both in terms of people movement but also freight movements. Data from the 2011 census suggests that 2% of all employees in the South-West England and South Wales region commute across the border for regular employment.[48]

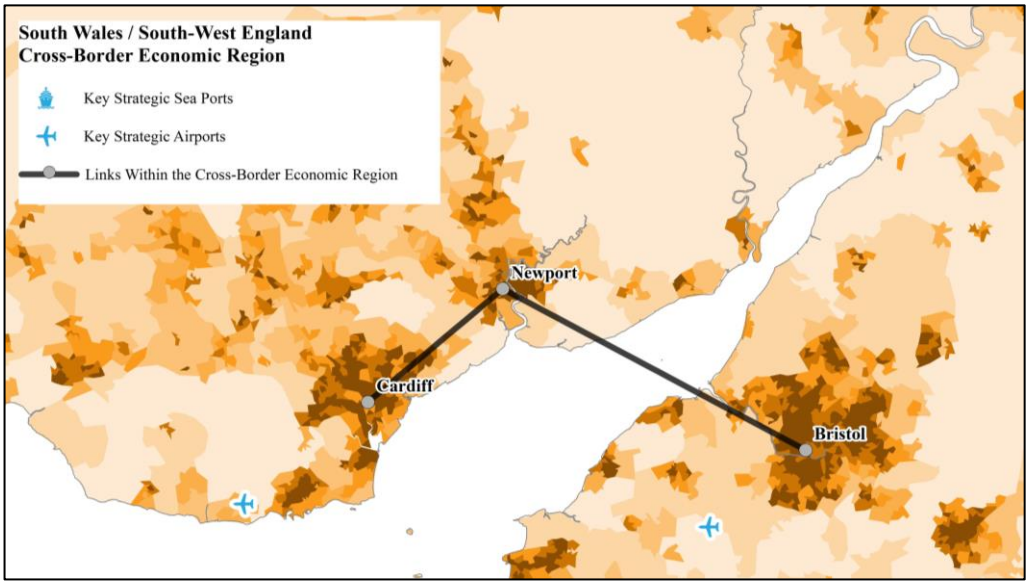
The table below highlights the expected peak-hour typical travel time between key centres of population in this region by both private vehicle and public transport.

Figure 28 – Travel time estimates between key population centres South-West England and South Wales

Key population centres	Private Vehicle Travel Time	Public Transport Travel Time
Bristol ↔ Newport	41 - 55 mins	30 mins
Bristol ↔ Cardiff	66 - 76 mins	44 - 56 mins
Cardiff ↔ Newport	35 - 40 mins	10 - 15 mins

Source – Travel Time API, Arup Analysis 2021

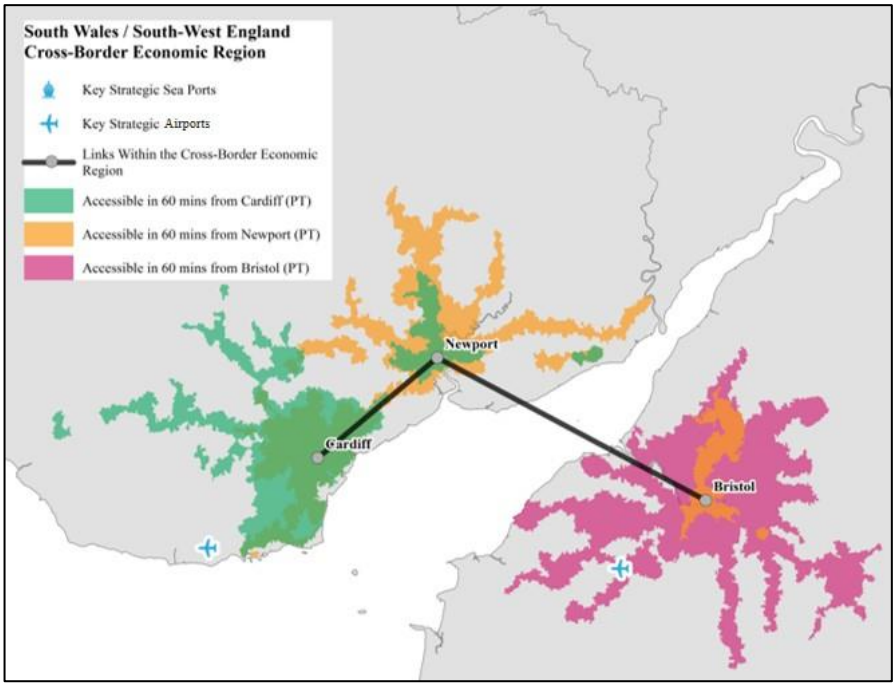
Figure 29 – Schematic links in the South Wales / South-West England cross-border region on population density, 2019



Source – Annual Population Survey, 2019

[48] WU01UK Table Census, 2011 (Local Authorities included: Bristol, South Gloucestershire, Cardiff, Newport, Monmouthshire)

Figure 30 – Public transport accessibility in the South Wales / South-West England cross-border region



Source – Travel Time API, Arup Analysis

4.3.3 The Scottish/English Borderlands

The Scottish/English Borderlands was not considered to have the density of economic activity or quantity of local cross-border commuting flows to be considered a strategic cross-border economic region.

The population is much less dense in this area then either of the other two cross-border regions (Figure 31). The population of the region is roughly 1 million, and the area comprises roughly 10% of the UK land mass, making it a predominantly rural region.[49]

Figure 31 – Scottish/English Borderlands population density, 2019

Source – Annual Population Survey, 2019

[49] Borderlands Growth Deal Heads of Terms, 2019

4.4 Layer 4 – Connections to Irish and regional networks

4.4.1 Connections to regional networks

While the population and economic activity of the UK is concentrated in major cities and towns across the country, there remain several regions that are more geographically isolated from the rest of the UK, either by land or by sea. To ensure a UKNET is able to meet the objectives of this review, including the need to address social and economic equalities across the UK with no area left behind, the geographically remote areas of the country must be connected into the UKNET either via road, rail, air or sea. These connections are important for several reasons including social cohesion, economic development and tourism.

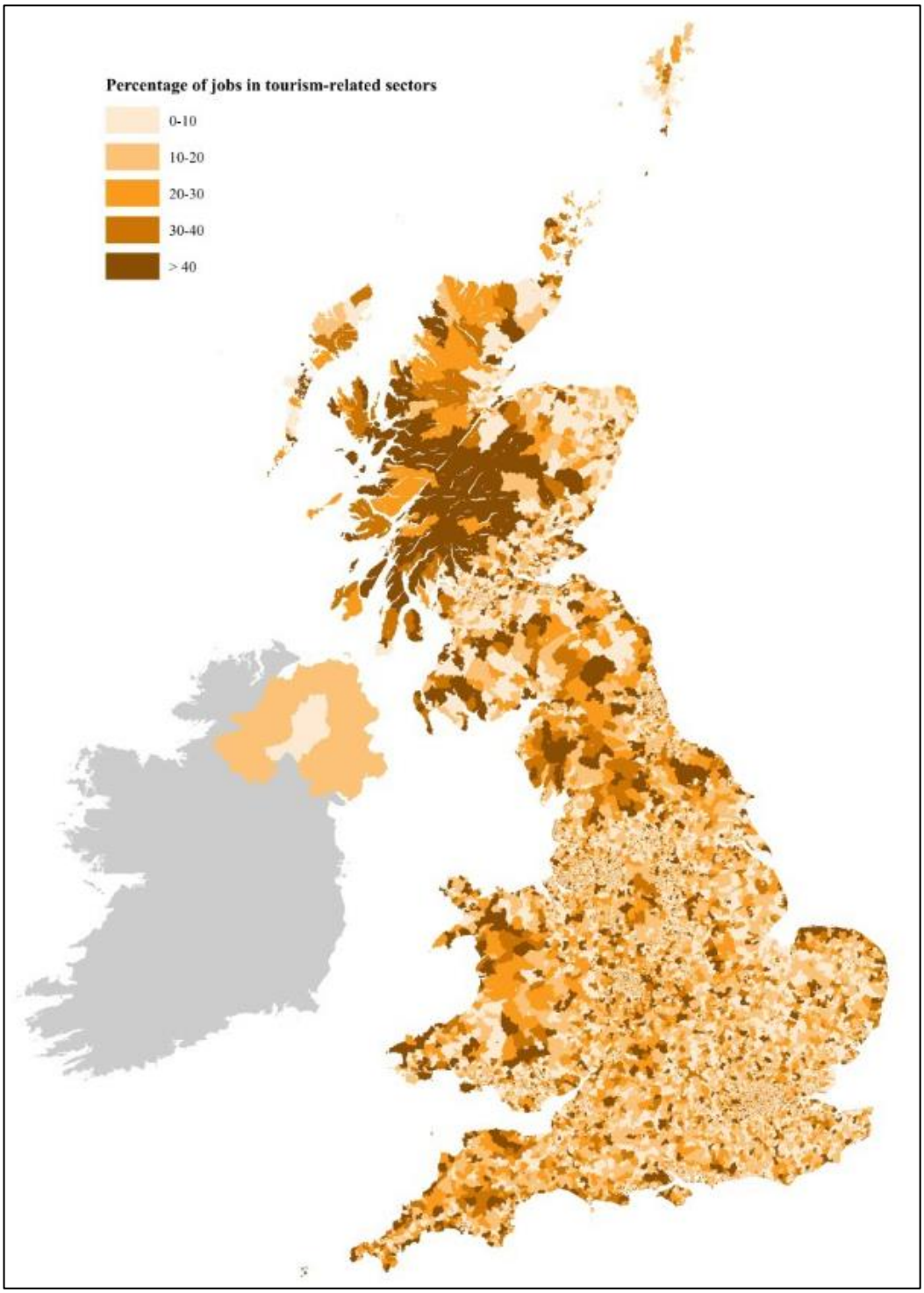
Figure 32 highlights areas of the UK which have a high proportion of jobs in tourism-related industries. That is to say, these regions are particularly economically reliant on tourism and the transport links that enable tourism. Being connected to the UKNET is of high importance to employment and economic performance in these regions.

Four remote regions particularly stand out in this category.

1. The north Pennines and English Lake District, which are served by existing strategic transport links highlighted earlier in this chapter.
2. The South West of England, west of Plymouth.
3. Mid Wales, from Shrewsbury to Aberystwyth.
4. The Highlands and Islands of Scotland.

Within Northern Ireland, there are many areas where the populations, economic activity and sea/air port volumes are not high enough to meet the criteria to be deemed ‘strategic’. This includes large centres such as Londonderry/Derry and Enniskillen. It is essential for the connectivity and economic performance of Northern Ireland that these smaller areas have excellent access to the UKNET.

Figure 32 – Percentage of Jobs in Tourism Related Sectors, 2019



Source – BRES Data, 2019 Includes jobs in SIC sectors H, I, and R.

Figure 33 shows these regional networks in addition to the UKNET already defined. The new links are shown in grey, symbolising that these regional networks are not themselves part of the UKNET but are vital in ensuring all regions of the country are able to access the strategic network, and thus vital for fulfilling the objectives of this review.

4.4.2 International connections through the Republic of Ireland

The transport geography of the UK is such that many domestic trips between Great Britain and Northern Ireland pass through the Republic of Ireland. As such, the transport infrastructure within the Republic of Ireland plays a role in UK connectivity whilst being outside of the jurisdiction of the UK government.

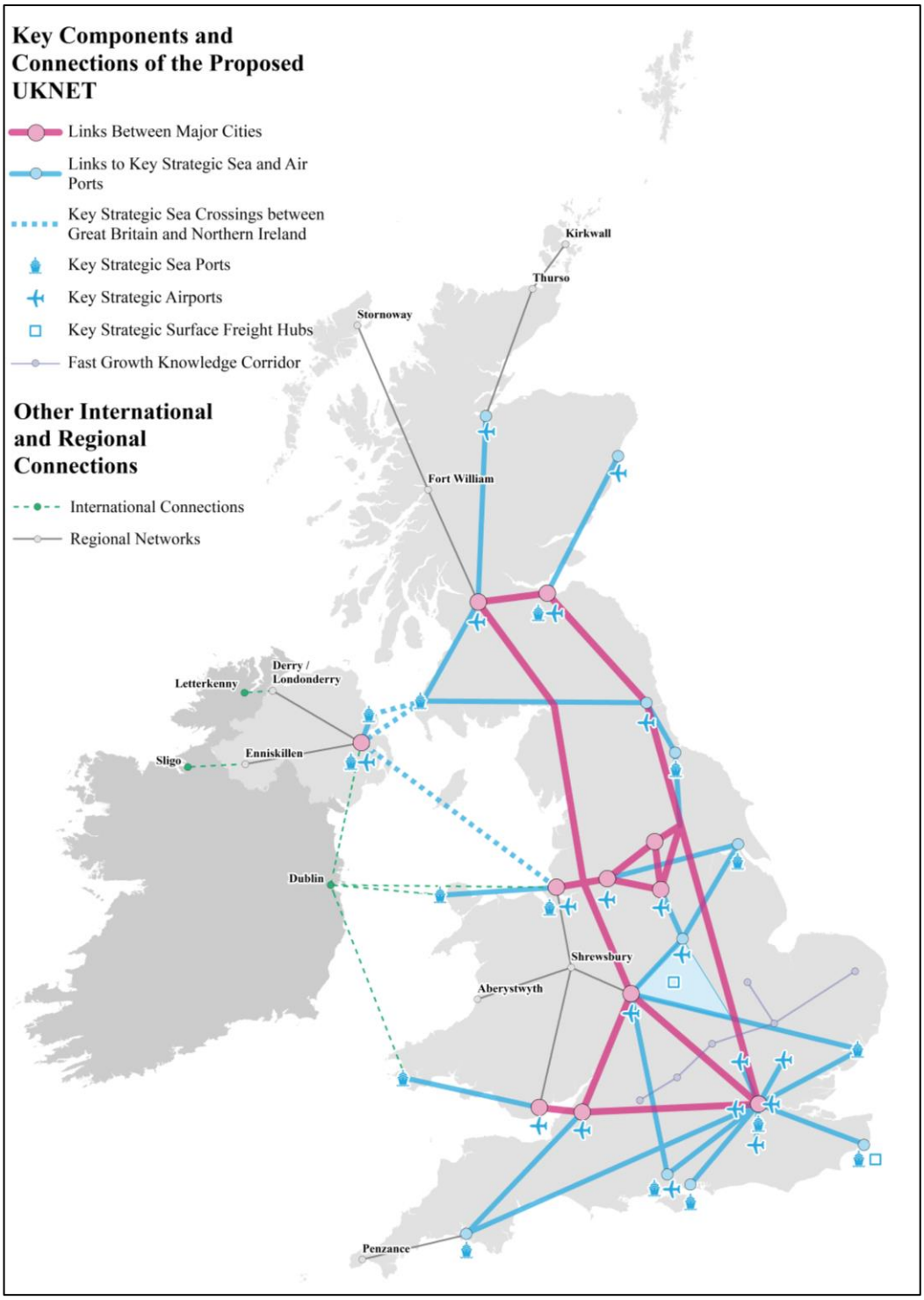
As Figure 20 shows, there are significant flows between Liverpool/Holyhead and Dublin. Confidential data which this Review has analysed emphasises the importance of these connections for freight, and additionally the freight connection between Milford Haven and Dublin. Some of these trips have their eventual destination (or origin) in Northern Ireland, meaning that it is important to UK connectivity that these routes are well served. They play an important role in connecting communities and businesses in north west England and Wales to Northern Ireland. These links also provide connectivity to a key neighbour and major trading partner in the Republic of Ireland.

Key cross-border land connections have also been included on the map between Northern Ireland and the Republic of Ireland (Derry / Londonderry – Letterkenny, Enniskillen – Sligo, Belfast – Dublin), recognising their strategic importance to UK connectivity. Of the estimated 110 million crossings of the NI–ROI border each year, 60% of them take place through the western and southern ends of this border at Derry / Londonderry and Newry (South of Belfast).[50]

Given that these connections are not wholly within the UK, they are not included as part of the UKNET. Improvement to these connections does not sit fully within the remit of UK or devolved governments.

[50] The movement of people across the Northern Ireland - Republic of Ireland border, Research Bulletin 18/5, Department for the Economy (2018): https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Research-Bulletin-18-5-Cross-Border-Movements-Research-Article.pdf

Figure 33 – Proposed UKNET Layer 3: Regional networks and international connections through the Republic of Ireland

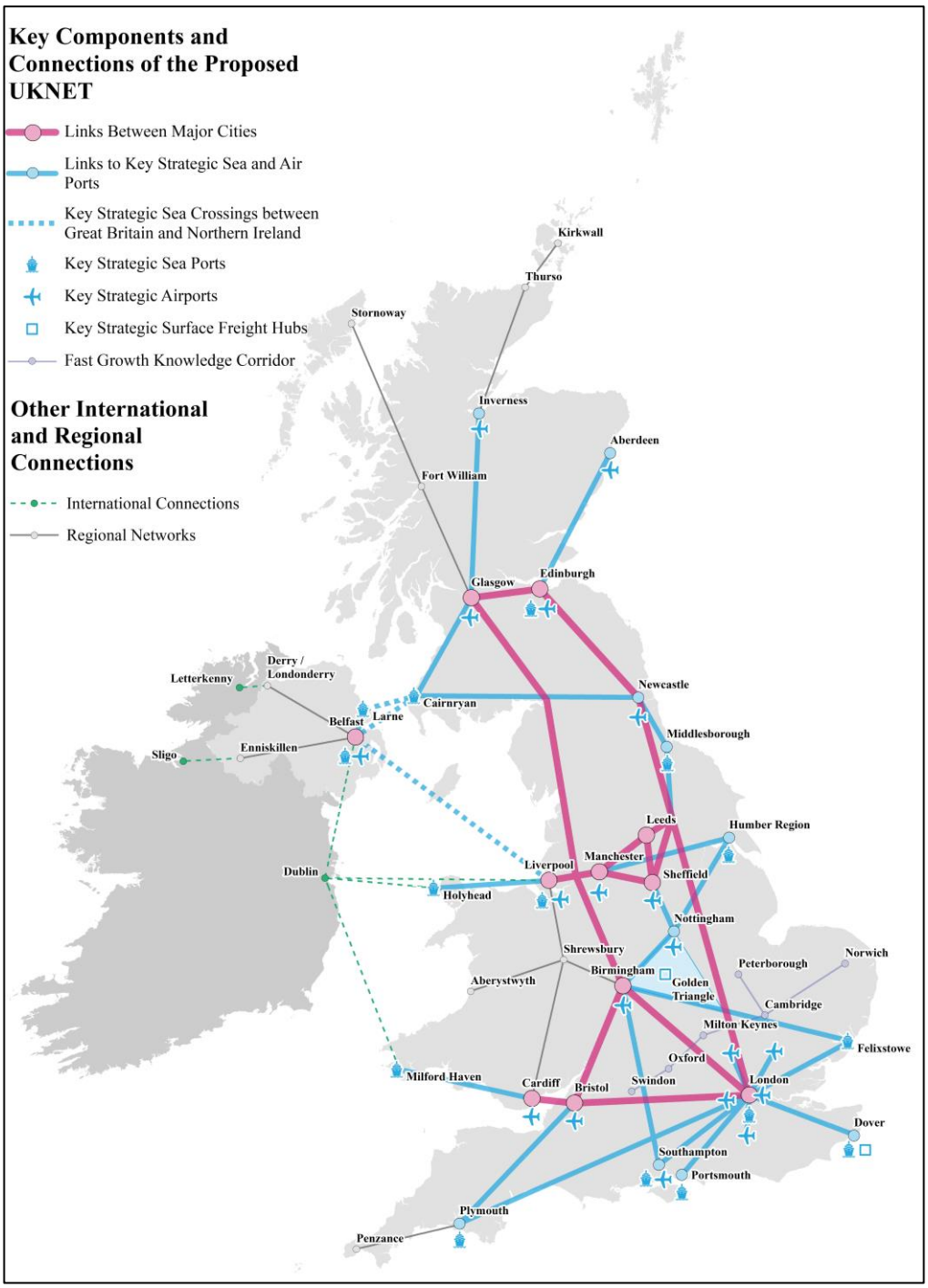


Source – Arup Analysis

4.5 The Proposed UKNET

Based on this section, Figure 34 displays the complete proposed Strategic Transport Network for the whole UK that has been built up in layers over the course of this chapter.

Figure 34 – A schematic representation of the proposed UKNET



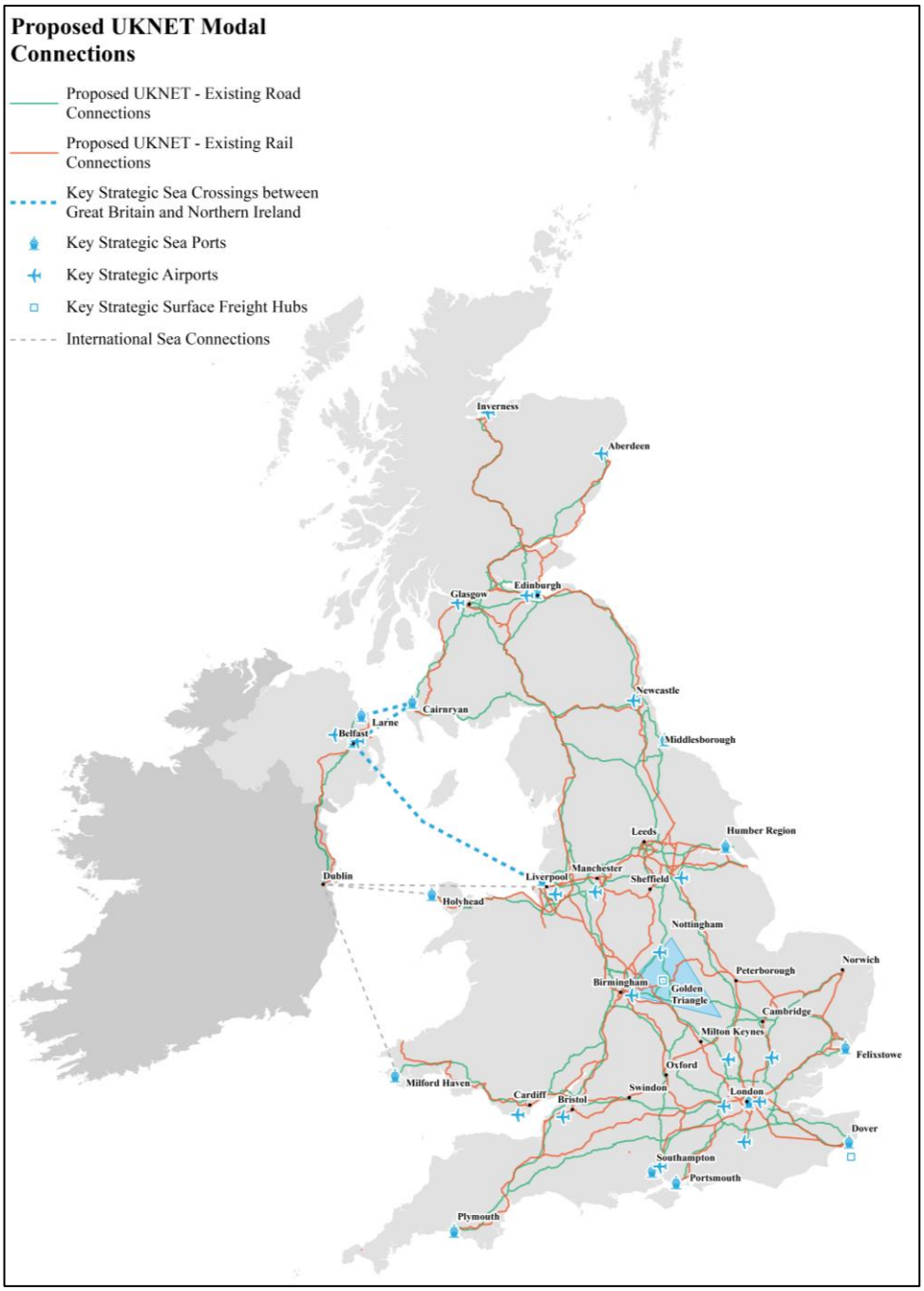
Source – Arup Analysis

**Belfast City (George Best) Airport and Belfast International Airport are not both shown, to avoid overcrowding this schematic map*

From this schematic representation, we can consider which elements of the existing national road and rail infrastructure form the connections between cities, ports, and towns identified as essential for the UKNET. Figure 35 shows the existing modal connections on the proposed UKNET.

Note that this is a proposed version of the modal network. Our understanding is that the UK Government will define the final UKNET after undertaking further work.

Figure 35 – The existing modal connections on the proposed UKNET (excludes regional networks)



Source – Arup Analysis

5 Review of Geographical Corridors

Having defined a proposed Strategic Transport Network for the whole UK, understanding how movements take place across the Union has been further explored. Building on the schematic UKNET in Figure 34, in this section we develop connectivity corridors, breaking down the network, setting out the multi-modal travel that takes place to, from and within each corridor, and also the economic and place-based context of them.

This is important to ensure that improvements to the Strategic Transport Network help identify where the benefits of growth may occur geographically. It also ensures that the movement between economic centres, both population and gateways, are understood and contextualised. The corridors seek to highlight the value and importance of intra and inter corridor movements.

Many of these corridors are connected to one-another, such as the West Coast Corridor connected the Central Midlands with the North Channel corridor, for movements on to the connected Northern Ireland corridor.

The qualitative analysis of the baseline data and report produced by Arup, and the call for evidence responses, has supported the development and narrative of these corridors, based around the UKNET. This includes factors such as W10 and W12 freight clearance, which is required for moving the largest of shipping containers from ports to freight distribution centres.

Descriptions on future road congestion have been taken from information contained within the National Transport Model, where sections of the SRN have been categorised as having occasional, moderate, regular, or severe congestion in the AM Peak in 2040 without intervention.

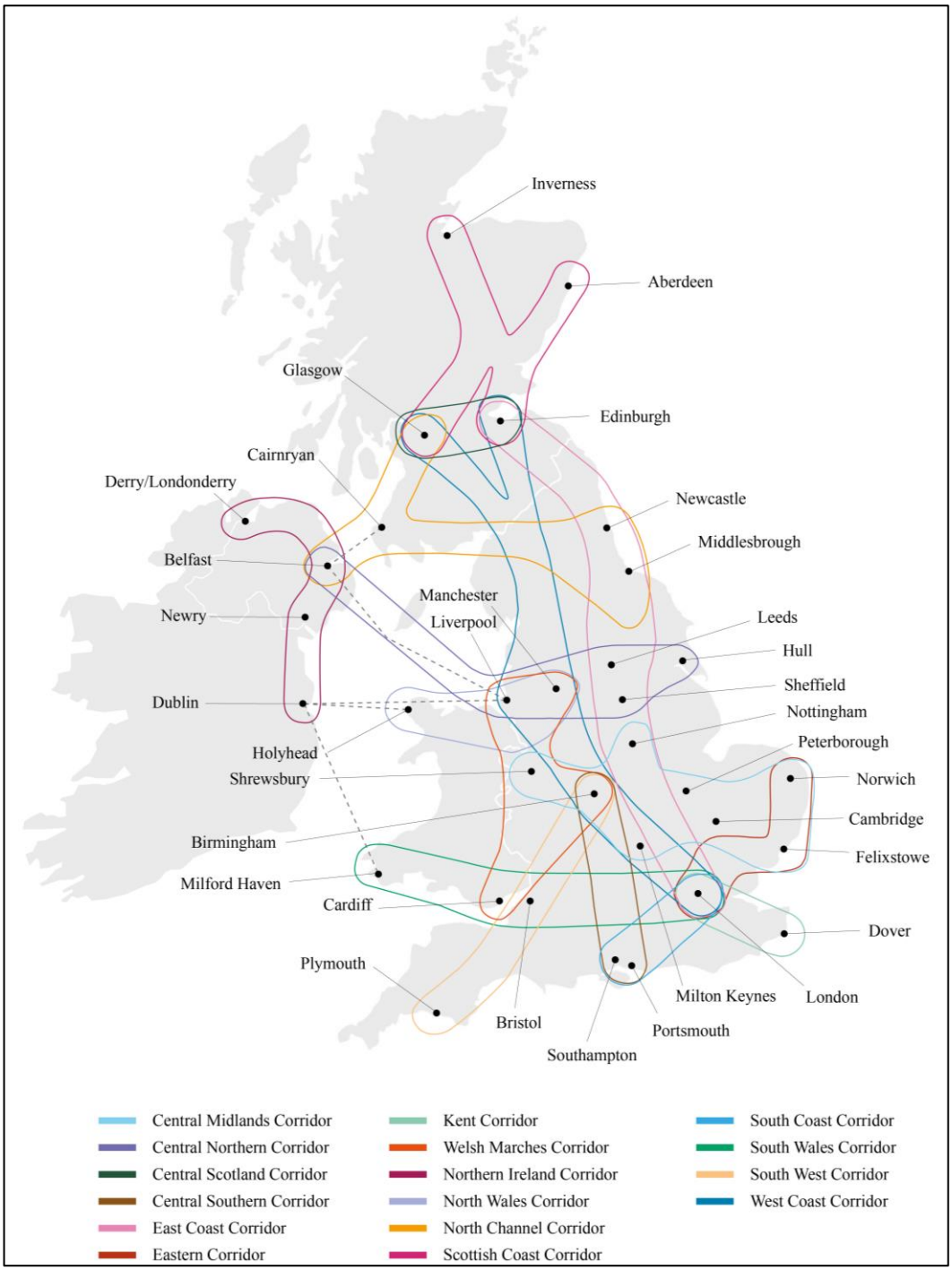
Understanding the context of these corridors is important in informing the identification of network gaps and opportunities of the Review.

A list specifying the connectivity corridors that have been identified across the proposed UKNET is shown in Figure 36 and mapped in Figure 37. A detailed review of each corridor can be found in Appendix B

Figure 36 – Identified Connectivity Corridors on the Proposed UKNET

#	Corridor Name	Key Population Centres
1	Northern Ireland Corridor	Derry/Londonderry, Belfast, Portadown, Newry, Dublin
2	Central Scotland Corridor	Edinburgh, Glasgow
3	Scottish Coast Corridor	Edinburgh, Glasgow, Dundee, Inverness, Aberdeen, Thurso
4	West Coast Corridor	London, Birmingham, Crewe, Liverpool, Manchester, Preston, Carlisle, Glasgow, Edinburgh
5	East Coast Corridor	London, Leicester, Sheffield, Leeds, Darlington, Newcastle, Edinburgh
6	North Channel Border Corridor	Newcastle-Gateshead, Middlesbrough, Carlisle, Glasgow, Cairnryan, Belfast
7	Central Northern Corridor	Liverpool, Warrington, Manchester, Preston, Bradford, Leeds, Sheffield, York, Hull
8	North Wales Corridor	Holyhead, Wrexham, Chester, Liverpool, Manchester
9	Welsh Marches Corridor	Swansea, Cardiff, Hereford, Worcester, Birmingham, Shrewsbury, Wrexham, Chester, Crewe, Liverpool, Manchester, Aberystwyth
10	South Wales and Western England Corridor	Swansea, Cardiff, Bristol, Swindon, Reading, Heathrow, London, Bath
11	Central Midlands Corridor	Felixstowe, Norwich, Cambridge, Peterborough, Birmingham, Shrewsbury, Derby, Leicester, Stoke-on-Trent, Logistics Golden Triangle, Oxford
12	South West Corridor	Birmingham, Bristol, Exeter, Plymouth, Penzance
13	Kent Corridor	London, Dover, Canterbury, Ashford, Maidstone, Folkestone
14	South Coast Corridor	London, Southampton, Portsmouth
15	Eastern Corridor	London, Chelmsford, Colchester, Stansted, Norwich, Felixstowe, Ipswich
16	Southern Central Corridor	Southampton, Portsmouth, Reading, Oxford, Birmingham

Figure 37 – Map of Identified Connectivity Corridors on the Proposed UKNET



Source – Arup

6 Future Changes

In the preceding chapters, a proposed UKNET was defined and its performance analysed. In this chapter, we investigate the contextual factors which could have future transformative impacts on demand or supply of transport in the UK. This includes behavioural and technological changes.

As well as improving connectivity and the efficiency of the UKNET, advances in technology and mobility have the potential to create new user and commercial opportunities. By fostering an 'enabling environment' for new transport technologies, and building on existing strengths and behavioural change, the UK can attract inward investment and capitalise on these opportunities, generating high-quality jobs in the process.

Future scenarios are being developed by many promoters and policy makers to inform the decisions they make and the interventions they prioritise. DfT recently published an Uncertainties Toolkit[51] as part of its Transport Appraisal Guidance updates[52]. The Uncertainty Toolkit introduces the Common Analytical Scenarios. These are central to how DfT intends to approach uncertainty in transport analysis. They are a set of six consistent, off-the-shelf, cross-modal scenarios exploring national level uncertainties which have been developed by DfT for use in forecasting and appraisal. They include the following.

- Known knowns (or risk) – refers to the inherent uncertainty that is always present due to underlying probabilistic variability (also known as aleatory uncertainty).
- Known unknowns – arises from the lack of complete knowledge about the complex system being modelled (also known as epistemic uncertainty).
- Unknown unknowns – arises from factors or situations that have not previously been experienced and cannot be considered due to lack of evidence (also known as ontological uncertainty).

The Toolkit sets out how DfT intend the scenarios to be used. DfT are developing and generating a final set of assumptions for these scenarios for which they will provide datasets for modelling/appraisal purposes later in the year. In this chapter, we will set out some knowns and unknowns in the behavioural, economic and technological areas.

6.1 Growth in transport to date

Before considering future trends for the use of the UKNET, it is worth reflecting on the increase in transport demand to date, across all modes. Overall growth in road travel demand across England and Wales is forecast to continue over the coming decades. This is largely driven by population growth; people are travelling less per person now than one or two decades ago.

[51] https://www.gov.uk/government/publications/tag-uncertainty-toolkit
[52] https://www.gov.uk/government/publications/tag-appraisal-and-modelling-strategy-update-report

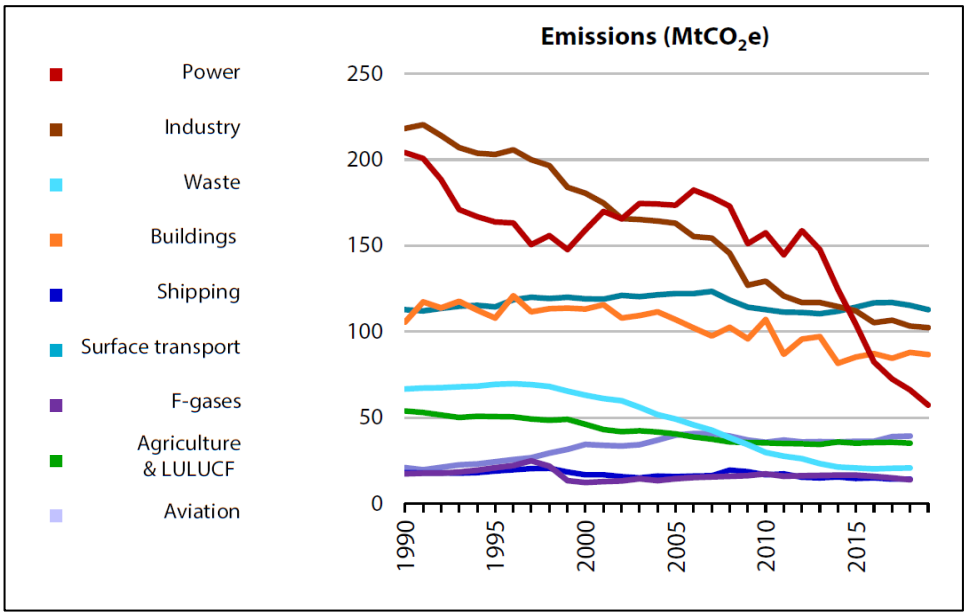
One of the reasons behind reduced individual travel is a decline in commuting, leisure and shopping trips. Between 1995 and 2014, while England's population grew by 11% and employment grew by 18%, commuting journeys fell by 16%.

6.2 The pathway to net zero

The UK Government is committed to achieving net zero emissions by 2050, to mitigate the impacts of climate change. Reaching net zero emissions in transport will demand far-reaching change in behaviour, policy, and infrastructure. Surface transport overtook both power and industry in 2015 to become the most highly emitting sector of the UK economy (Figure 38), with aviation and shipping also significant contributors to the emissions total.

The Government is also expected to publish its Transport Decarbonisation Strategy in 2021 which will set out how it plans to reduce carbon emissions from all forms of transport in line with the targets that have been set. This will have implications for the transport interventions that are promoted across the UKNET.

Figure 38 – Contribution to total UK emissions by each sector of the economy



Source – Reducing UK emissions: Progress report to Parliament (page 72), The Committee on Climate Change, 2020

The Committee on Climate Change (CCC) is the Government's advisory body on reducing emissions; they are responsible for setting the 'carbon budgets' which impose legally binding limits on emissions. The CCC have set out the policies and societal changes needed to achieve net zero in the transport sector: their 'balanced pathway' to net zero. While the carbon budgets are legally binding, the government does not have to adopt the specific strategies recommended by the CCC, and the imminent 'Decarbonising Transport' publication will reveal more details of the government's chosen approach. Since this is not yet available, this section considers the implications which the CCC's balanced pathway to net zero may have on both the demand and supply side of the UK transport network.

In line with the objective to support sustainable development, the Union Connectivity Review must do the following.

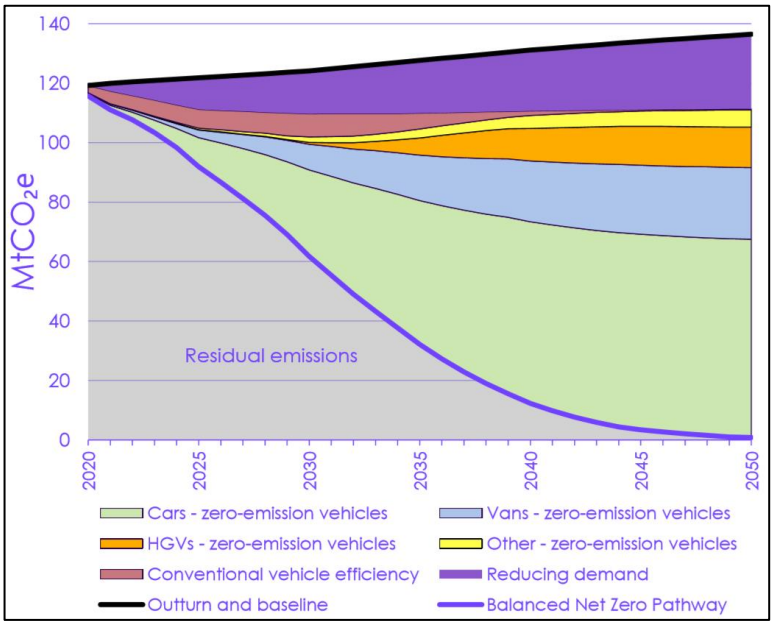
- *Be driven by the net zero pathway*. The changes outlined by the CCC in their 'balanced pathway' have significant implications for the volume and modal distribution of demand across the transport network over the next thirty years. These changes must be clearly understood such that the recommendations of this Review are carefully tailored to an evolving economy and society. This is the focus of this section.
- *Be a driver of the net zero pathway*. Later in this report, the longlist of proposed improvements will be evaluated against environmental criteria to ensure that the recommendations achieve the UCR objective of supporting sustainable development.

6.2.1 Surface Transport

Rapidly falling battery prices, improvements in energy density and electric motors and developments in alternative fuels have the potential to reduce emissions across a range of modes. As set out in the Government's Road to Zero, the UK Government has an ambition for the UK at the forefront of the design and manufacturing of zero emission vehicles, with all new cars and vans effectively zero emission by 2040.

Figure 39 shows the Committee on Climate Change's (CCC) latest balanced pathway to achieving net zero emissions in surface transport, and the proportionate impact of each contributing factor. This is a 'central' scenario; as mentioned above, there is uncertainty around the precise pathway and the outturn contribution of each driver of reduction.

Figure 39 – The 'balanced pathway' to net zero emissions in the surface transport sector



Source – Unpacking the Sixth Carbon Budget – The transition for transport (page 12), The Committee on Climate Change, 2020

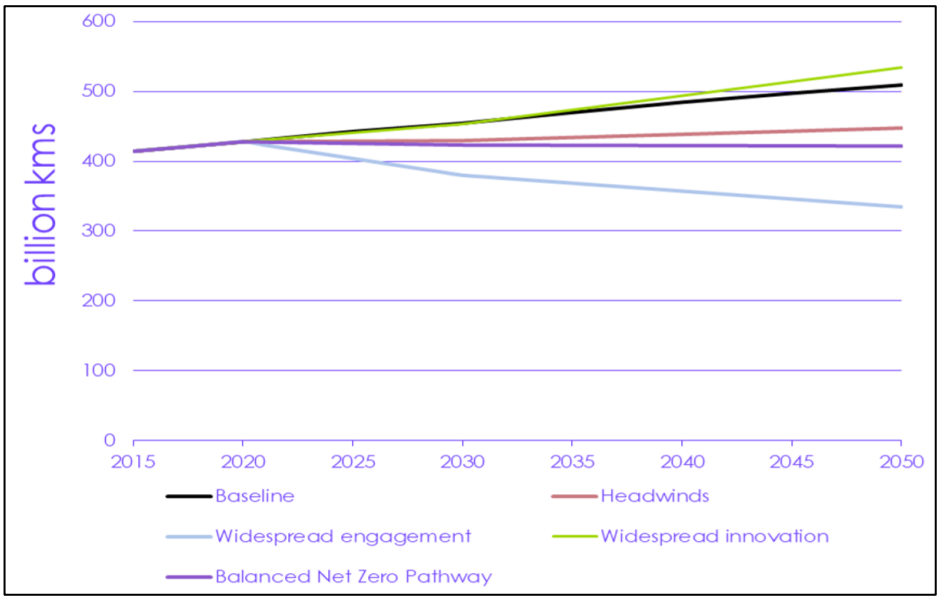
- By far the greatest contribution will be the **transition from conventional petrol and diesel fuelled cars, vans & HGVs to electric vehicles**, with the ban on sales of conventionally powered vehicles recently brought forward to 2030.

  The effective rollout of electric vehicle charging infrastructure across the UK highways network will be vital to avoid new deficiencies in the UKNET. Range anxiety – the concern that an EV will run out of charge mid-journey leaving drivers stranded – is consistently noted as one of the key concerns restricting uptake of EVs. Depending on the evolution of battery technology, inter-city journeys will likely need one or more intermediate charges. Fast and available charging must be readily available on all roads which form the UKNET, to prevent any new barriers to connectivity.

- The CCC also consider that **stopping growth in demand for car travel** will be required to achieve net zero by 2050. Modelling for the CCC's Sixth Carbon Budget estimated that, compared to the baseline forecast:

  - 9% of car miles could be reduced (through increased home working, modal shift) by 2035, increasing to 17% by 2050. The opportunities presented to lock-in positive behaviours seen during the Covid-19 pandemic and technological changes to reduce demand (eg. shared mobility) are key enablers.
  - 10% of HGV miles could be reduced by 2035 (through improved logistics)
  - 3% of van miles could be reduced by 2035

Figure 40 – Car demand scenarios to 2050



Source – Unpacking the Sixth Carbon Budget – The transition for transport (page 14), The Committee on Climate Change, 2020

Limiting growth in car travel will clearly limit pressure on the roads of the UKNET. However, the change in car travel will not be uniform across the UK. Modal shift is dependent on the convenience and cost of alternative options, which vary widely by geographical corridor. Increased home working will impact short distance commuting more than long distance inter-city routes. It is therefore difficult to make firm conclusions for individual geographic corridors on the basis of broad UK-wide projections (such as Figure 40). Furthermore, the extent of car demand reduction needed is dependent on a wide range of variables: the uptake of electric vehicles, the decarbonisation of the electricity grid (from which EVs source power), and conventional vehicle efficiency improvements. Figure 40 therefore shows a wide range of possible futures by 2050; there is a high degree of uncertainty around road demand going forward. A transformative change in road demand will therefore not be assumed by this Review.

6.2.2 Rail

While not shown in Figure 39, the balanced pathway assumes that emissions from rail will reduce by around 55% by 2035. This assumes that the Government ambition is achieved for passenger rail, with almost half of the network electrified and existing diesel trains replaced by hydrogen, battery electric or hybrid trains where electrification is not cost effective. Several key freight corridors will also be electrified. The recommendations of this Review should support and reinforce this rail decarbonisation.

Network Rail have also developed an Environmental Sustainability Strategy 2020-2050[53] with priorities around a low-emission railway, a reliable railway service that is resilient to climate change, improved biodiversity, and minimal waste and sustainable use of materials. As the Strategy recognises, rail is one of the lowest-carbon, greenest ways to travel, only contributing 1.4% to total UK transport emissions. There are opportunities to reduce emissions further through encouraging passengers and freight away from more carbon-intensive methods of travel like road and air onto the railway.

Network Rail have already electrified 42% of the rail network and they are advising Government and setting the future direction of travel through the development of the TDNS. Rail in Britain has kept its carbon emissions relatively stable over the last 30 years, despite experiencing a significant increase of around 35 billion passenger kilometres in the same period.

As set out in the TDNS publication in 2020, railway traction accounts for the greatest proportion of emissions within rail. With all traction electricity for electric rail services matched by an equivalent amount of nuclear power, the emissions can be considered almost entirely from diesel train operation.

For rail to support the UK in achieving its net-zero legislative target, diesel operation will need to reduce and potentially cease. For areas of the network with significant freight flows or long-distance high-speed services, electrification is the only technology currently able to support these service types.

[53] https://www.networkrail.co.uk/wp-content/uploads/2020/09/NR-Environmental-Strategy-FINAL-web.pdf

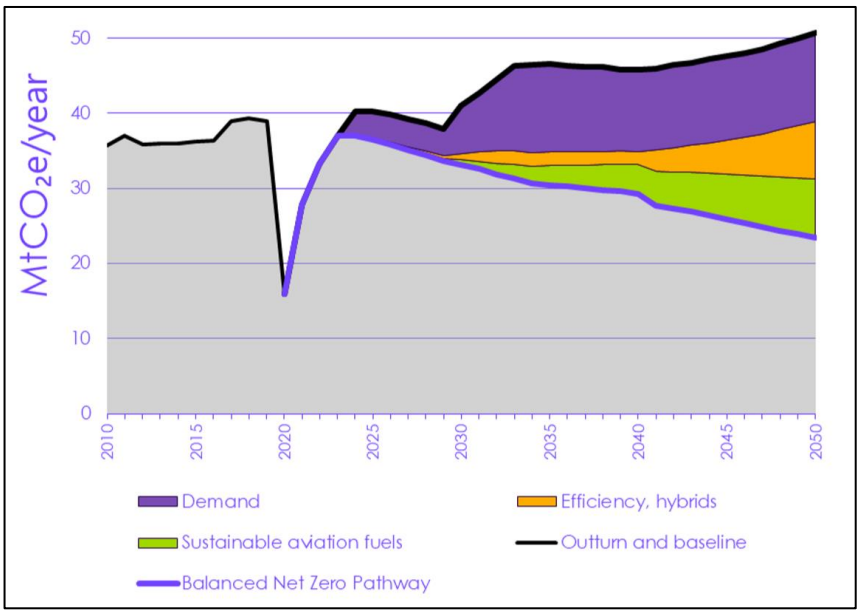
Analysis suggests that electrification is also the best whole life cost solution for more intensively used areas of the network. Away from these areas of operation, the deployment of battery and hydrogen rolling stock on both an interim and permanent basis will be critical in achieving decarbonisation of rail.

6.2.3 Aviation

Aviation and shipping have previously been treated separately to surface transport in the CCC analysis. However, for the first time, the UK's share of international aviation and shipping emissions will be included in the sixth carbon budget, depending on the time of publication and legislation.

Figure 41 shows the 'balanced pathway' for aviation emissions, which includes both domestic flights and international flights departing from UK airports. Note that aviation is one of the few sectors where positive emissions are still expected in 2050.

Figure 41 – The 'balanced pathway' for emissions in the aviation sector



Source – Unpacking the Sixth Carbon Budget – The transition for transport (page 19), The Committee on Climate Change, 2020

The emissions reduction attributed to demand management has clear implications for this Review. Clearly, there is a high degree of uncertainty around the aviation sector's recovery following Covid-19, but the CCC 'balanced pathway' allows for 25% growth in demand by 2050 compared to 2018 levels, against a baseline growth of 65%. This is not sub-divided into contributions from international and domestic aviation.

Importantly, the CCC's balanced pathway does not allow for any net increase in UK airport capacity, unlike in the baseline forecast.

While most international routes are not practically reachable by other modes, rail provides an attractive alternative on some domestic routes. For example, rail's mode share on routes between London and Edinburgh and Glasgow has been

rising over the last ten years as journey times fall and consumers become more climate conscious in their modal decisions. Improving the speed of rail links to encourage mode shift from aviation is an opportunity for the government to reduce domestic aviation emissions.

The UKNET includes key surface access links to airports. The demand for these links, whether road or rail, is derived from demand for flights (both international and domestic). As such, limitations on air passenger numbers or the capacity of airports will have important implications for other modal networks. These impacts should be considered carefully for the individual corridors affected.

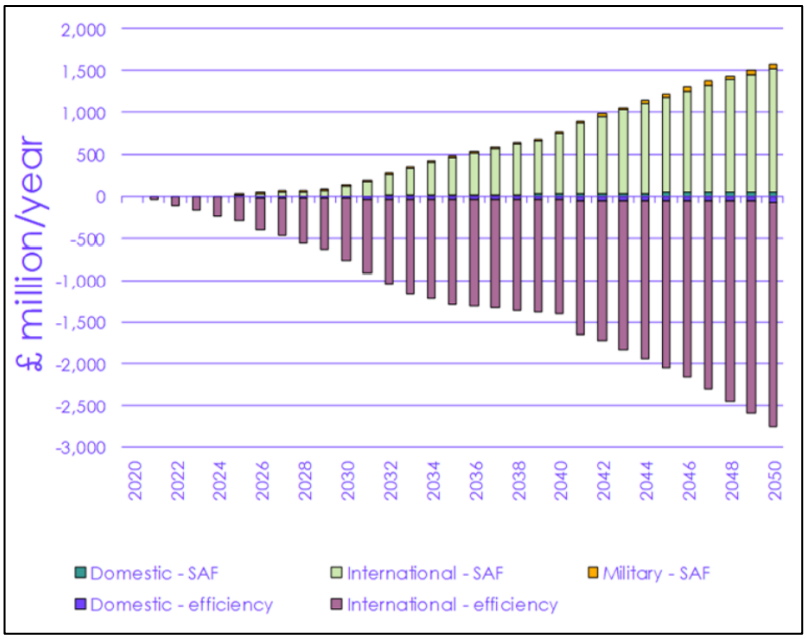
Figure 41 shows that 'efficiency and hybrids' will begin to contribute to emissions reductions from the late 2020s. The fuel efficiency per passenger of aviation is assumed to improve at 1.4% per annum, compared to 0.7% per annum in the baseline. Included in this is 9% of total aircraft distance being flown by hybrid electric aircraft in 2050. Sustainable aviation fuels will contribute 25% of aircraft liquid fuel in 2050, with just over two thirds of this from biofuels and the remainder from carbon-neutral synthetic jet fuel.

Domestic routes may be excellent candidates for part-electrification and sustainable fuels, since the engineering challenges are less pronounced for smaller planes. If these innovations are particularly successful, the need for domestic demand management and urgent domestic mode shift to rail may reduce, but this cannot be assumed given the technological uncertainty.

Efficiency gains in aviation could offset the added cost of sustainable aviation fuels, as illustrated in Figure 42. If the technology can mature, aviation is a cost-effective sector for greenhouse gas reductions.

The UK's airspace is also in a process of modernisation. This involves upgrading the UK airspace (invisible infrastructure in the sky), which will increase capacity and reduce delays which will be beneficial to domestic air routes especially those coming into Heathrow for those people wanting to onward connect. This will have huge benefits for air passengers and operators.

Figure 42 – Breakdown of aviation sector costs and efficiencies, following the balanced pathway

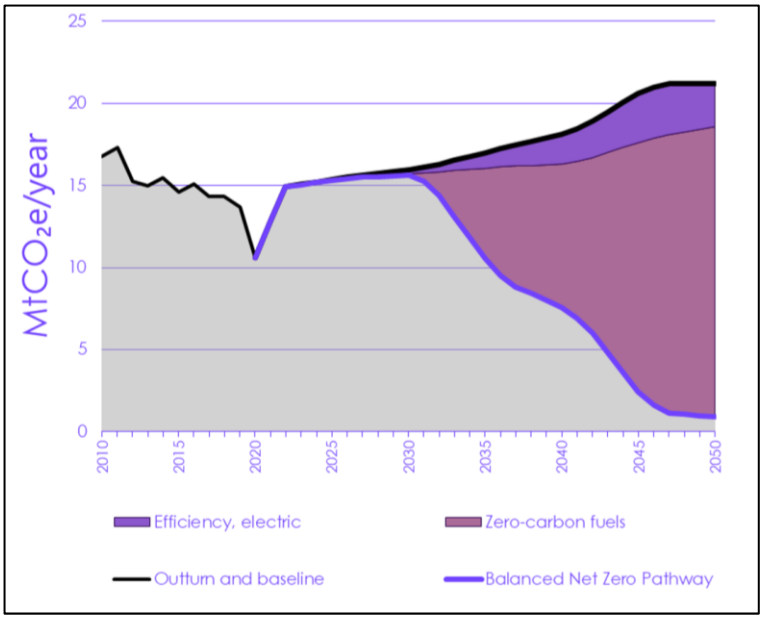


Source – Figure 3.7d: Breakdown of aviation sector additional investment, The Sixth Carbon Budget (Page 181), The Committee on Climate Change, 2020

6.2.4 Shipping

Zero-carbon fuels and efficiency improvements form the contributions to reduce shipping emissions to near-zero by 2050, as shown in Figure 43.

Figure 43 – The 'balanced pathway' for emissions in shipping

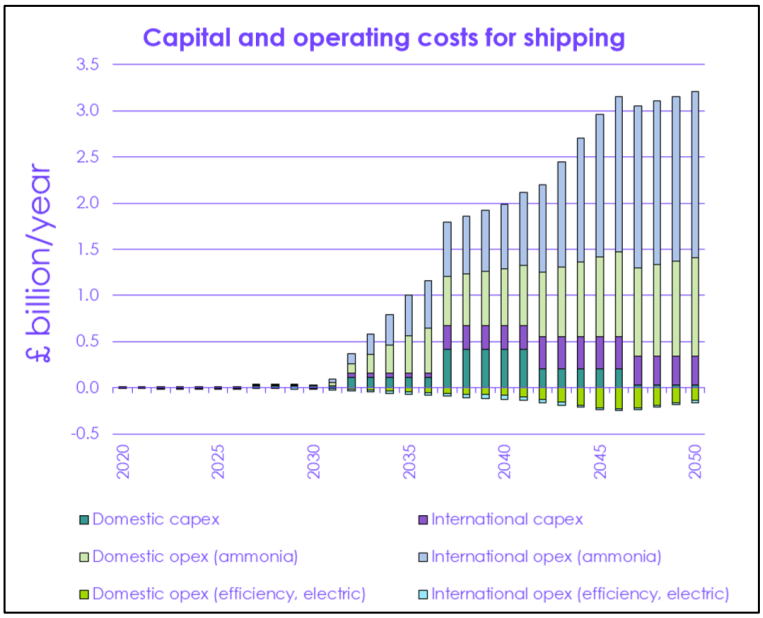


Source – Unpacking the Sixth Carbon Budget – The transition for transport (page 19), The Committee on Climate Change, 2020

To achieve this transition, the increase in total fuel use will have to be limited to an average of 0.9% per annum compared to 1.2% per annum in the baseline, through electrification and efficiency improvements. Zero carbon fuels, assumed in the balanced pathway to be ammonia, will be deployed from 2030 and form 87% of the emissions savings from shipping.

This transition will be challenging from a costs perspective – Figure 44 shows that the reduction in operating costs associated with improved efficiency is comfortably outweighed by the increase in operating costs associated with purchasing the Ammonia itself.

Figure 44 – Capital and operating costs for shipping to 2050, compared to current levels



Source – Unpacking the Sixth Carbon Budget – The transition for transport (page 19), The Committee on Climate Change, 2020

Government support may be available to assist the transition, but it is likely that some of the increased cost will be borne by exporting businesses, ferry passengers and operators themselves. This may make the UK maritime sector less competitive with other countries (reducing UK trade) or less competitive compared to other modes (such as aviation).

Overall, since demand management is not a key aspect of emissions reduction for shipping, the implications for this Review are limited.

6.3 Economic change

6.3.1 The long-term impact of Covid-19

The Covid-19 pandemic has had a transformative impact on life and mobility. As DfT figures[54] show, in June 2021 we have seen rail levels reaching 50% of pre-pandemic levels, and car usage on the transport network at 95% pre-pandemic

[54] https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic#history

levels, even while restrictions were still in place. This is expected to continue to increase as restrictions are lifted.

For the purposes of this Review, it is important to understand the extent to which changes in behaviour and mobility will persist into the long-term future. If the reduction in travel proves to be permanent, there could be implications for the needs and shape of the future UKNET.

That said, it could be a number of years before the true long-term mobility impacts of the pandemic become clear. This section sets out the trends that may emerge and the implications for Union Connectivity if these trends come to pass.

A large portion of UK transport demand is formed of commuters, and so a long-term structural shift towards remote working could have a significant impact on the needs of the UKNET. However, it should be recognised this is only a small representation of the workforce, and those in 'white collar' jobs.

While home working has increased and proximity to the workplace has become less important for some workers, most workers are still expected to visit an office for at least one day per week. This means that longer, but less frequent, commutes may be expected. However, a large majority of the workforce are in jobs that do not allow them to work at home.

The global lockdown has effectively dismantled barriers that previously existed in relation to working from home – namely technology, trust and security.

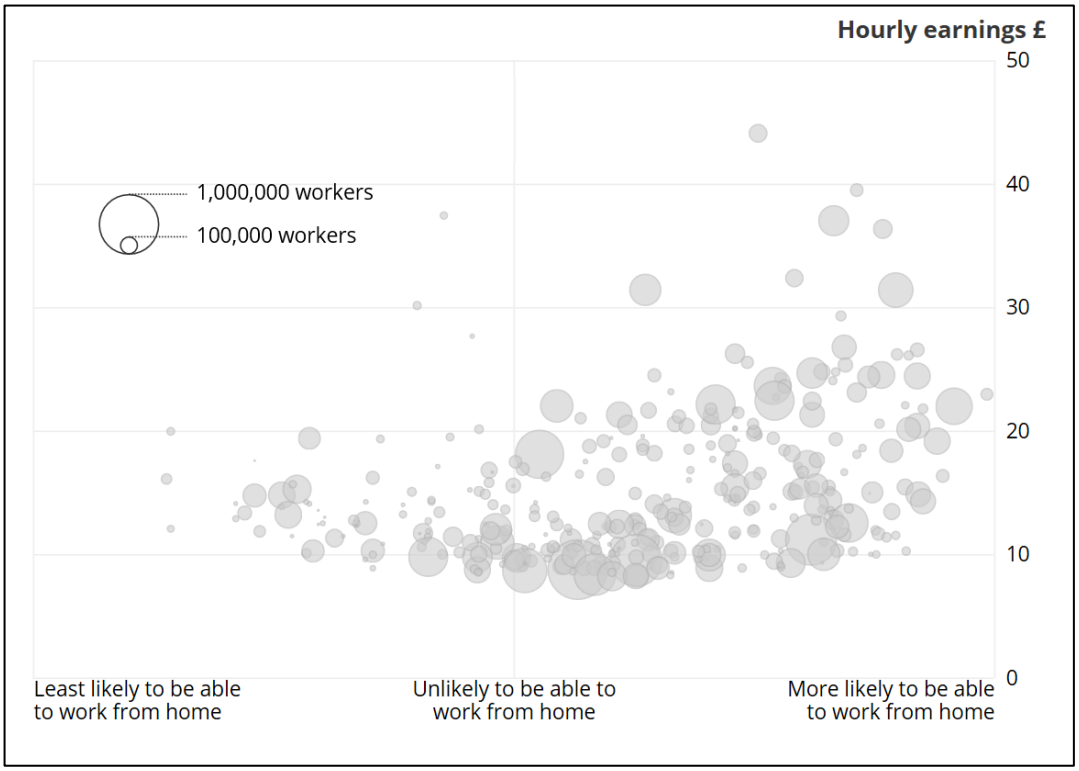
- The crisis has necessitated the organisation of working spaces and areas at home for many millions of people. IT systems have been upgraded, and distributed teams have been upskilled to work remotely.
- The concerns of employers and managers regarding trust have started to fall away as they have had no choice but to embrace remote working and flexible working hours. The experience of mass collective home working will likely lead to greater support from employers and managers for flexible working in future.
- Security concerns have been allayed as companies test and prove their digital systems are safe and secure.

However, in being absent from the office, many employees have come to appreciate what is most valuable about conventional workplaces – the buzz and excitement of a busy office environment, the opportunities for collaboration, the social interaction and the chance encounters. Younger staff in particular are missing the ability to build in-person relationships and wider networks. Going forward, many businesses will continue to want to attract a mix of people co-located together to build new alliances, cross-fertilise ideas and drive innovation. As a proportion of staff return to the office, other employees who would prefer to continue at home may begin to feel isolated or excluded and decide to return also.

Many sectors, such as hospitality and manufacturing, simply cannot operate remotely. Therefore, it is important not to focus thinking disproportionately on white-collar office jobs. As Figure 45 shows, jobs that can be done effectively from home tend to be in higher paying sectors. In April 2020, at the height of the

UK lockdown, only 47% of people in employment did at least some of their work from home.

Figure 45 – Graph showing how the ability to work from home varies by sector and pay



Source – ONET - US Department of Labor, Annual Population Survey and Annual Survey of Hours and Earnings - Office for National Statistics

A wide array of research studies has been undertaken seeking to quantify the permanent impacts on remote working patterns.

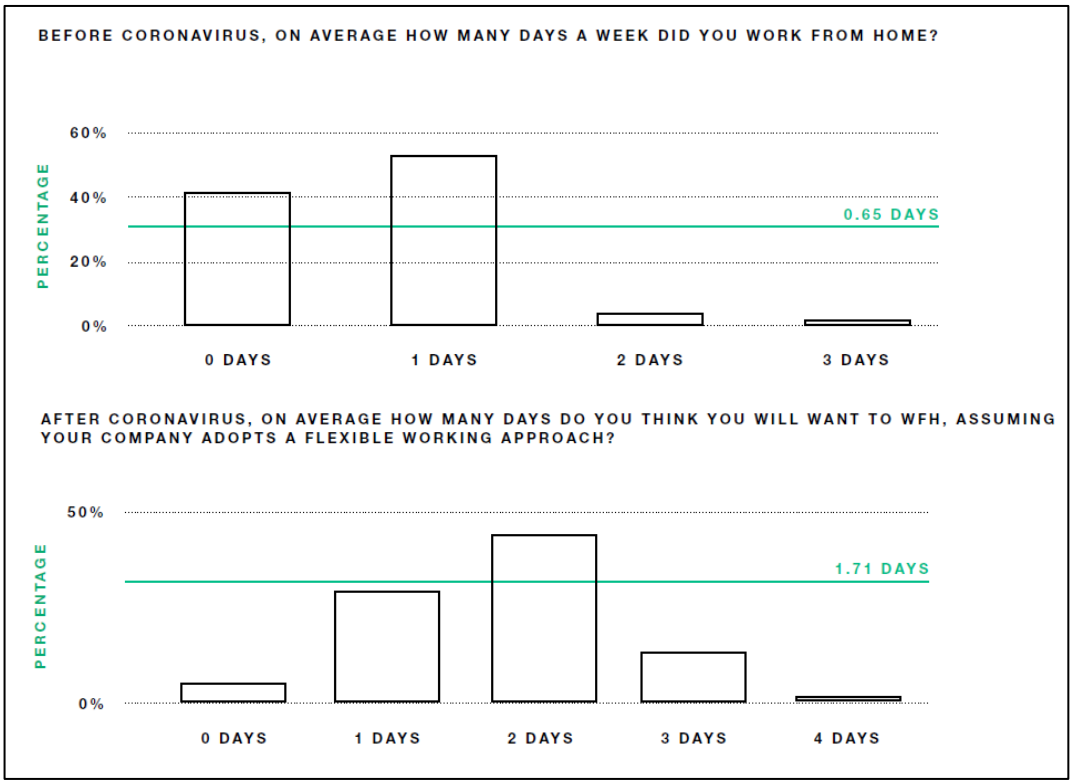
- In a survey of nearly one thousand company directors in October 2020, the Institute for Directors found that 74% would maintain increased home working going forward.[55]
- In September 2020, the Welsh Government stated its long-term ambition to see around 30% of Welsh workers working from home or 'near from home' (e.g. at hubs near their home), including after the threat of Covid-19 lessens.[56]
- An Arup survey, the results of which are shown in Figure 46, found that less than 10% of workers favour a full-time return to the office, with the majority keen to work 1-2 days per week from home.
- In one paper[57], Jose Maria Barrero, Nick Bloom and Steven Davis surveyed thousands of Americans and conclude that, after the pandemic, the average employee would like to work from home nearly half the time.

[55] https://www.iod.com/news/news/articles/Home-working-here-to-stay-new-IoD-figures-suggest
[56] https://gov.wales/aim-30-welsh-workforce-work-remotely
[57] https://bfi.uchicago.edu/working-paper/why-working-from-home-will-stick/

Employers are less keen, but their expectation is that a fifth of working time will be spent at home.

- Data from New Zealand (which has emerged from Covid) shows that, in the three months to December 2020, 27% of people in employment worked at home at least some time during the week.

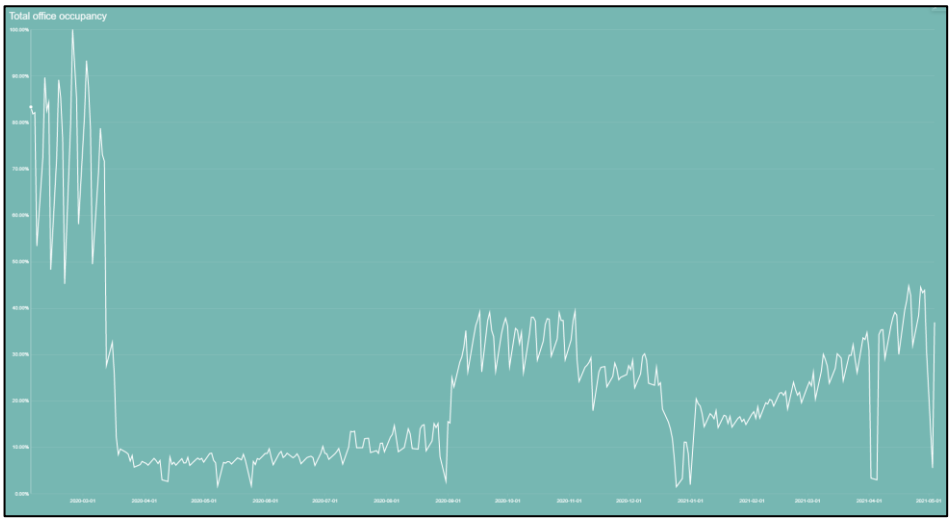
Figure 46 – Results of an Arup survey into employees' desires for working remotely



Source – Future of offices in a post pandemic world, Arup, https://www.arup.com/perspectives/publications/research/section/future-of-offices-in-a-post-pandemic-world

Figure 47 shows outturn data for the UK. Office working is on the rise, with occupancy reaching 49.15% on the 21st April 2021. There is a considerable difference in occupancy on different days of the week, with Tuesday and Wednesday consistently the busiest days of the week and Fridays the least popular.

Figure 47 – Office occupancy from February 2020 until May 2021



Source – Total Office Occupancy, Metrikus Occupancy Index, https://index.metrikus.io

While the eventual extent of the sustained shift to home working remains unclear, the evidence suggests there will be a permanent increase, with many keen to work 2-3 days per week from home. This will clearly reduce demand pressure on aspects of the UKNET.

However, we must be careful to understand where this commuting demand is concentrated and the extent of the implications for the UKNET that we has been proposed.

The UKNET is mostly, though not entirely, focused on longer distance inter-city and inter-regional travel. Most commuter trips are either within cities or accessing cities from satellite towns. These do not tend to be the routes that are critical to the broader connectivity of the United Kingdom. However, there are routes on which commuting flows are of high significance to the UKNET.

- **Routes within single economic regions –** As noted earlier in the report, there are two key areas of single economic geography which span England and Wales: at the far north and far south of the border. In these regions, links between towns and cities are short distance, but of strategic importance. A permanent shift towards home working would have a material demand impact on the commuter flows in these geographic corridors.

- **Routes where commuting flows add congestion –** Short distance commuters add to congestion on rail and road routes which are critical to Union connectivity. For example, commuters to/from London utilise services on the West and East Coast Main Lines, reducing capacity for longer-distance passengers (to/from the North of England and Scotland) and freight services. A permanent shift towards home working would release capacity and reduce congestion problems on these routes.

A further caveat is that while overall demand on the UKNET may reduce in the long term, the occupancy and commuting ‘peakiness’ shown in Figure 47 is likely

to remain. The UKNET must have capacity and be resilient at the busiest times, so a reduction in peak passenger numbers is of particular importance. If office working is concentrated on the days in the middle of the week, any reduction in peak volumes will be dampened.

It is also possible that if people are commuting less, they will be more willing to travel more and further for recreation and leisure. If employees are spending some or all of their working week at home, the attractiveness of going away at the weekend will grow. These longer distance leisure trips are important on many of the important links on the UKNET.

As people and businesses adjust, and with the investment by business in virtual connectivity, such as Microsoft Teams and Zoom, we may see less business trips, with clients and customers choosing to use these means instead. But as the analysis shows, there is still likely to be a key role in the future for face-to-face meetings for networking and working.

Tourism also plays a key role on the transport network. According to Visit Britain[58], the UK received 11.1 million inbound visits in 2020, a 73% decline from the visit levels seen in 2019. Their revised central scenario for inbound tourism in 2021 is for 11.3 million visits, up 2% on 2020 but only 28% of the 2019 level, with European inbound markets forecast to recover quicker than long haul markets. A number of factors are likely to prevent inbound tourism quickly recovering to pre-COVID levels. Aside from vaccines and new variants, these include the economic situation in each market, with demand hit by unemployment and possible fiscal tightening; new behavioural habits affecting leisure and business travel, both short and long term; potential loss of supply.

Visit Britain's central scenario forecast[59] is for a recovery to £51.4bn in domestic tourism spending in Britain in 2021; this is up 51% compared to 2020 but still only 56% of the level of spending seen in 2019. This is only a short-term forecast that describes one possible outturn and involves many assumptions and simplifications due to the fast-moving and uncertain situation. With longer international travel restrictions, we may see an increase in domestic tourism, however not in the short term.

In summary, it is highly likely that the Covid-19 pandemic will prompt a permanent increase in home working for white collar workers, with a more flexible approach to home – office working, and so the long term impacts on rail may be more detrimental to those on car. Reduced commuting overall, and any continued restrictions on international travel, may create additional demand for leisure travel.

This may affect the case for improved connectivity across the UK through a proposed UKNET, which is mostly concerned with long distance, inter-urban linkages, or indeed those that are more business travel and by rail. For any proposed interventions on corridors with significant commuter flows, the

[58] https://www.visitbritain.org/2021-tourism-forecast#:~:text=According%20to%20these%20estimates%2C%20the,87%25%2C%20compared%20to%202019.
[59] https://www.visitbritain.org/2021-tourism-forecast#:~:text=According%20to%20these%20estimates%2C%20the,87%25%2C%20compared%20to%202019.

economic case for intervention will have to be considered carefully as the actual trends emerge in the coming months and years.

The potential impact of reduced commuting on population distribution is discussed in the following sub-section.

6.3.2 The impact of Brexit

The UK's exit from the EU has a number of implications which are pertinent to the Union Connectivity Review. We mentioned in an earlier section the UK's departure from the TEN-T network, eliminating access to transport investment through the Connecting Europe Facility (CEF).

The impact of Brexit will not be limited to network supply and scheme investment, however. There will be implications for the volume and distribution of network demand too, owing to new checks and restrictions on freight flows across the Irish Sea.

1. Freight flows between the UK and the EU

Since the UK and the EU are now separate customs territories, new checks and regulations have been imposed on exports to and imports from the EU. While at present it is difficult to separate long-term structural economic change from short term teething problems and the impact of the pandemic, there is evidence of declining trade volumes (although this should be caveated that there will likely be COVID trading impacts as well making it harder to analyse like-for-like):

- French exports to the UK were 13% lower in January 2021 compared with the average of the previous six months, while UK exports to France fell 20% (although this may also be due to other factors such as a national lockdown in France)[60]
- Italian exports to the UK reduced 38% year-on year in January 2021, while UK exports to Italy fell by 70%
- German exports to Britain were down approximately 30% year on year in January 2021[61]

While international freight flows are not the focus of this review, the new trading relationship between the UK and the EU constitutes structural economic change, which will have significant impact on the UK transport network:

- **Reduction in use of Great Britain as a 'land-bridge'**: At the start of 2021, there was a marked increase in maritime freight travelling directly between the Republic of Ireland and Northern France, rather than using the UK as a 'land-bridge'. Despite longer journey times, hauliers preferred to avoid customs checks at Welsh and Irish ports. Ferry operators introduced new sailings between Ireland and France. The cost to ports on the Welsh coast could be great, as well as the communities which rely on the local port economy. Better connectivity to these ports and faster journey times

[60] https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/uktrade/january2021
[61] https://www.reuters.com/article/uk-germany-economy-britain-idUSKBN2AU0QZ

to south-east England could help the 'land-bridge' compete more effectively with direct routes to the continent.

- **Change in total freight volumes**: If the total volume of freight to and from the EU reduces as expected, and this is not offset by increased domestic freight and passenger travel, the need for connectivity to some ports and airports may become less critical. Ports and airports that handle a high proportion of affected goods (eg. products of animal origin) are likely to be more affected than others.

2. Freight flows between Great Britain and Northern Ireland

The Northern Ireland Protocol was agreed between the EU and the UK. This Protocol stipulates that the checks and paperwork required for goods to enter the EU market (as described above) must be conducted when the relevant goods are moved from Great Britain to Northern Ireland, upon arrival at Northern Ireland ports or airports.

Goods that would be subject to tariffs (eg. those that do not meet 'Rules of Origin' requirements) must gain certification that they are not 'at risk' of crossing the Irish border into the EU after they have arrived in Northern Ireland.

As with UK-EU trade, the new checks and paperwork will add cost for affected businesses in Great Britain when supplying goods to Northern Ireland.

This has several key implications for the Union Connectivity Review:

- **Change in freight volumes between Great Britain and Northern Ireland:** The demand for maritime freight services across the Irish Sea may diminish, which would have a knock-on impact on road and rail flows to Cairnryan, particularly the A75 and A77.
- **Freight flows out of Northern Ireland**: Northern Ireland may become a highly desirable location for exporters. This may increase the pressure on the transport corridor across the Irish border.
- **Ongoing uncertainty:** The Northern Ireland Assembly will vote on whether to continue with the arrangements every four years. As such, there is significant uncertainty associated with freight volumes across the Irish Sea. The implications of any alternative arrangements put in place later may have even greater impacts on the transport network than the existing Protocol

6.4 Demographic trends

6.4.1 Population growth and distribution

Demand for transport between different cities and regions is derived partly from the population within those places. It is therefore important to understand how population distribution and growth patterns may vary in the coming years, and whether this will transform the shape of demand on the UKNET.

Figure 48 shows the projection of population growth on a whole-nation basis, while Figure 49 provides more granular detail, mapping growth by local authority.

England's population is expected to grow more than any other UK nation by 2043, with projected growth of 10.3% on 2018 levels; the highest areas of projected growth are concentrated in the West Midlands. London's growth is expected to track that of the wider population, with 10.2% growth projected by 2043. There is significant growth projected along the English side of the Welsh border, whereas growth tends to be low or negative in the local authorities near the Scottish border.

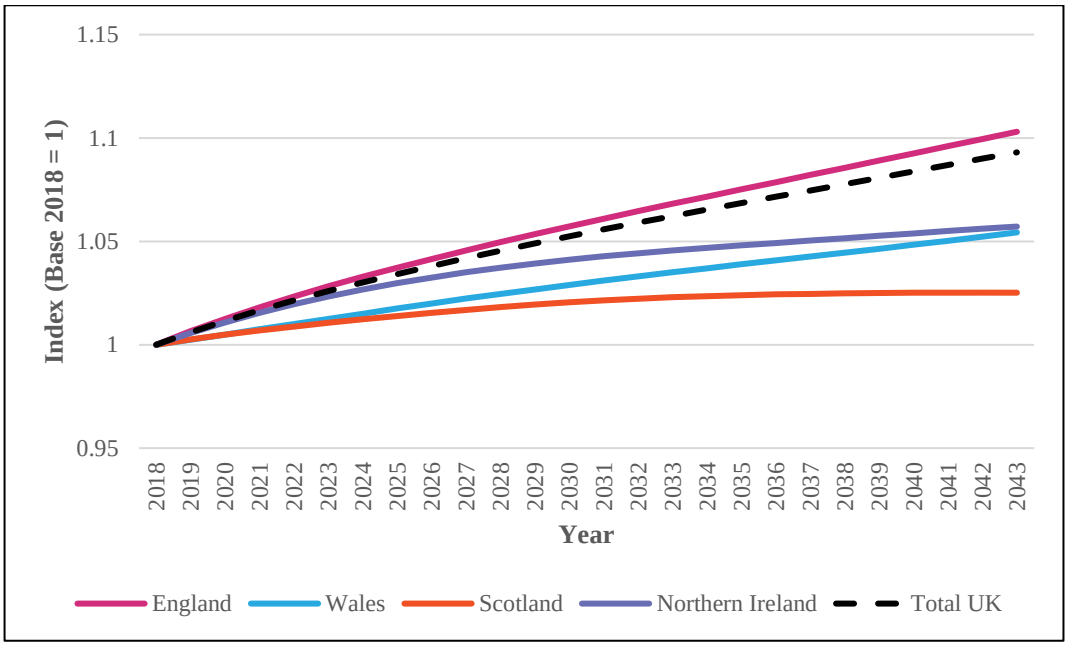
Wales' population is projected to grow by 5.4% from 2018 to 2043, with moderate growth across most of the nation. The six local authorities of greatest projected growth are all located in South Wales, with Newport and Vale of Glamorgan projected to grow by more than 10%.

Scotland is only projected to grow 2.5% in population from 2018 to 2043. The rate of population increase has slowed recently and is projected to continue doing so. If the projections are realised, growth could stall by mid-2043[62]. More than half of Scottish local authorities are projected to decline in population over the period, with growth concentrated in and around Edinburgh. Midlothian is projected to grow by 31%, double the growth of the next largest growing authority, East Lothian (15%).

Finally, Northern Ireland is projected to grow by 5.7% from 2018 to 2043. The population of Belfast is expected to remain largely constant, with growth of more than 10% projected in Lisburn & Castlereagh, Armagh City, Banbridge & Craigavon, and Mid Ulster. Population decline over the period is projected in the North of the nation, with Causeway Coast & Glens and Derry & Strabane both expected to reduce in size.

[62] https://www.nrscotland.gov.uk/files/statistics/population-projections/2018-based/pop-proj-2018-scot-nat-pub.pdf

Figure 48 – Projected population growth by individual nation, indexed to a 2018 base



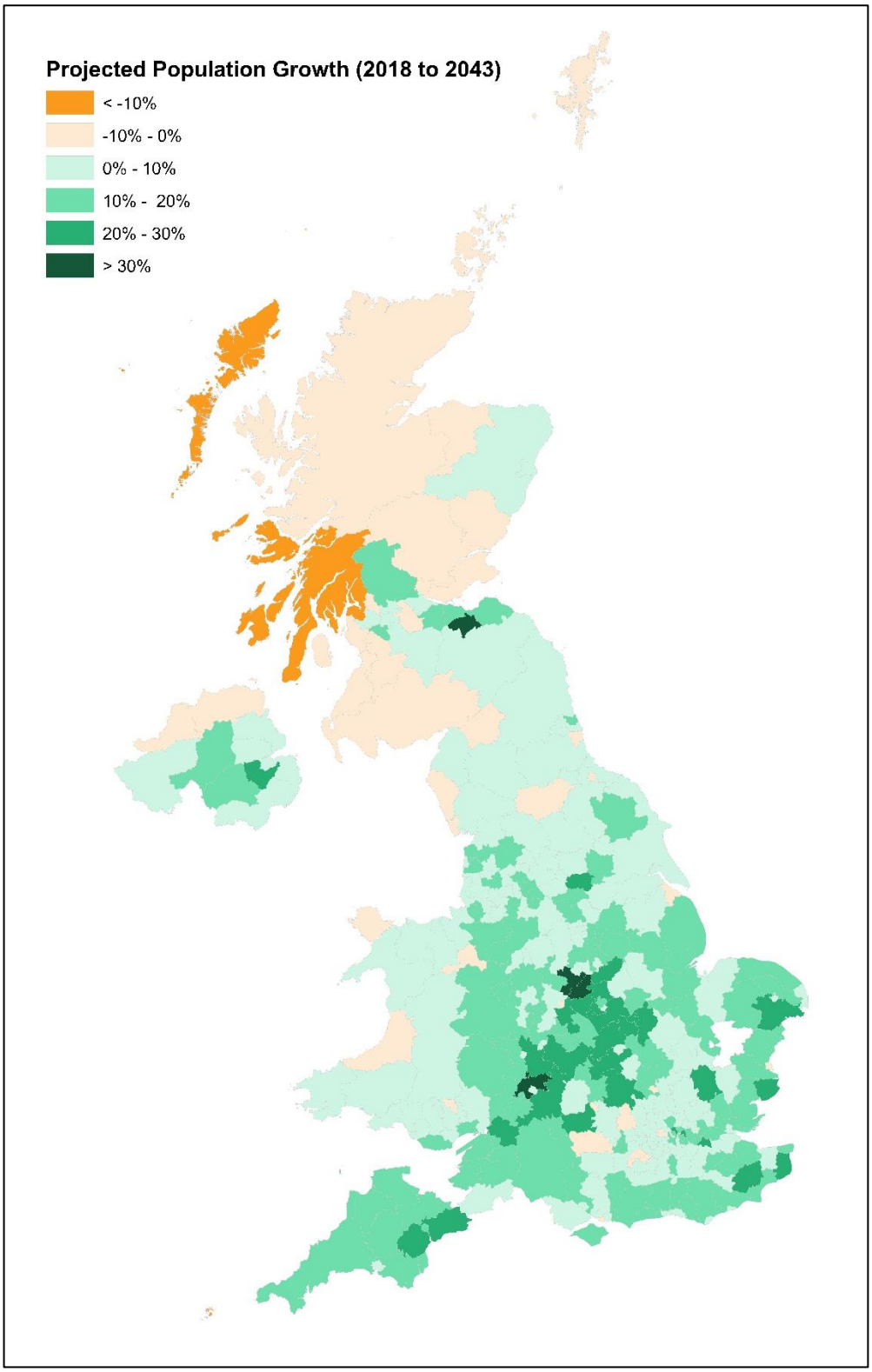
Source – Population projections for local authorities, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2

Population projections by local authority and year, StatsWales, https://statswales.gov.wales/Catalogue/Population-and-Migration/Population/Projections/Local-Authority/2018-based/populationprojections-by-localauthority-year

Population projections for Scottish Areas, National Records of Scotland, https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-projections/sub-national-population-projections/2018-based

Sub-national population projections, Northern Ireland Statistics and Research Agency, https://www.nisra.gov.uk/statistics/population/sub-national-population-projections

Figure 49 – Projected sub-national population growth from 2018 to 2043



Source – See Figure 48

These projections were made prior to the Covid-19 pandemic. Following from the discussion earlier in the report, it is possible that a trend of increased remote white-collar working could impact on population distribution in the coming years. If individuals are only making the commute two or three times per week, they may be more willing to live further from their workplace (and commute further when they do travel) to live in a more desirable location. As such, the catchment area of cities may increase and the attractiveness of the city centre may fall, with employees no longer keen to pay a premium on property costs with proximity to the office less valuable. Whilst the overall volume of these individuals is low, we would expect to have a higher propensity to travel overall, particularly by rail and air.

Figure 49 has important implications for this Review.

- The growing population in the West Midlands may increase pressure on the road and rail links. The Midlands also has key strategic trips that take place to, from, with and through the region, with added local trips adding to the impacts. HS2 will provide additional north-south capacity for rail passengers, but it is important that capacity is available, and performance is maintained, on the strategic road links, such as the M6, and east-west road and rail connections.
- Edinburgh's projected population growth reinforces its importance for the strategic connectivity of the UK, and the importance of its links to the rest of Scotland and English cities.
- The south west of England is set to grow significantly, further making the case for improvements to its transport connectivity by road, rail and air.
- The growth in cities has included more apartment blocks without parking, with younger populations less reliant on car-based travel for work and leisure.

These demographic changes matter because of clear generational differences in people's transport choices and needs. For example, younger people are less likely to own cars than previous generations and are driving less, due to factors such as staying in education for longer, moving into long-term employment and starting families later, and the cost of driving. It is important to note that the relationship between population and transport infrastructure is not one-way. While growing populations certainly generate a greater demand for transport provision, improved transport links will also attract more people to a place (induced demand). The economic impacts of improved connectivity, in terms of agglomeration and skills, were discussed in the Assessment Framework and are not revisited here.

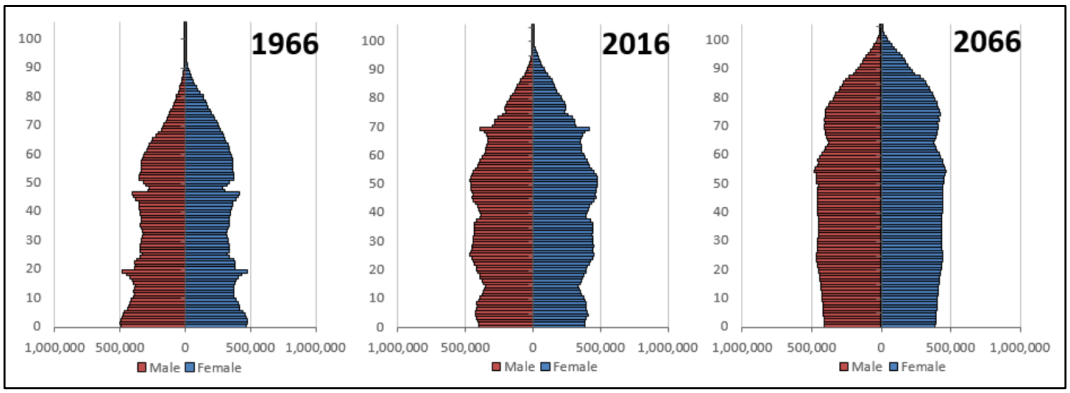
6.4.2 Ageing population

The UK has an ageing population, with life expectancy rising and birth rates reducing. The latest ONS projections[63] suggest that in 50 years' time, there will be

[63] *ONS 2021 - Living longer: how our population is changing and why it matters*

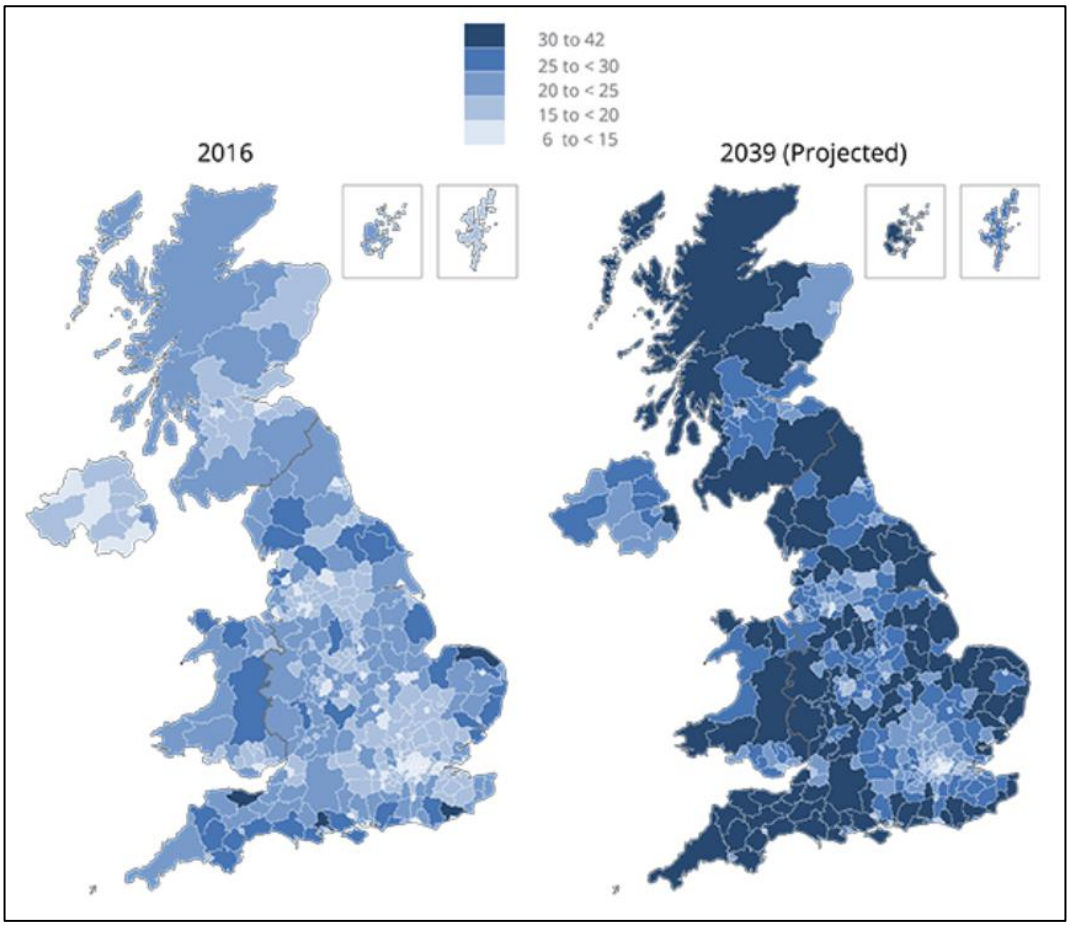
an additional 8.6 million people aged 65 years and over. Figure 50 illustrates this overall trend, while Figure 51 shows how the ageing population is and will continue to be particularly pronounced in certain regions of the UK. Major cities, and the areas surrounding them, are expected to remain the youngest regions while older people make up a greater proportion of rural and coastal areas.

Figure 50 – Population pyramids for the UK



Source – Population estimates, Principal population projections (2016), Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/livinglongerhowourpopulationischangingandwhyitmatters/2018-08-13

Figure 51 – Proportion of the UK population aged 65 years and over



Source – Living Longer: how our population is changing and why it matters, Office for National Statistics (2018), https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/livinglongerhowourpopulationischangingandwhyitmatters/2018-08-13

A greater proportion of older people in the community will result in an altered profile of transport demand. Figure 52 and Figure 53 do not show a simple trend of miles travelled reducing as age increases. It is those in their fifties travel the greatest number of miles by car and those in their forties who travel the greatest number of miles by rail.

They do, however, show that as age increases the use of rail as a mode drops more abruptly than driving. As such, an increase in the average age of the population is likely to result in an increase in modal share for road over rail.

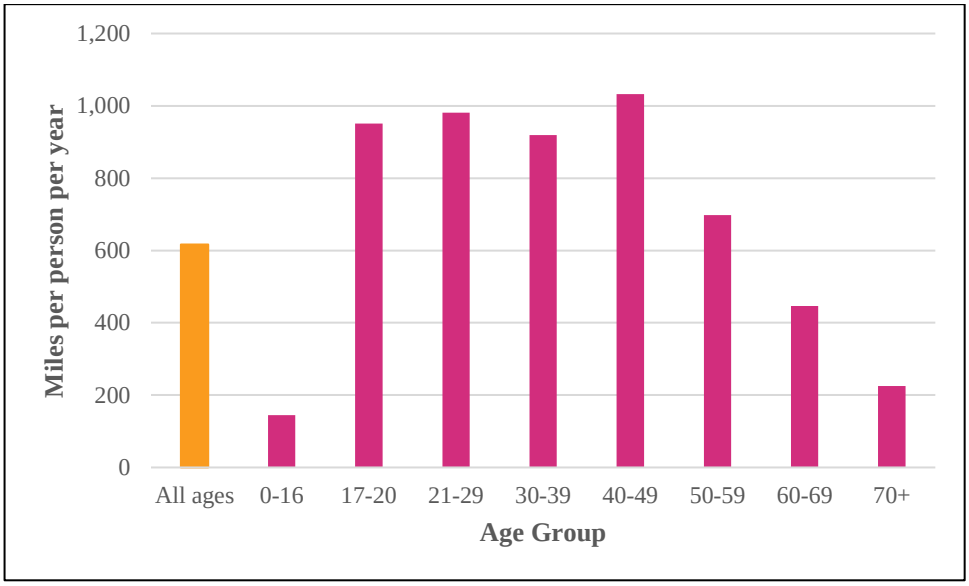
Again, care must be taken not to over-draw conclusions. There will be a raft of technological innovations in the coming years. Electric, and particularly autonomous vehicles could transform the experience of driving, while travelling by rail is not predicted to experience such change. Uptake for technology tends to be lower among those in older age brackets, who may therefore prefer to travel more by rail.

The number of young people qualified to drive has also fallen to the lowest level on record as driving lessons and tests have been suspended and financial pressures

have increased as a result of the Covid-19 pandemic. Just 2.97 million people aged 16 to 25 in Great Britain hold a full licence, down from 3.32 million in March 2020 and the lowest number in records dating back to 2012, when there were 3.42 million[64].

Therefore, it is unlikely that an ageing population in the UK will have a transformative impact on demand for the UKNET.

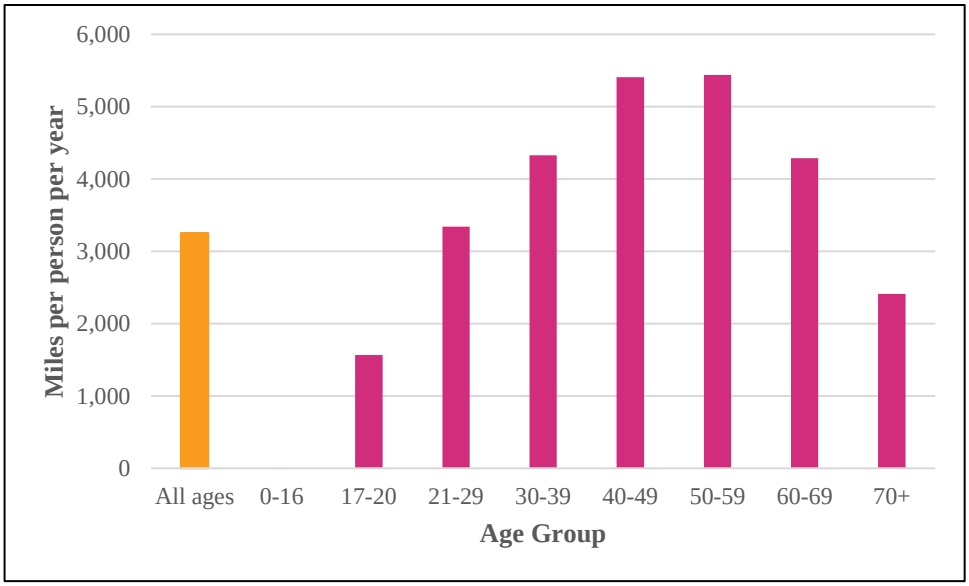
Figure 52 – Annual average distance travelled per person by surface rail, by age group, 2018



Source – Table NTS0601a National Travel Survey, Office for National Statistics, https://www.gov.uk/government/statistics/national-travel-survey-2019

[64] https://www.theguardian.com/money/2021/apr/05/number-of-young-people-with-driving-licence-in-great-britain-at-lowest-on-record

Figure 53 – Annual average distance travelled per person by car or van (driving), by age group, 2018



Source – Table NTS0601a National Travel Survey, Office for National Statistics, https://www.gov.uk/government/statistics/national-travel-survey-2019

The existence of an ageing population has other important implications for transport - for example, station & train accessibility and last mile trips by public transport will grow in importance. These aspects are not explored in detail here since this study is principally concerned with the implications of macro future trends for demand and supply on the UKNET.

6.5 The future of domestic aviation

Domestic flights have been an option for longer distance trips across the Union, especially those that involve crossing the Irish Sea. However, routes from London to Manchester and Scotland are also popular. However, with the delivery of HS2, journey times to Manchester will be reduced significantly, as will those on to Scotland. For Heathrow, with the exclusion of the originally planned HS2 link, passengers will be able to transfer on to Crossrail for links to Heathrow. Previous work also explored a 3-hour journey time between Scotland and London. If this is further progressed in the future this could be a more attractive alternative to air but would also need to compete on price and affordability for users. There is however likely to still be a demand for these domestic routes for inter-connecting long-distance flights, such as feeder services to Heathrow, as one of the World's largest airport hubs.

In France, lawmakers have moved to ban short-haul internal flights where train alternatives exist, in a bid to reduce carbon emissions[65]. The bill seeks to end routes where the same journey could be made by train in under two-and-a-half hours. The measures however do not apply to routes that typically form part of a connecting international flight; meaning that Charles de Gaulle airport is largely exempt, because it is France's main international transport hub. In the UK, further

[65] https://www.bbc.co.uk/news/world-europe-56716708

data collection and analysis is required to understand which aviation routes are likely to be able to transfer the greatest number of passengers to rail. However, it is anticipated that even services duplicated by HS2 (e.g. London - Manchester) will need to be maintained to serve interlining, international passengers, who cannot easily transfer to the rail network. This mirrors the reality of France, where services will continue for interlining, international connecting passengers.

6.5.1 Revised route support / Public Service Obligation Routes Policy

In some cases, aviation routes are deemed critical to connectivity, but there is not sufficient demand and revenue for these routes to be operated by the private sector. National or local governments can choose to subsidise these routes through 'public service obligation' (PSO) / route support arrangements.

As of September 2019, there were 22 PSO air routes in operation in the UK. The vast majority of these routes connect the Scottish Islands to the Mainland. PSO Routes which do not serve the Scottish Islands (as of 2019) are shown in Figure 54. While the 'awarding authority' is usually the local council, PSO agreements tend to be funded by a combination of local and central government.

Figure 54 – PSO Routes that do not serve Scottish Islands as of September 2019

Airport 1	Airport 2	Awarding Authority	Annual Passengers	Annual Compensation
Cardiff	Anglesey	Welsh Government	14,584	€2,040,992
Newquay	Heathrow	Cornwall Council	173,446	€708,652
Dundee	Stansted	Dundee City Council	20,534	€1,992,292
Derry	Stansted	Derry City & Strabane District Council	47,375	€2,326,213

Source - https://ec.europa.eu/transport/modes/air/internal-market/pso_en

Following the UK's exit from the EU, the Government is reviewing its approach to route support. Initially they may consider the PSO policy, with a longer-term plan to review options available to provide route support which would be more targeted and move away from PSOs which sit in retained EU regulations. However, this process will take time with the need to consult and deliver. A revised PSO policy could be a vital step to aid in the recovery of the sector and supporting the levelling up agenda.

The Government's Aviation 2050 report[66], published in 2018, cited the role that PSOs could play in ensuring connectivity to international hubs:

> *"New research has found limited evidence for wider economic impacts improving the value for money of PSOs under the current appraisal framework. The exception is where capacity constraints at hub airports lead to an inability for commercially viable domestic services to expand to meet demand. There is a stronger case for the government to intervene in such cases. Enhancing an existing domestic route into a hub airport or*

[66] https://www.gov.uk/government/collections/aviation-strategy

fostering new routes can improve productivity across the UK, contributing to a rebalancing of the economy."

In practice, the report indicates this could lead to the following changes in the coming years.

- The reserving of take-off slots for domestic flights at international hub airports such as Heathrow.
- New PSOs into international airports in the North and Scotland, such as Manchester and Edinburgh, which will require a revision to the current PSO policy to include region to region.
- If Heathrow is expanded, new PSOs into Heathrow where justified by evidence of onward connectivity benefits.

The collapse of Flybe in March 2020, with Covid-19, along with pre-existing commercial challenges of operating in the domestic aviation market, had contributing factors.

- Airlines must pay Air Passenger Duty (APD) for each passenger they carry, which is either passed on to the consumer in higher fares (reducing demand) or is borne by the airline. In either case, APD reduces profit margins. Whereas for international airlines APD is only payable on outbound flights, domestic carriers have to pay the tax on both outbound and inbound legs.
- Unlike most international aviation, domestic air routes have to compete with surface transport as an alternative; however, this is not the case for Northern Ireland – Great Britain trips which still rely on aviation and maritime. With rail journey times improving and 'climate-consciousness' increasingly factoring into modal decisions, domestic aviation has become less competitive.

There were other strategic choices made by the management of Flybe which contributed to its financial performance, but for this Review it is important to consider these structural issues that will persist regardless of who operates the routes. With the arrival of HS2 and the long-term demand impacts of Covid-19, more routes may become commercially challenging, but further analysis will be required before and after HS2 is completed.

The key consideration for Union connectivity is this: will there be sufficient incentive for the private sector to continue operating the full network of domestic routes flown in 2019? There is already evidence that the network may be diminishing, with many of Flybe's former routes currently unserved, for example:

- Edinburgh ←→ Manchester
- Edinburgh ←→ Cardiff
- Glasgow ←→ Manchester

Other routes are still operated by Flybe's contemporaries, but are now served at a reduced frequency and without competition to drive down prices for passengers.

A large degree of this can be attributed to hesitancy as the private sector waits for the long-term impacts of Covid-19 to become clearer, but government intervention, in policy, funding, and operation, may be necessary if domestic air connectivity is to be sustained at 2019 levels.

6.5.2 Air Passenger Duty

As mentioned above, Air Passenger Duty (APD) is levied on the passenger's outbound and inbound flights domestically.

This is of particular concern for the competitiveness of Northern Ireland airports. The Republic of Ireland does not levy aviation tax on short or long-haul flights, meaning that airline costs and (therefore) passenger ticket prices tend to be lower than those at Northern Ireland airports. The following excerpt is taken from Diane Dodds' (the former Minister for the Economy, Northern Ireland) submission to the Call for Evidence:

> *"Pre-COVID, residents of the Republic of Ireland enjoyed a level of aviation connectivity roughly twice that for their NI counterparts. In 2019 ~1m NI residents travelled via ROI airports, accounting for 15% of all NI Passenger Flow. Although there is some movement in the opposite direction, net movement across the border has proved to be a significant competitive drain on NI's airports."*

In the Government's Aviation 2050 report[67], it is highlighted that the UK does not tax aviation fuel and does not impose VAT on ticket prices, concluding that 'without APD, aviation would be relatively under-taxed compared to other sectors, with a £3.4bn loss to the public purse'.

6.6 Technological developments

6.6.1 The future of fuel

In order to achieve the net zero targets set by Government, there has been great focus and investment in cleaner and greener fuels for transport. This includes battery power and hydrogen, as well as other types. There are also challenges around how some fuels can be used for different types of transport modes.

Electric Vehicles

From 2030 there will be the end of the sale of new petrol and diesel cars and vans[68]. However, the sale of hybrid cars and vans that can drive a significant distance with no carbon coming out of the tailpipe will be in place until 2035.

Electric vehicles have gained in popularity as vehicle technology has improved, purchase prices have gone down and Government legislation has been introduced to incentivise uptake. In June 2021 there were 260,000 pure-electric vehicles and more than 535,000 plug-in models on the road in the UK. Last year saw the

[67] https://www.gov.uk/government/collections/aviation-strategy
[68] https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030

biggest annual increase in number of registrations, with more than 175,000 electric vehicles registered showing a growth of 66% on 2019[69]. The continued uptake of electric vehicles looks all but certain following the Government's announcement that no sales of new petrol or diesel cars or vans will be allowed beyond 2030.

To overcome barriers to adoption for electric cars, real and perceived concerns will need to be addressed; notably range anxiety and long charging times. Improvements in battery technology are continuing to increase the distance that can be travelled between charges, with some models stating the ability to travel more than 400 miles on one charge. However, there are still significant gaps in the charging network to fill before range anxiety is addressed.

Work by Arup for Highways England has demonstrated that 95% of the Strategic Road Network (SRN), which comprises motorways and major A roads across England, has a rapid charge point every 20 miles[70]. In terms of charging times, rapid chargers can already provide 80% charge within 20 minutes and new technology is promising the same in just five minutes. It is reasonable to expect that these barriers will be overcome in the next 20-30 years. Overall, charging infrastructure will need to be embedded along the UKNET. As well as cars, this includes charging for e-bikes and e-scooters at mobility hubs and other locations, as well as charging infrastructure for public transport at depots and perhaps on-route inductive charging at stops. To support the shift from petrol and diesel the infrastructure that enables electric-powered forms of transport will need to become a ubiquitous feature on the UKNET and beyond.

The Government has stated that they will invest £1.3 billion to accelerate the roll out of charging infrastructure, targeting support on rapid charge points on motorways and major roads to dash any anxiety around long journeys, and installing more on-street charge points near homes and workplaces to make charging as easy as refuelling a petrol or diesel car. And whilst the costs of EVs are already falling, the Government plan to provide £582 million to extend the plug-in car, van, taxi and motorcycle grants to 2022 to 2023 to reduce their sticker price for the consumer[71].

HGV fuel

HGVs are amongst the most challenging vehicles to decarbonise, due to their high-power requirements and long distances travelled with little downtime. However, solutions are being developed including hydrogen fuel cell HGVs and Electric Road Systems (where major roads are electrified, similar to rail electrification).

As set out in the Pathway for Long Haul Heavy Goods Vehicle report by the Connected Places Catapult[72], the key near-term options for fully decarbonising HGVs are hydrogen and Electric Road Systems (ERS). The most developed and HGV compatible ERS is a conductive overhead catenary system, which involves

[69] https://www.nextgreencar.com/electric-cars/statistics/
[70] https://www.arup.com/projects/highways-england-rapid-electric-vehicle-charge-points-programme
[71] https://www.gov.uk/government/news/plug-in-car-van-and-truck-grant-to-be-targeted-at-more-affordable-models-to-allow-more-people-to-make-the-switch
[72] https://cp.catapult.org.uk/wp-content/uploads/2021/03/A-Pathway-for-Long-Haul-Heavy-Goods-Vehicles-March-2021-FINAL.pdf

wires suspended above the carriageway and a pantograph mounted on top of the vehicle, designed to extend to meet the catenary and draw power when the vehicle is in position. This technology has been deployed in trials on public highways across Europe, including in Germany and Sweden, and is proven to provide sufficient power for large HGVs at highway speeds. This could become a feature of the UKNET in the future.

The Report[73] also highlights work exploring the potential of a pure battery electric HGV solution, alongside ERS and hydrogen fuel cells. Based on analysis of battery technology and industry engagement, it is considered that battery electric HGVs are unlikely to be able to meet the necessary requirements for the majority of long-haul operations in the short term. However, battery technology underpins both hydrogen fuel cell and ERS vehicle systems and is vital for the zero-emission transition of smaller vehicles.

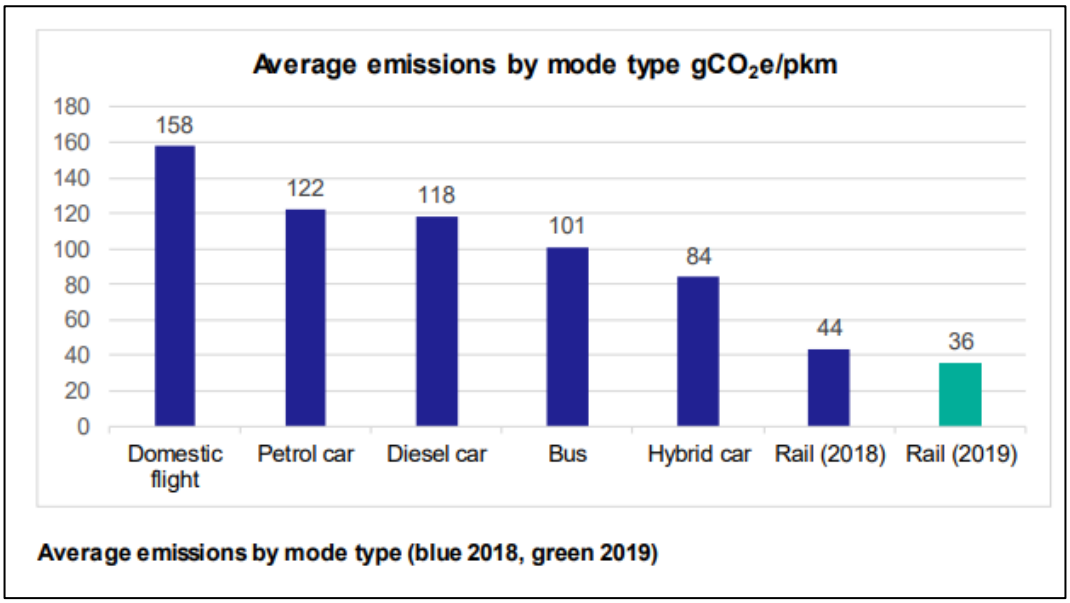
To achieve full decarbonisation of HGVs by 2050, a significant coordinated national effort will be required. If all vehicles on the road need to be zero-emission by 2050, sales of non-compliant HGVs will need to cease at least ten years earlier, so by 2040. The Report states it could take at least ten years to develop a fully competitive vehicle marketplace and build supporting refuelling / recharging infrastructure across the country, so key decisions on which mix of technologies to deploy at scale must be taken by around 2027. Given the number of trips undertaken on the UKNET, it is likely that this network will be a key focus of complementary charging infrastructure.

Electrification of rail

Network Rail's Traction Decarbonisation Network Strategy[74] (TDNS) published in July 2020 the infrastructure manager reports that only 38% of all railway in the UK is currently electrified.

[73] https://cp.catapult.org.uk/wp-content/uploads/2021/03/A-Pathway-for-Long-Haul-Heavy-Goods-Vehicles-March-2021-FINAL.pdf
[74] https://www.networkrail.co.uk/wp-content/uploads/2020/09/Traction-Decarbonisation-Network-Strategy-Interim-Programme-Business-Case.pdf

Figure 55 – Average emissions by mode type[75]



There has been a reduction in average emissions per passenger rail kilometre due to the increased electrification of the rail network, improved fuel efficiency and increased capacity. There are benefits to be gained simply from mode shift from air or road to diesel rail and these benefits are increased further from an additional shift to an electric or non-diesel rail service.

The National Infrastructure Commission (December 2018)[76] report advised that per tonne kilometre, rail emits only about a quarter of the CO2 of road freight. Across the UK, in 2017, the heavy goods vehicle (HGV) sector contributed around 25 MtCO2e per year. The entire UK rail sector contributes around 3 MtCO2e per year. Accordingly, a 10% modal shift of HGV traffic to rail would reduce almost as much annual CO2 as the entire rail industry currently emits. Electrification of the network would extend the capability of existing electric-traction rail freight and encourage conversion from diesel rail freight which, if allied to network improvements such as connections to ports and expansion of freight depots, could make a substantial contribution to achieving modal shift and significantly improving the health of the environment. A small amount of infill electrification could enable significantly more rail freight to be hauled by electric traction.

As Transport Scotland Rail Services Decarbonisation Action Plan[77] states, newly electrified passenger railway lines often show what is known as a 'sparks effect' - a term coined to describe experience in Britain which noted that if a line was electrified patronage increased. The reasons for the increase are due to newly electrified lines often utilising modern rolling stock which is smoother, quieter and faster. Electric trains are lighter than their diesel counterparts and therefore cause less wear on the tracks.

[75] Rail Decarbonisation Action Plan, Transport Scotland, July 2020
[76] https://nic.org.uk/app/uploads/Future-of-Freight-Interim-Report-2.pdf
[77] https://www.transport.gov.scot/media/47906/rail-services-decarbonisation-action-plan.pdf

However, electrification through overhead wires has challenges. The only alternative to diesel that can run freight or passenger services at high speed with zero carbon emissions. Electric trains require electrification of the network which comes at a high cost and long delivery times, with trains being powered from the grid at the point of use. Trains travelling at peak electricity demand time uses a combination of renewable and fossil fuels, compromising decarbonisation impact. Regarding delivery of electrification, it can also be highly carbon intensive and would need to be offset by carbon saving measures.

Battery powered trains

Batteries can be charged from a variety of sources including, overhead wires or hydrogen fuel cells. As is already being seen on the UK's rail network, existing, good-quality rolling stock is being fitted with batteries meaning new rolling stock is not required. As set out in the BBC Future analysis, Hitachi Rail and battery company Hyperdrive Innovation have partnered to develop a battery pack suitable for powering trains – they estimate that there is a potential market for 400 battery trains in the UK[78].

Battery-powered trains can be used on either non-electrified or electrified railways. On electrified lines, they will be recharged by the overhead wires. On shorter branch lines with less frequent services, where electrification may not be economical, they can be recharged between services. Hitachi have commented that battery trains have 50% lower life-cycle costs than hydrogen trains[79].

However, longer distance journeys on battery powered trains are currently less feasible.

Hydrogen

Hydrogen is the lightest, simplest and most abundant chemical element in the universe. As set out in the 10 Point Plan for Decarbonisation, the aim is for the UK to develop 5GW of low carbon hydrogen production capacity by 2030 that could see the UK benefit from around 8,000 jobs. This includes Hubs where renewable energy, CCUS and hydrogen congregate, with industrial 'SuperPlaces' at the forefront of technological development[80].

Similar to battery power, hydrogen trains can be used on a combination of electrified and non-electrified lines (they are not reliant on the overhead wires to charge). It is possible to refit existing, good-quality diesel rolling stock with hydrogen fuel technology meaning new rolling stock is not required. For example, the Porterbrook Hydroflex fit an existing Class 319 train with new hydrogen technology (this started trial operations on the mainline network in September 2020).[81]

Hydrogen powered trains could be an option for non-strategic lines and lines where electrification is challenging, with longer distance journeys currently not

[78] https://hyperdriveinnovation.com/insights/news/hitachi-rail-and-hyperdrive-agreement-opens-way-for-battery-trains-across-britain/
[79] https://www.theengineer.co.uk/sncf-signs-with-alstom-for-hydrogen-trains/
[80] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title
[81] https://www.ashurst.com/en/news-and-insights/insights/decarbonisation-of-the-rail-industry/

feasible. Hydrogen also takes up more space than diesel which is problematic in the UK where the trains kinematic envelope needs to fit Victorian infrastructure and tunnels.

Regarding the wider supply chain, it is highlighted that there is currently a small, growing hydrogen economy. Whilst technology developments are promising there is no economy of scale so that the price of hydrogen is high compared to other alternatives.

Hydrogen trains could be a feature of the UKNET in the future, but further development is required. For both battery and hydrogen operated trains, these technologies are not currently capable of pulling freight trains.

Shipping fuel

The shipping industry currently emits 3% of all greenhouse gases.[82] Hydrogen is also being explored as an alternative for cargo ships and ferries. Synthetic fuels are seen as a particularly promising solution as they can be made using clean electricity – such as solar or wind power – and burned without emitting any greenhouse gases.

Biofuels made from plant materials or animal waste could also be an option for all transport modes, but the transport sector is not the only sector planning to use sustainable energy means, which can limit supply.

Batteries charged using renewable electricity could be an option for short distance ferries, such as those across the Irish Sea, however there will likely be limits on the distance these can power, and the size and scale of the batteries required to run them.

The 10 Point Plan for Decarbonisation also set out an invest of £20 million into the Clean Maritime Demonstration Programme to develop clean maritime technology[83]. This includes the running of hydrogen ferry trials in Orkney and the launch a hydrogen refuelling port in Teesside.

Steamology, is in the early stages of developing steam-powered hydrogen electricity and received Government First of a Kind investment[84]. Steam created by burning hydrogen with pure oxygen from a tank is used to drive a turbine, generating electricity. The technology is currently being tested in trains but has strong potential to be used in the shipping sector.

Aviation fuel

The Government has stated that the UK will be at the forefront of aviation and maritime technology to push forward low carbon travel and build on UK strengths. This includes taking immediate steps to drive the uptake of sustainable aviation fuels, investments in R&D to develop zero-emission aircraft and

[82] https://www.bbc.com/future/article/20201127-how-hydrogen-fuel-could-decarbonise-shipping

[83] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title
[84] https://www.bbc.com/future/article/20201127-how-hydrogen-fuel-could-decarbonise-shipping

developing the infrastructure of the future at our airports and seaports – with the UK the home of green ships and planes.

The Jet Zero Council has been established as a partnership between industry and government with the aim of delivering zero-emission transatlantic flight within a generation, driving the ambitious delivery of new technologies and innovative ways to cut aviation emissions. The Government will set out its strategy to reach net zero aviation later this year.

Government is funding the £15m FlyZero project – a 12-month study, delivered through the Aerospace Technology Institute (ATI), into the strategic, technical and commercial issues in designing and developing zero-emission aircraft that could enter service in 2030[85].

The Government is funding the £15 million 'Green Fuels, Green Skies' competition to support the production of Sustainable Aviation Fuels (SAF) in the UK, building on the success of the Future, Fuels for Freight and Flight Competition[86]. The Government will also consult on a SAF mandate to blend greener fuels into kerosene, which will create a market-led demand for these alternative fuels. To support the emergence of a market in zero emission aircraft the Government have commissioned an R&D project on Zero Emission Flight Infrastructure to identify adaptations required at UK airports to move to battery and hydrogen aircraft.

In May 2021, flights on the route between the Danish cities Sønderborg and Copenhagen will use sustainable aviation fuel (SAF). Alsie Express is the first operator of a domestic route in Denmark to use aviation fuel made from sustainably sourced, renewable waste and residue raw materials, helping to reduce the carbon emissions of its flights. In its neat form, SAF reduces CO2 lifecycle emissions by up to 80% compared to fossil jet fuels.[87]

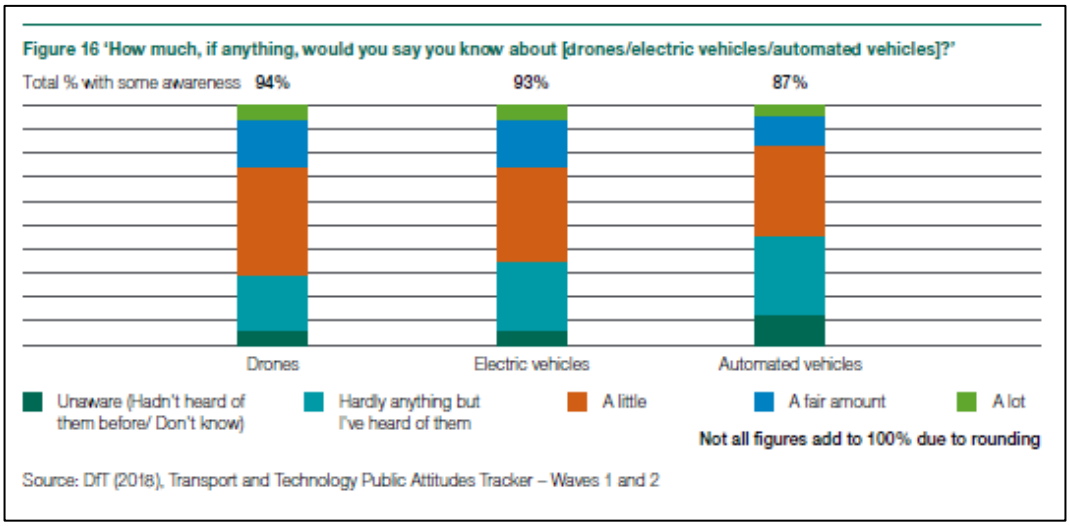
6.6.2 Data and mobility

As the Future of Mobility Urban Strategy[88] noted, the proportion of 18 to 75-year-olds owning or having access to a smartphone increased from 52% in 2012 to 87% in 2018. Nearly 9 in 10 smartphone users (87%) use their phones for travel purposes, with navigation and route planning being the most popular uses.

The increasing availability of data and improved connectivity is allowing transport users to better plan multi-model journeys with confidence and knowledge. This includes through open data and app developers provide new platforms.

However, more needs to be done to explain to transport users what the future modes are, with the graphics below show high levels of people unaware of drones, electric vehicles, and automated vehicles.

[85] https://www.ati.org.uk/events-media/news-blog/ati-launches-flyzero-initiative/
[86] https://www.gov.uk/government/news/jet-zero-launches-15-millioncompetition-to-reduce-aviation-emissions
[87] https://www.shellaviation.dk/post/first-domestic-route-in-denmark-to-use-sustainable-aviation-fuel
[88] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf



Increasing levels of data are also fuelling advances in machine learning, a branch of artificial intelligence allowing systems to learn and improve by identifying patterns in data, without being explicitly programmed. The applications of machine learning to transport include enabling self-driving vehicles, identifying congested areas and more accurately predicting bus times.

Connected and Autonomous Vehicles

Vehicles are already capable of communicating with each other and with infrastructure have the potential to provide information to network operators and users in real time to optimise fleet and network management. As the Future of Mobility Urban Strategy[89] notes, there are at least 3 million vehicles with internet connectivity on UK roads, with 50% of new vehicles connected by 2020.

Technology is already being used to maximise the capacity of the existing road network. For instance, Split Cycle Offset Optimisation Technique uses data from vehicle detectors and optimises traffic signal settings to reduce vehicle delays and stops. Technology could provide further opportunities in future to tackle congestion, bringing environmental, social and economic benefits on the UKNET.

Connected and Autonomous Vehicles could enable smoother driving, reduce accident-induced delays and improve overall network management. It has been estimated that even a low (25%) penetration of connected and self-driving vehicles in urban areas could lead to peak journey time savings of 21% and a reduction in journey time variability of nearly 80%[90]. Self-driving vehicles and the increased use of data and mobile applications to assist journeys should make it easier for disabled people and older people to get around. A recent study found that the cost of running a self-driving ride-sharing service with an on-board steward could be 26-41% cheaper than current 'Dial-a-Ride' services, in addition to offering a more integrated booking platform.

[89] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf
[90] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf

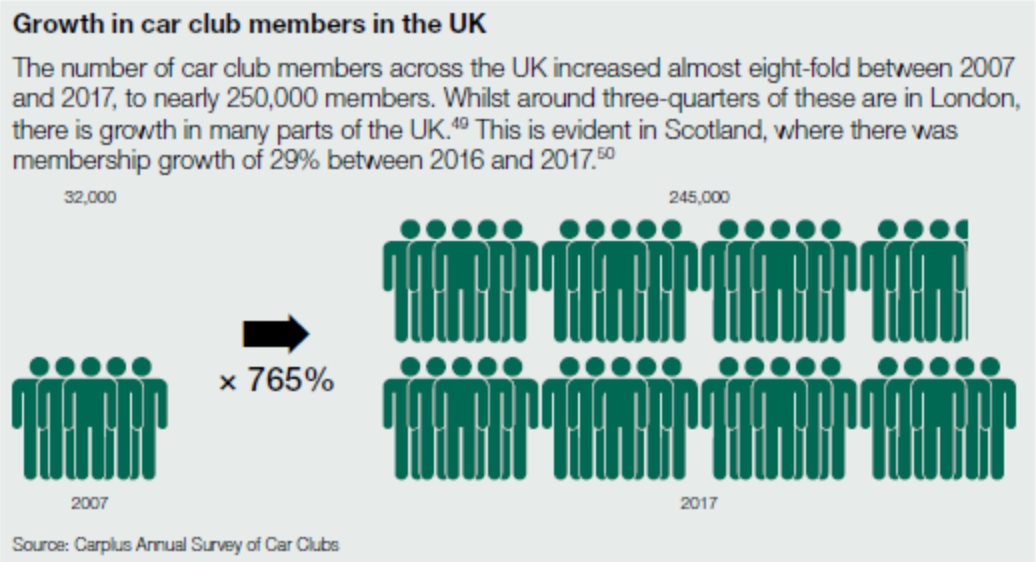
Connected and Autonomous Vehicles called become a key feature of the strategic transport network, with supporting infrastructure by the public and private sector likely to be required to support the safe and effective movement of vehicles.

Car sharing and Mobility as a Service

While public transport remains a fundamental form of shared mobility, new models based on shared use or ownership of vehicles are fast developing, enabled by digital platforms, and changing owner habits and greater embracing of the shared economy.

As Figure 56 shows, in the 10-year period from 2007-2017, there was a substantial uptake in car club memberships across the UK.

Figure 56 – Car club membership in the UK



Mobility as a Service (MaaS) is also emerging as a possible shared transport offering. It is a systematic, data-led approach to mobility that enables users to plan, book and pay for multiple types of transport service through a centralised channel or platform, such as a digital app. Essentially, MaaS brings together journey planning, ticketing, reservation and payment services to a fully integrated system.

A Connected Place Catapult report explored the opportunity for Mobility as a Service in the UK. The report[91] found that MaaS could provide users with convenience and value to meet their mobility needs. Users might utilise the MaaS system for the whole trip, or just specific journey segments. The aim is to provide viable alternative options to use of the private car to promote more efficient and sustainable modes. Demand Response Transport (DRT) is also form of flexible shared transport that provides on-demand transport options for people who live near one another and want to travel in the same direction at the same time. It is likely to play a key role in rural areas as it can provide a convenient option in

[91] https://ts.catapult.org.uk/wp-content/uploads/2016/07/Mobility-as-a-Service_Exploring-the-Opportunity-for-MaaS-in-the-UK-Web.pdf

places where the public transport offer is poor or non-existent. Its flexibility means that it can also respond quickly where demand is changeable.

The better integrated these transport options can be, the easier and more attractive they become as an alternative to the car. This may address some intra-corridor movements on the strategic transport network in the future.

Air Taxis

UK Research and Innovation commissioned PwC UK to undertake a study to develop a holistic framework that can be used to assess the potential costs and benefits of certain use cases selected by the FFC. The framework has been tested on six different use cases which represent potentially valuable applications of new aviation technologies. One of these that could be relevant for the UKNET is Air Taxis.

The sub-regional use case focuses on a journey of about 68 miles from York to Preston. These two cities were chosen to illustrate an instance where there is no direct route by rail, so the distance travelled is much longer than the direct distance. The work compared the differences in costs for an individual using an air mobility vehicle (the use case) to travel from York to Preston with travel by train (the business as usual).

The analysis suggested the costs of using air taxis for interregional journeys between two areas with relatively poor transport connectivity are around 47% lower compared to the use of trains in the business as usual scenario. The key driver of the cost difference is the time taken to complete the journey, which is expected to be around 2 hours faster in the use case. As a result, the time costs for passengers using the train (business as usual) are £90 compared with £38 in the use case.

Although these present interesting findings, the technology is still emerging, but could support connectivity on key parts of the UKNET in the future.

Hyperloop

The Hyperloop concept is an emerging mode of ultra-fast transportation that could transform the way we travel. Using electromagnetic propulsion in steel tubes evacuated from air, Hyperloop could achieve speeds of up to 670mph, combining the speed of air travel with the convenience of high-speed rail and the frequency of a metro system.

Arup research has identified three typical settings whereby Hyperloop could have the potential to radically transform the wider economy on a local, regional, and global level.

- City Superhubs – Hyperloop technology could unlock new levels of agglomeration economies. With radically reduced journey times, towns and cities that are currently isolated from one another could be integrated to form large economic hubs. City centre could be connected to ports and airports to operate as one mega-city.

- National Metro – Hyperloop could enable countries to operate as large urban areas currently do. Economic growth could be more evenly distributed, and housing challenges addressed through national-scale commuter networks.
- Long Distance – On a larger scale, Hyperloop could minimise trafficked air routes, grow established business markets, and open opportunities for international commuting. This would redefine international travel and accessibility, reduce carbon footprint as Hyperloop aims to use green energy for operation, and could facilitate better collaboration between national economies.

In addition, we have investigated viable operational models, station footprints, and infrastructure designs that could support the implementation of a Hyperloop system. We have estimated and compared typical CAPEX and OPEX values to demand cases and associated revenue models to conclude on the benefits on this mode of transport. In particular, we stipulate that:

- hyperloop has potential to reduce the end-to-end high-speed rail journey time by 50% and lower end-to-end journey times than air travel for city centre connections;
- optimal operational models and station footprints will vary depending on use cases but would often be comparable to metro schemes;
- there are cost opportunities to be achieved in integrating the infrastructure and technology designs which would significantly reduce payback time; and
- there are parameters under which Hyperloop is expected to make a significant operating surplus, which could pay off capital costs.

Hyperloop is however still in concept development, and not as developed as existing modes of road and rail transport solutions. If developed successfully in the future, it could form part of the UKNET.

6.7 The movement of goods

Online shopping and package delivery

Prior to Covid-19 we had seen an increase in the convenience and popularity of online shopping and home deliveries. It was also associated with some physical becoming digital goods. It is increasing in its popularity due to increasing affordable, with consumers expect online purchases to arrive promptly.

There have been reductions in shopping trips and the use of the high street, with decreases of 30% over the past decade, coinciding with a rise in online shopping, which now represents almost 17% of total UK retail sales. However, as the Future of Mobility Last Mile Urban Freight report highlights, the evidence gaps around freight deliveries mean the net impacts of online shopping on traffic are uncertain.

To support this increased demand, there are current and emerging forms of micro-mobility, providing ever more options for the movement of people and goods. These include electric scooters, electrically assisted pedal cycles (e-bikes) and e-cargo bikes. Light electric freight vehicles could carry out 10-15% of delivery vehicle trips in cities.

There are also new models of high-speed rail freight services (InterCity Railfreight, Orion) which are offering new city-to-city freight solutions for smaller packages/parcels. These services could also connect with low carbon last mile delivery solutions (such as e-cargo bikes). These services will help provide environmental benefits and help reduce congestion.[92] These high-speed freight services could become a greater feature on the UKNET in the future.

Drones

Drones are increasingly being used to address local needs, from supporting emergency services to improving the safety of infrastructure inspections and providing urgent medical supplies from England to the Isle of Wight.

As part of DfT's developing Aviation Strategy and the Aerospace Sector Deal, we are considering the role that new potential air mobility solutions, such as vertical take-off and landing (VTOL) concepts, could play in transforming aerial mobility and improving regional connectivity.

The Connected Places Catapult has been developing a Pathfinder Programme aimed at enabling integration of drones. The Programme has focussed on identifying and overcoming the technical, operational, and commercial barriers, providing a platform for industry innovators to engage with government and the regulator at early stages, to jointly explore solutions and share information throughout the community.

It is envisaged that this will assist in optimising the use of drones in the private and public sectors, enabling efficiency savings, improving their capabilities. The Programme will continue to explore solutions for safe, routine beyond visual line of sight (BVLOS) drone operations across a range of application.

In another case study for the UK Research and Innovation work by PwC UK, the attractiveness drones transporting goods between Inverness and Kirkwall was assessed. The analysis suggested the total costs of transporting mail from Inverness to Kirkwall would be around 35% lower in the use case compared with business as usual.

Drones could play a role in the movement of goods to and from the UKNET in the future, building on the existing trials to date. This could include transporting goods across challenging physical barriers, such as the Irish Sea, the Pennines, and the Highlands and Islands of Scotland.

[92] https://www.railfreight.com/business/2020/08/20/new-style-rail-parcels-nearer-to-delivery/?gdpr=accept

6.8 Conclusions

In conclusion, investment in the UKNET will need to respond to behavioural and technological changes in the short and medium term. Some of these are more known and understood, such as modal trends to date, the use of personal mobile means, and forecasted areas for economic and population growth.

It is also still to be understood what the long-term behavioural and economic changes may be after Covid-19, such as modes of choice, work-home choices, and even greater reliance on home deliveries. Compounded with Covid-19, it is still to be understood what leaving the European Union may mean for the movement of people and goods through the UK.

Technological innovation and interventions are developing at pace, such as greener and cleaner fuels that can use the existing transport system; this makes it easier to understand what this may mean for the existing and enhanced network, and what interventions are required to unlock these.

Disruptors and future mobility, such as drone and CAVs, are still in earlier stages of development and implementation, and at this stage not a viable alternative to current road, rail, aviation and maritime modes.

7 Network Improvements

This chapter identifies and prioritises the improvements across the proposed UKNET which best align with the objectives of the Union Connectivity Review, as set out in the Assessment Framework.

The method for generating a longlist of infrastructure improvements is first set out, followed by the RAG assessment of this longlist against the UCR criteria. The assessment of the infrastructure longlist is presented by geographic corridor rather than by mode; this enables an integrated approach, where rail improvements can be considered as possible solutions for road problems and vice versa.

The chapter then progresses to discuss recommendations for policy improvements to better serve the proposed UKNET. The focus is predominantly on the aviation and maritime sectors where the role of government in influencing changes in connectivity is largely through policy levers, rather than infrastructure interventions (although infrastructure improvements do play an important role in improving access to ports and airports).

All improvements, whether infrastructure or policy, have been assessed against the UCR criteria to determine which improvements are included in the final recommendations.

7.1 Infrastructure Improvements

7.1.1 Identifying a longlist of infrastructure improvements

The following method was followed to identify a longlist of infrastructure improvements for the proposed UKNET by corridor. This includes a mixture of road and rail infrastructure connections and some corridors where both may be required.

1. The areas or routes for improvement highlighted by transport agencies and bodies (e.g. Highways England, Network Rail, Transport for the North) and by devolved government representatives (e.g., Welsh Government Transport Directorate) in their call for evidence submissions.
2. Further analysis and evidence gathered by the Arup team in the Network Review by mode (and by corridor) drawing on the wider Call for Evidence submissions as well as from published reports and publicly available statistics.
3. The network was checked for any ‘missing links’. That is, where two places are connected on the UKNET schematic map, but there is no direct road or rail connection (e.g., Oxford ←→ Cambridge for rail).
4. For each area of improvement, the main aspect(s) in need of improvement was determined (e.g., journey time, capacity, resilience).

5. Where schemes are already committed to address the areas for improvement (e.g., London ←→ Birmingham HS2 Phase One, dualling the A9 between Perth and Inverness), these improvements were filtered out from the long list.

6. Checks were undertaken of the long list against the corridor review to ensure no important areas had been omitted.

7. The long list was reviewed by internal experts and discussed with DfT analysts, to ensure no important areas had been omitted. Where required, areas for improvement were added based on this review.

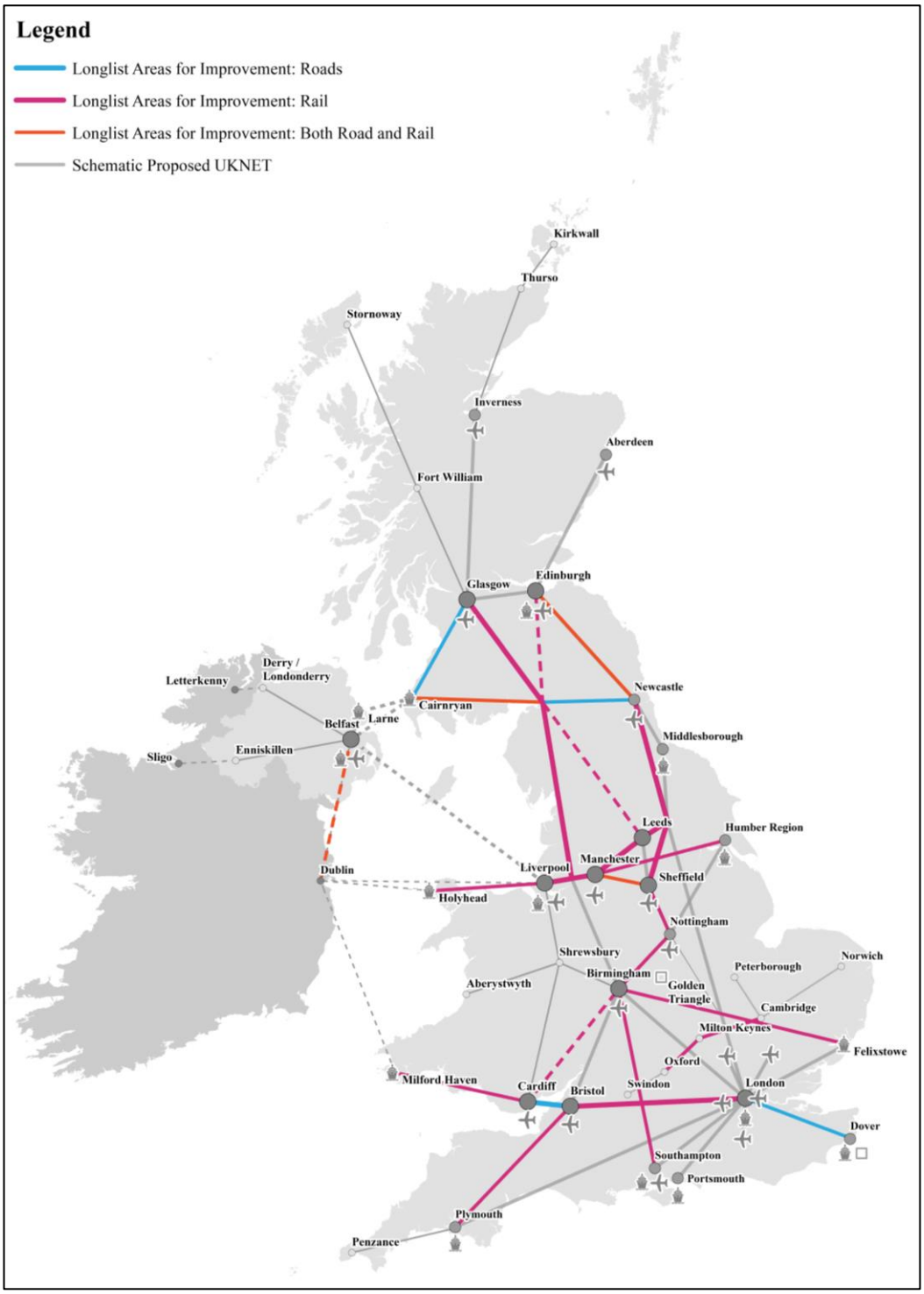
Following this method, a total of twenty-six areas for infrastructure improvement were identified as part of the longlist as illustrated on Figure 57 and summarised in Table 14 by road/rail. These improvements are described in more detail in the following sub-section.

The specific means for addressing the issues identified has deliberately not been defined in most cases, although some areas of improvement already have potential solutions outlined as part of strategic studies undertaken by one of the transport agencies or bodies (these strategic studies are not considered committed and as such have been included in this list).

In most cases, further optioneering analysis and business case development will be required for each improvement area that is beyond the scope of this study. This will require more detailed analysis of the specific challenges in these areas and the options for addressing them. In some cases, this will be limited to a single mode of transport (e.g., the rail network) and in others, there may be a need to look across all modes of transport. Whilst improvements to the road network provide benefit to road users (passengers and freight) they also include the potential for strategic public transport improvements by bus and coach as well as the opportunity to provide more localised improvements in active travel.

In some cases, the network improvements required to address issues within the road network could be delivered through a mixture of improvements across different modes of transport, such as the proposals for improvements on the M4 corridor as part of the South Wales Transport Commission. This will allow emerging policy such as that established by the Welsh Government freezing all new road building projects, to be considered in detail.

Figure 57 – The longlist of areas for improvement on the proposed UKNET



Source – Arup analysis

Figure 58 – The longlist of road and rail network improvements

Corridor	Area for Improvement	ID
West Coast	West Coast Mainline North of Crewe	A
	Glasgow - Leeds / Sheffield	B
	Carlisle – Edinburgh	C
East Coast	A1 Improvements	D
	East Coast Mainline North of Northallerton	E
North Channel	A69 Capacity	F
	A75 Capacity	G
	A77 Capacity	H
	Stranraer – Dumfries	I
Central Northern	Trans-Pennine Corridor	J
	Rail Connections Between Northern English Cities	K
North Wales	North Wales Coast Line	L
Welsh Marches	Cardiff - Midlands / Yorkshire & NE	M
South Wales	Severn Resilience	N
	Bristol – Cardiff	O
	South Wales Mainline West of Cardiff	P
	Western Access to Heathrow	Q
Central Midlands	Birmingham - Notts / Sheffield / Leeds	R
	Birmingham – Felixstowe	S
	Oxford – Cambridge	T
South West	Exeter - Plymouth / Penzance	U
Kent	A2 Dover Access	V
	M25 South West Quadrant	W
Southern Central	Birmingham – Solent	X
Northern Ireland	Belfast – Dublin	Y
	Belfast – Dublin	Z

Source –Arup

7.1.2 Assessing the infrastructure longlist by corridor

This section progresses through each of the geographic corridors defined in Chapter 5, describing the longlist of improvements on that corridor and then ranking each improvement by applying the RAG assessment framework. The framework enables the evaluation of which improvements best support the objectives of this review. The rationale for each ranking is provided as an appendix to this report.

The environmental impact of any intervention is an essential consideration of this Review, as set out in the Assessment Framework Chapter. Therefore, a more thorough assessment underlies the Environmental RAG score for each longlisted improvement. The full environmental assessment is included in Appendix E.

There were no issues longlisted within the **South Coast Corridor**, the **Eastern Corridor**, the **Central Scotland Corridor** or the **Scottish Coast Corridor**, either for rail or road. This is the case because:

- there were no calls for improvement in these corridors in the key Call for Evidence submissions from leading industry bodies, or the improvements cited were on road and rail connections excluded from the proposed UKNET; and
- there was no clear evidence from our analysis that improvements should be added to the longlist for these corridors.

West Coast Corridor

Longlist Areas for Road Improvement

None included in longlist: There are congestion issues on the M6 north of Birmingham and more generally in the North West of England. However, the M54/M6 Link Road is already committed for Road Period 2, so this has not been included in the longlist of network improvements.

Longlist Areas for Rail Improvements

West Coast Mainline north of Crewe: Infrastructure (rather than on-train) capacity constraints for both freight and passenger services. Once HS2 is operational, journey times on the West Coast corridor between Crewe and Scotland will be (in proportion to distance) much longer than between London and Manchester. Improvements to journey times north of Crewe could unlock mode shift from aviation for long-distance cross-border routes such as London-Glasgow. *Main Source: Network Rail*

Glasgow - Leeds / Sheffield: A new direct route between Glasgow and Leeds/Sheffield via the Settle and Carlisle Line would potentially offer a faster journey time than the existing service via the East Coast Mainline. This would also relieve some congestion on the northern section of the East Coast Mainline. *Main Source: CrossCountry*

Carlisle - Edinburgh: Extension of the Borders Railway from Galashiels to Carlisle would provide resilience to the West Coast Mainline between Carlisle and Edinburgh and improve journeys in and around the Scottish/English borderlands. *Main Sources: HSRG, Secretary of State for Scotland*

Multi-Modal Considerations

Road based solutions would not effectively address the problems with the rail network in this corridor.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
West Coast Mainline north of Crewe	G	G	G	A	G	A	A	G	A	A	A
Glasgow - Leeds / Sheffield	G	A	A	R	G	R	R	A	A	A	A
Carlisle - Edinburgh	A	A	A	R	A	R	G	R	A	A	R

East Coast Corridor

Longlist Areas for Road Improvement

A1 Improvements: Single carriageway sections between Ellingham and Edinburgh, issues during maintenance or accidents leading to poor journey time reliability. Non-continuous motorway designation causing safety issues on this route.

Longlist Areas for Rail Improvements

East Coast Mainline North of Northallerton: Infrastructure (rather than on-train) capacity, particularly the bottleneck between Northallerton and Newcastle, constrains the freight and passenger paths that can operate on the East Coast Main Line, including cross-border services. *Main Source: Network Rail, Arup rail experts*

Multi-Modal Considerations

The road network problems cannot be comprehensively addressed by rail enhancements in this corridor. Challenges with the rail network will not be addressed by enhancing the road network. The full business case for the A1 improvements should consider to what extent the challenges on the road network can be addressed by a switch in demand from road to rail.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
A1 Improvements	G	A	A	R	G	A	G	A	A	A	R
East Coast Mainline North of Northallerton	G	G	A	A	G	A	A	G	A	A	A

Northern Channel Corridor

Longlist Areas for Road Improvement

A69 Capacity: Single carriageway sections with high volumes of HGV demand (18% of overall traffic on weekdays), insufficient capacity to form an alternative route between A1/A1(M) and M6 for network resilience. A66 Northern Trans Pennine dualling committed in RP2 may provide some of the east-west resilience for this corridor. Increase capacity on the A69 through dualling single carriageway sections to provide resilience.

A75 Capacity: Single carriageway sections with high volumes of HGVs. Resilience and reliability issues in the event of an incident. HGVs limited to 40mph on single carriageway roads, particularly an issue for disembarkation when HGVs are released in waves.

A77 Capacity: Same issues as A75

Longlist Areas for Rail Improvements

Stranraer - Dumfries: In the event that a Fixed Link is constructed for rail travel between Stranraer and Northern Ireland, rail connectivity between Dumfries and Stranraer would need to be provided for both passenger and freight services. This would facilitate a connection between the Fixed Link and Carlisle for onward connectivity via the West Coast Mainline. *Main Source: Fixed Link Technical Advisors*

Multi-Modal Considerations

If a Fixed Link were to be constructed and the rail line re-opened, there could be a material reduction in road demand, particularly on the A75. The future of the Fixed Link should be determined before final decisions are taken on the option for and extent of any road investment in the corridor.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
A69 Capacity	A	A	A	A	A	A	R	A	A	A	R
A75 Capacity	G	A	G	G	G	A	A	A	A	A	A
A77 Capacity	G	A	G	G	A	R	A	A	A	A	A
Stranraer – Dumfries*	G	G	G	A	A	A	G	A	A	A	A

**This improvement is considered (and assessed) on the basis that a Fixed Link is constructed between Stranraer and Northern Ireland.*

Central Northern Corridor

Longlist Areas for Road Improvement

Trans-Pennine Corridor: M62 is the only motorway standard east-west route in north of England and carries half of all Trans-Pennine traffic including the majority of road freight - set to increase by 23% by 2050. There are existing capacity issues on this route. Options are being considered on improving connectivity focussing on Manchester to Sheffield. The Trans-Pennine tunnel study and the Central Pennines study are both being considered for this area.

Longlist Areas for Rail Improvements

Rail Connections Between Northern English Cities: Poor passenger and freight rail connectivity across several metrics including journey times, frequencies, infrastructure capacity, crowding and freight gauge. Northern Powerhouse Rail is being developed to deliver major improvement but is not committed at the time of writing. This is also important for the connectivity of North Wales, with infrastructure capacity constraints in the North of England currently limiting service frequencies (lots of competing regional requirements)**.** *Main Source: Transport for the North*

Multi-Modal Considerations

Potential Trans Pennine road and rail improvements should be considered in an integrated way and developed in partnership to maximise benefits and ensure maximum consideration is being given to reallocating demand from road to rail where possible.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Trans-Pennine Corridor	A	G	G	A	A	A	R	R	A	A	A
Rail Connections Between Northern English Cities	A	G	G	A	G	G	R	G	A	A	A

North Wales Corridor

Longlist Areas for Road Improvement

None included in longlist: The A55 is key for freight connectivity and suffers from seasonal congestion and congestion on approach to urban areas. However, there are committed/more than likely schemes on the A55 (3rd Menai Crossing, planned; Flintshire Corridor Scheme, WelTAG Stage 3; J14-16, European funding secured)) which seek to address these issues, so they are not included in the longlist. There is also a committed scheme on the M56 (J6-8 Smart Motorway) connection across the border to Warrington.
NB: Following the announcement on 22nd June 2021 that the Welsh Government has announced a freeze on all road building projects, there may be implications for highway schemes across Wales which have not already begun construction.

Longlist Areas for Rail Improvements

North Wales Coast Line (and onward connections into the north-west of England): Improved line speed on the North Wales Coast Line would boost connectivity between North Wales and England. This would also better link North Wales into the benefits of HS2 and NPR (if and) when operational, and to international flights at Manchester Airport. Capacity constraints at Chester Station limit service frequencies on the line and onward connectivity to the North of England. *Main Source: Welsh Government Transport Directorate*

Multi-Modal Considerations

Potential North Wales road and rail improvements should be considered in an integrated way and developed in partnership to maximise benefits and ensure maximum consideration is being given to reallocating demand from road to rail where possible. A high-frequency coach connection from Chester to Manchester Airport would build on any improvement to the North Wales Coast Line.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
North Wales Coast Line	G	A	A	G	G	G	G	A	A	A	R

Welsh Marches Corridor

Longlist Areas for Road Improvement

None included in longlist: Road problems have been identified on this corridor; for example, delays on the A49 and A5, and congestion on the A483. However, these roads are part of 'Regional Networks' (see schematic representation of the proposed UKNET) rather than part of the proposed UKNET. As such, they are not considered in the longlist for this study.
NB: Following the announcement on 22nd June 2021 that the Welsh Government has announced a freeze on all road building projects, there may be implications for highway schemes across Wales which have not already begun construction

Longlist Areas for Rail Improvements

Cardiff - Midlands / Yorkshire and North-East: Improvements to the quality (particularly journey time) and range of direct connections between Cardiff and major English & Scottish cities (Birmingham and on to Sheffield, Yorkshire, Newcastle and Scotland) would enhance the connectivity of the Welsh capital. The options for improvement on the corridor are numerous with widely varying levels of ambition: from deploying better rolling stock on the line from Cardiff to Birmingham, to HRSG's suggestion of extending HS2 from Birmingham to Cardiff to form an X-shape. A direct through service from Cardiff to Edinburgh via Birmingham and Leeds could be implemented, and the Midlands Rail Hub programme would also bring some improvement. *Main Source: HSRG, Arup rail experts*

Multi-Modal Considerations

None

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Cardiff - Midlands / Yorkshire & NE	G	A	A	A	A	A	A	G	A	A	A

South Wales Corridor	**Longlist Areas for Road Improvement**
	Severn Resilience: Traffic flows on the Severn Crossings are expected to increase significantly between 2015 and 2041. The Severn Crossing tolls were removed in December 2018 resulting in an increase in cross-border flows between England and Wales. The Severn resilience package, a RIS 3 pipeline scheme, will develop a package of possible improvements to sections of the M4, M5 and M32 motorways on the eastern side of the Severn Crossing, to tackle current and future congestion levels. **Bristol – Cardiff:** There is severe congestion on the M4 in South East Wales, with congestion in the most severely affected locations extending for at least 3.5 miles. The M4 Corridor around Newport scheme was previously proposed as an option in this location, effectively creating a bypass to the south of Newport between Junctions 23 and 29, the First Minister of Wales decided in June 2019 that the Welsh Government would not fund this project due to cost and impact on the environment. Following this decision, the strategic study by the South East Wales Transport Commission has proposed a multi-modal solution to address congestion issues, which is included under rail in the table below. *NB: Following the announcement on 22nd June 2021 that the Welsh Government has announced a freeze on all road building projects, there may be implications for highway schemes across Wales which have not already begun construction. The Severn Resilience scheme included above is on the English side of the Wales-England border, so is not expected to be directly affected by this freeze on road building projects*
	Longlist Areas for Rail Improvements
	South Wales Mainline West of Cardiff: Line speeds west of Cardiff could be improved to reduce journey times for people and businesses travelling between south Wales and Cardiff. Journeys between Bristol and south Wales (west of Cardiff) must transfer at Cardiff, adding time and inconvenience to journeys. Track capacity constraints, with long and short distance passenger services and freight services sharing the track, limit frequencies and the service level. *Main Source: Welsh Government Transport Directorate* **Western Access to Heathrow:** Lack of rail connectivity into Heathrow from the West. Cardiff and South Wales would particularly benefit from improved international connectivity if Western Rail Link to Heathrow was constructed, providing a direct link and significantly reducing journey times. *Main Source: CBI Wales*
	Multi-Modal Considerations
	A viable alternative solution to enhancing the M4 is improvement to the rail service between Bristol and Cardiff. The 'network of alternatives' recommended by the South East Wales Transport Commission includes utilisation of the Relief lines to provide additional services and serve new stations, attracting demand away from the M4. Taking a multi-modal approach to addressing the transport connectivity problems between Bristol and Cardiff is recommended and therefore included as a separate package of improvement for assessment.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Severn Resilience	G	A	G	A	A	A	R	A	A	A	A
Bristol - Cardiff (Rail-Led Solution)	G	G	G	A	A	G	R	G	A	A	A
South Wales Mainline West of Cardiff	A	A	A	A	G	A	G	G	A	A	R
Western Access to Heathrow	G	G	A	G	R	A	R	G	A	A	R

Central Midlands Corridor

Longlist Areas for Road Improvement

None included in longlist: Some overlap with other corridors where issues have been identified such as the M6 mentioned above

Longlist Areas for Rail Improvements

Birmingham - Nottingham / Sheffield / Leeds: Journey times and frequencies could be improved between the Midlands and North. Full delivery of HS2 Phase 2b, combined with the more local improvements proposed by Midlands Rail Hub, would deliver this improvement. This improvement has some overlap with the 'Cardiff - Midlands / Yorkshire and North-East' improvement on the longlist – this would go some way to improving connectivity between Cardiff and the north-east of England. *Main Source: Midlands Rail Hub, HS2*

Birmingham – Felixstowe: This is an important freight artery which connects Felixstowe to the West Coast Mainline and onward to all four countries of the UK. Improvements to infrastructure capacity for freight would boost supply chains and growth. This would likely involve completion of the Felixstowe to Nuneaton (F2N) programme. *Main Source: Arup analysis & rail experts*

Oxford – Cambridge: No direct rail connection between these important knowledge economies included along the Fast Growth Knowledge Corridor of the proposed UKNET. East West Rail is advanced in seeking to deliver this improvement, though the full line is not yet committed and so the connection is included here. *Main Source: East West Rail*

Multi-Modal Considerations

None

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Birmingham - Notts / Sheffield / Leeds	R	G	G	A	G	G	R	G	A	A	A
Birmingham - Felixstowe	R	G	G	G	A	R	R	G	A	A	A
Oxford – Cambridge	R	G	G	R	R	G	R	G	A	A	A

South West Corridor

Longlist Areas for Road Improvement

None included in longlist: There are seasonal congestion issues, particularly on the single carriageway sections of the A30 and the A303. However, there are a number of committed schemes to address these problems, including the A303 Expressway improvements and the A358 improvements. The Chiverton to Carland Cross improvement is due to open. As such, a road improvement was not longlisted for this corridor.

Longlist Areas for Rail Improvements

Exeter - Plymouth / Penzance: Journey times and frequencies could be improved on this link, though it is challenging to improve journey times owing to route wide constraints. *Main Source: Arup analysis and rail experts*

Multi-Modal Considerations

Road solutions would not effectively address the rail problems that exist

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Exeter - Plymouth / Penzance	R	A	R	A	G	A	G	A	A	A	R

Kent Corridor

Longlist Areas for Road Improvement

A2 Dover Access: Sections of the A2 with at-grade junctions cause delays and safety issues. Resilience for Dover Port access

M25 South West Quadrant: Section of road with the highest delays on the SRN in England, with severe congestion between 0600-1800. Provides freight connectivity to Heathrow and Southampton Ports

Additionally, there are capacity issues for the eastern side of the M25 and provision for ports in the South East via this route. However, the Lower Thames Crossing is Committed for Road Period 2

Longlist Areas for Rail Improvements

None included in longlist: There were no calls for rail improvement in this corridor from the Call for Evidence. There was no clear evidence from our analysis that any additional improvement should be added.

Multi-Modal Considerations

The A2 Dover scheme focuses on freight movements and unlikely that a rail solution would be viable given cost/complexity of constructing orbital rail infrastructure for freight movements around London or accommodating an increase in freight movements on the rail network through London.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
A2 Dover Access	A	A	A	A	R	A	R	A	A	A	A
M25 South West Quadrant	A	A	A	G	R	R	R	A	A	A	A

Southern Central Corridor

Longlist Areas for Road Improvement

None included in longlist: There were no calls for road improvements in this corridor from the Call for Evidence; this is unsurprising since it is not an important corridor for cross-border flows within the Union. There was no clear evidence from our analysis that any additional improvement should be added.

Longlist Areas for Rail Improvements

Birmingham – Solent: This is an important freight artery which links into the West Coast Mainline. Most of the issues have been solved in recent years, but there is a case for further improving capacity to provide better access from the port to the rest of the UK. *Main Source: Network Rail, Arup analysis and rail experts*

Multi-Modal Considerations

None

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Birmingham - Solent	R	R	G	A	A	R	R	G	A	A	A

Northern Ireland Corridor

Longlist Areas for Road Improvement

Belfast – Dublin: This route provides for 20% of all freight demand between Great Britain and Northern Ireland. Poor connectivity between the M1 to the A1 in Northern Ireland.

Longlist Areas for Rail Improvements

Belfast – Dublin: Journey times and frequencies could be improved between these cities. An all-Island rail study has recently been commissioned which will further investigate the options. *Main Source: Network Rail*

Multi-Modal Considerations

Potential road and rail improvements should be considered in an integrated way and developed in partnership to maximise benefits and ensure demand assumptions consider other modal schemes.

Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy
	Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money
Belfast - Dublin	G	A	G	G	A	A	R	R	A	A	A
Belfast - Dublin	A	G	A	G	A	A	A	G	A	A	A

This is a UK Government review, and so the Belfast-Dublin improvements have been evaluated on their benefits to Northern Ireland and the rest of the UK, and not on their benefits to the Republic of Ireland. The overall benefit of these improvements may therefore be underestimated here, and collaborative studies such as the all-Island rail study are very important.

Having considered and scored each of the longlist improvements on a corridor basis, Figure 59and Figure 60 provide a summary of the prioritised list of improvements for road and rail. Note that each of the seven overall objectives is weighted equally in the total score of improvements. For each objective, a green ranking represents a score of three, an amber ranking a score of two, and a red ranking a score of one. If there are two criteria under a single objective, the score is averaged. Therefore, the maximum score for a scheme is twenty-one points.

Figure 59 – Longlist road improvements prioritised according to the RAG assessment

Rank	Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Environment	Technological innovation		Fiscal strategy	Score
		Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money	
1	A75 Capacity	G	A	G	G	G	A	A	A	A	A	A	**16.5**
2	A77 Capacity	G	A	G	G	A	R	A	A	A	A	A	**15**
3	Severn Resilience	G	A	G	A	A	A	R	A	A	A	A	**14.5**
3	A1 Improvements	G	A	A	R	G	A	G	A	A	A	R	**14.5**
5	Belfast - Dublin	G	A	G	G	A	A	R	R	A	A	A	**14**
6	Trans-Pennine Corridor	A	G	G	A	A	A	R	R	A	A	A	**13.5**
7	M25 SWQ	A	A	A	G	R	R	R	A	A	A	A	**12.5**
7	A2 Dover Access	A	A	A	A	R	A	R	A	A	A	A	**12.5**
7	A69 Capacity	A	A	A	A	A	A	R	A	A	A	R	**12.5**

Figure 60 – Longlist rail improvements prioritised according to the RAG assessment

Rank	Area for Improvement	Transport provision across the Union		Economic growth and recovery		Economic and social inequalities	Quality of life		Env.	Technological innovation		Fiscal strategy	Score
		Connecting the Union	Transport improvement	Increase productivity	Secure inward investment	Deliver inclusive growth	Enhance accessibility	Connections to isolated areas	Environmental Assessment (Appendix E)	Embraces emerging technologies	Flexible to shifts in demand	Delivers value for money	
1	West Coast Mainline North of Crewe	G	G	G	A	G	A	A	G	A	A	A	**17.5**
2	Rail Connections Between Northern English Cities	A	G	G	A	G	G	R	G	A	A	A	**17**
2	East Coast Mainline North of Northallerton	G	G	A	A	G	A	A	G	A	A	A	**17**
4	Bristol - Cardiff (Rail-Led Solution)	G	G	G	A	A	G	R	G	A	A	A	**16.5**
4	Birmingham - Notts / Sheffield / Leeds	R	G	G	A	G	G	R	G	A	A	A	**16.5**
6	North Wales Coast Line	G	A	A	G	G	G	G	A	A	A	R	**16**
6	Stranraer-Dumfries	G	G	G	A	A	A	G	A	A	A	A	**16**
6	Belfast - Dublin	A	G	A	G	A	A	A	G	A	A	A	**16**
9	South Wales Mainline West of Cardiff	A	A	A	A	G	A	G	G	A	A	R	**15.5**
9	Cardiff - Midlands / Yorkshire & NE	G	A	A	A	A	A	A	G	A	A	A	**15.5**
11	Birmingham - Felixstowe	R	G	G	G	A	R	R	G	A	A	A	**15**
12	Western Access to Heathrow	G	G	A	G	R	A	R	G	A	A	R	**14**
12	Glasgow - Leeds / Sheffield	G	A	A	R	G	R	R	A	A	A	A	**14**
12	Oxford - Cambridge	R	G	G	R	R	G	R	G	A	A	A	**14**
15	Exeter - Plymouth / Penzance	R	A	R	A	G	A	G	A	A	A	R	**13.5**
15	Birmingham - Solent	R	R	G	A	A	R	R	G	A	A	A	**13.5**
17	Carlisle - Edinburgh	A	A	A	R	A	R	G	R	A	A	R	**11.5**

Recommendations and Priorities

From the above assessment, a shortlist of improvements which best achieve the objectives of the review has been determined. Those improvements with an overall score of 14.5 or more out of 21 are recommended to be progressed. Note that more rail improvements exceed this threshold than road improvements. This is unsurprising since rail improvements tend to score significantly higher against the Environment criteria than road improvements. It is right that the rankings and resulting recommendations reflect the importance of the Environment and the government's commitment to achieving net zero emissions.

In all cases, further development and assessment should be undertaken to identify the best specific solution to the issues highlighted. For some improvements, there are existing studies undertaken or proposed options which have been developed, which will need to be considered.

As mentioned previously, since this is a UK Government review, Belfast-Dublin improvements have been evaluated on their benefits to Northern Ireland and the rest of the UK, and not on their benefits to the Republic of Ireland. The total benefit of these improvements may therefore be underestimated in this assessment, though the Belfast-Dublin improvements do score moderately. While this corridor has been included in the assessment owing to its high importance in connecting the Union together, **recommendations have not been made for this corridor since it is not fully within the UK**. Collaborative studies between the UK and the Republic of Ireland to understand the full benefits for both countries of improvement on this corridor are recommended.

Recommended road improvements

- **Improvements to capacity on the A75**, to deliver resilience and reliability on this route. The A75 provides a key connection between England and Southern Scotland to Northern Ireland via the ferries at Cairnryan, with a high proportion of HGV demand along the single carriageway route. This would additionally improve access to Dumfries and Locharbriggs employment centres.

- **Improvements to capacity on the A77**, to deliver resilience and reliability on this route. The A77 provides a key connection between Scotland and Northern Ireland via the ferries at Cairnryan, with a high proportion of HGV demand along the single carriageway route.

- **Severn Resilience Package on the M4 corridor**, a package of possible improvements to sections of the M4, M5 and M32 motorways on the eastern side of the Severn Crossings near Bristol to tackle current and future congestion levels following the 2018 removal of the tolls to cross the Severn bridges. This has been identified as a pipeline for Road Investment Strategy 3 but is not currently committed.

- **Improvements to the A1 (north of Ellingham to Edinburgh)**, to improve safety and journey time reliability on the single carriageway sections of the route and provide greater resilience on the cross-border routes between Scotland and England. Highways England have undertaken

a study into potential options along the A1 on the English side of the border ranging from dualling the remaining single carriageway sections in England and more targeted options, and there is a further strategic study proposed as part of the Road Investment Strategy 2. This should be considered alongside improvements to the East Coast Mainline.

Each of these scores 'green' on the 'Connecting the Union' criteria.

Recommended rail improvements

In the rail prioritisation, some improvements rank highly despite not scoring 'Green' on the 'Connecting the Union' criterion. These improvements are separated out in the shortlist recommendations. While they are not the top priority for a Review focused on connectivity of the Union, they are very important for the broader goal of improving connectivity across the whole of the proposed UKNET.

The shortlisted recommendations which are critical for Union Connectivity are as follows.

- **Improvements to capacity and journey times on the West Coast Mainline north of Crewe,** to deliver significant mode shift from aviation for England-Scotland routes and to service the increasing demand from freight and passenger services.
- **Improvements to the capacity of the East Coast Mainline north of Northallerton**, to enable more freight and passenger paths. Network Rail plan to investigate options once the Integrated Rail Plan has been published.
- **Rail-led 'network of alternatives' between Bristol and Cardiff,** to alleviate congestion on the M4. This 'network of alternative' recommended by the South East Wales Transport Commission includes utilisation of the Relief lines to provide additional services and serve new stations, attracting demand away from the M4.
- *In the event that a Fixed Link is constructed for rail travel between Stranraer and Northern Ireland,* **re-opening and upgrading of the line between Dumfries and Stranraer**, to facilitate a connection between the Fixed Link and Carlisle for onward connectivity via the West Coast Mainline.
- **Improvements to line speeds on the North Wales Coast Line**, to boost connectivity between North Wales and England, and better link North Wales into the benefits of HS2 and NPR (if and) when operational, and to international flights at Manchester Airport.
- **Improvements to the quality of direct connections between Cardiff and the Midlands, north-east England and Scotland**, to enhance the connectivity of the Welsh capital.

Additionally, the following improvements are recommended as high priority for the broader goal of delivering improvement across the proposed UKNET, but do not score 'Green' on 'Connecting the Union'.

- **Improvements to rail connections between northern English cities**. The delivery of Northern Powerhouse Rail or an alternative scheme, offering better journey times, frequencies and capacity between northern English cities is crucial to delivering improvement on the proposed UKNET.
- **Improvements to line speeds and alleviation of infrastructure capacity constraints on the South Wales Mainline west of Cardiff**, to reduce journey times and to better service the mix of short-distance passenger, long-distance passenger, and freight trips on the route.
- **Improvements to journey times and frequencies between Birmingham and the North of England**. Full delivery of HS2 Phase 2b, combined with the more local improvements proposed by Midlands Rail Hub, would deliver this improvement.
- **Improvements to freight capacity between Felixstowe and Birmingham**, to boost supply chains and economic growth. This would involve completion of the Felixstowe to Nuneaton (F2N) programme.

7.2 Policy Improvement Areas

7.2.1 Context

There are aspects of the UK transport network where changes in policy could have a significant impact on the level of connectivity provided and therefore the outcomes that will be delivered. Key policy drivers such as pricing, approaches to taxation and demand management will all impact on the connectivity provided by the existing network. In some cases, such as aviation and sea connectivity, the majority of the infrastructure is delivered and operated by the private sector and Government policy is a critical factor in creating conditions for investment and growth as well as the transformation of sectors to a low carbon future.

7.2.2 Rail

The UK rail industry is going through a period of change with the release of the 'Williams-Shapps Plan for Rail' and the forming of a new organisation called 'Great British Railways'. Consideration has been given to future operating models of the old franchise system, with private operators in future not taking on 'revenue risk' as they did in the previous franchise system. Operators will still be incentivised to improve services and increase demand.

The pandemic has had an unprecedented effect on rail travel which may one day be restored to a 'pre-covid trend' but may also be permanently affected by a shift to home working. In the short term there may be some pent-up leisure demand as people reunite with those they haven't seen during the pandemic and as people go on holiday in the UK.

One of the key driving factors of getting people back to the railways after covid and then driving future growth is pricing. *Fares reform* has been discussed in the industry for some time. Fares simplification can lead to an overall reduction in

revenue (which would need to be accounted for through additional government funding or cost savings) however there is a golden opportunity to 'reset fares' as we emerge from the pandemic and as we shift to a different operating model. Passengers would benefit from a simpler fares structure and new and/or more frequent journeys could be encouraged with a well thought through pricing system.

The infrastructure improvements assessed above were focused on specific routes and corridors for improvement. On the broader policy level, a commitment to infill electrification across the UK would improve connectivity and enable greener journeys for both rail passengers and rail freight. While this report has not been able to investigate each specific area for electrification in detail, a programme of infill electrification could bring major benefits in alignment with the objectives of this Review.

7.2.3 Road

Changes in technology or policy can influence how people make use of road infrastructure. Whether this is through increased work from home, and thus a change in commuting and leisure patterns directly and indirectly; or through the vehicles used on the roads. Policies which encourage sustainable modes of transport for first and last mile journeys have the potential to influence the overall mode choice for the whole journey. Roads will still have a part to play be it through providing for bus and coach services or for active modes.

The transition from diesel and petrol cars to electric cars has taxation implications for the government. With the reduction in fuel and vehicle excise duty on petrol and diesel during this transition, alternative revenue streams will be needed to fund the maintenance and development of infrastructure. Road pricing could be considered here. This additionally provides the opportunity to encourage a shift away from private vehicle use where it is practicable to do so – i.e. where public transport provision and active travel are convenient, affordable, and viable alternatives for an individual user for that journey purpose. This will need to be done in such a way as to ensure that those where these are not viable options are not disadvantaged, and so any future road pricing schemes would need to vary by geography based on the transport provision in that area.

Decarbonisation of road freight provides additional challenges. A shift from road to rail where possible should be undertaken along with improvements to logistics to enable greater efficiencies in delivery. Should home deliveries remain at higher levels than pre-pandemic levels, this provides the opportunity to consider how freight consolidation could further be improved, with the potential to make use of rail and cargo-bikes for home deliveries.

7.2.4 Sea

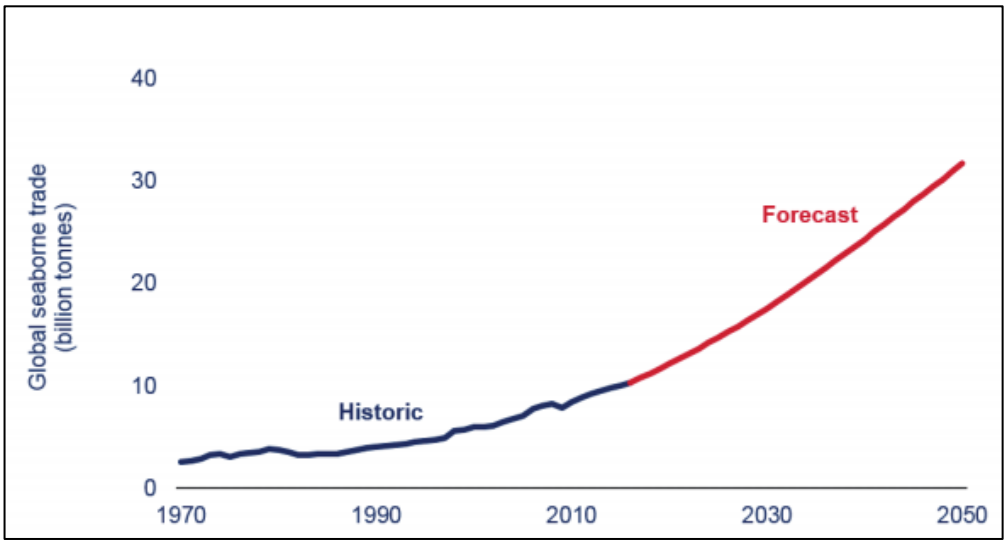
Ownership, operation and investment in sea ports is primarily the responsibility of the private sector port owners and operators. Sea routes are provided by private sector ferry operators typically without any subsidy. However, the public sector plays a significant role in supporting investment in transport routes (both road and rail) to sea ports. Current Government policy relating to sea ports is contained

within *Maritime 2050: Navigating the Future*.[93] There are several key challenges facing UKNET seaports which are summarised below.

International freight competition

The demand for global seaborne trade is continuing to accelerate with growth anticipated through 2050.

Figure 61 – Historic and projected global seaborne freight



Source – Maritime 2050, Navigating the Future, DfT, 2019

In this climate of growth, British Ports are not only competing amongst themselves to manage the import and export of international freight, but are also competing with other key European ports including Rotterdam, Le Havre etc. In order for British ports to be globally competitive and support the UK economy they need to demonstrate a competitive advantage. This can include factors like accessibility for larger container ships, the UK's fiscal competitiveness for customs and trade, technology and navigation, and the skills and maritime workforce to meet the demand. While many of these challenges fall outside of the scope of the UCR, there are key challenges related to automation and surface access to ports that should be considered by the UCR.

Automation

To maintain competitiveness there is an increasing importance for UK ports to become increasingly technologically advanced and automated for both the efficiency of moving goods as well as the safety of ports. For the UK to maintain its competitiveness and to fully embrace sea-side and land-side automation of port activities it is essential to ensure the appropriate skilled workforce is available to meet these modern port requirements.

Highly congested and constrained surface access to major seaports

The success and competitiveness of UK ports is contingent on the quality of the physical transport infrastructure links to and from seaport by road and rail.

[93] Maritime 2050: Navigating the Future, Department for Transport (January 2019)

According to a 2017 study of port connectivity feedback from the industry: "delivering the right infrastructure, at the right time, to the right specification, to bring about an efficient freight transport network on rail and road" was the key infrastructure priority (*Source - Transport Infrastructure for our Global Future, A Study of England's Port Connectivity, DfT, 2017*). This included addressing limitations and pinch points on the network which impact port connectivity, such as appropriate gauge clearance on rail, and removing congestion on key road corridors.

Key priorities for sea connectivity as part of the UKNET

Resilience, Reliability and Flexibility

A greater recognition and emphasis by government on the cost of congestion and delay to the supply chain, and the knock-on effect on the economy is needed to ensure that the UK port industry is able to adapt and remain competitive in a global market. As such, the need for suitable and resilient diversionary routes, and a network which is better able to respond to challenges in the supply chain, was identified as a high priority by the industry *(Source - Transport Infrastructure for our Global Future, A Study of England's Port Connectivity, DfT, 2017).*

Looking specifically at sea crossings between Great Britain and Northern Ireland as the key domestic sea connection within the UK. Maintaining a quality and competitive service across the Irish sea is critically important, particularly for freight movements. Ensuring there is a sufficient level of capacity and connectivity and there is sufficient resilience in the network are all priorities. From a customer perspective, ensuring there is sufficient price competition and choice.

Maintaining a range of connections between Great Britain and Northern Ireland also allows journey times by road to ports to be optimised and minimised where possible. Enhanced surface access connections will help achieve this, alongside policy that supports maintaining a choice of options by different corridors. This includes the corridor from England to Northern Ireland via Wales and the Republic of Ireland.

Improving Surface Access to Seaports.

The infrastructure improvements review (Section 7.1) identifies key surface to sea links (ie: A2, M3, A34 etc) which are highly congested and constrain the flow of goods from seaports to national distribution centres. Furthermore, key seaport connectivity routes like the A75 through Dumfries and Galloway have been identified as areas where the quality of the road corridor could be improved to shorten journey times and significantly improve safety.

It is beyond the scope of this report to look at all of the local 'pinch points' on the road networks connecting with sea ports that prevent the smooth transition of goods from port facilities onto the surface UKNET for movements across the UK and internationally. Continuing to improve surface to sea transport connectivity is a vital requirement for maintaining and increasing the competitiveness of UK seaports as a central part of the future for global British trade.

Broader customs and taxation policy

While it is beyond the scope of the UCR to comment on improving and simplifying customs and taxation policy, it is recognised as a central component to the future competitiveness of UK ports. It is acknowledged that the ongoing government Freeports programme is seeking to address these challenges directly and support major UK ports to maintain their competitive advantage through policy, investment in technology and automation.

This is particularly important in the context of the Irish Sea. Ensuring continued ability to act as a cost-efficient land bridge between the Republic of Ireland and mainland Europe is vital for the future of Ports on the western seaboard of Great Britain (Milford Haven, Holyhead, Liverpool, Cairnryan ports).

7.2.5 Air

The UK aviation network is delivered through a combination of airport capacity, which is owned, operated and maintained by a mixture of predominantly private sector airport operators and air routes which are **s**cheduled and operated by private sector operators (with some limited Government support in isolated cases). There is also a significant regulatory framework for aviation that controls airspace and introduces specific standards and requirements for airports around noise and emissions. UK wide policy for aviation is contained within *Aviation 2050 – the future of UK aviation*.[94] Many air routes within the UK are subject to competition from a number of airlines and airports (for example, London to Edinburgh) and other routes are operated by a single carrier.

Surface access to airports is of critical importance and this is provided through a network of (road and rail) surface access routes that are controlled by multiple agencies – some of this at the national level (or devolved nation level) and others at the city level.

Looking to the future: The changing role of air connectivity in the UK

Before the COVID-19 pandemic there were a number of growing trends that were creating challenges and opportunities for UK air connectivity. While the immediate dimensions of some of these challenges has shifted given the significant reduction in air travel since the onset of the pandemic in the UK, challenges remain or are expected to return as the aviation sector returns to previous levels of traffic over the longer-term.

Long term demand expected to recover – but rate of recovery uncertain

2020 forecasts from the International Air Transport Association emphasise the expectation of recovery with the aviation sector but there remains a high degree of uncertainty about the pace and nature of recovery, with an expectation that there will be significant variation between regions based on the realities of the pandemic. IATA expects "domestic and short-haul markets will recover faster, with long-haul travel being the last to return to 2019 levels of demand" (https://www.iata.org/pax-forecast/). The pace, and nature of this recovery is

[94] Aviation 2050 – the future of UK aviation, Department for Transport (June 2021)

likely to have significant impacts on the pressures facing the UK aviation industry over the short-medium term

Shifting a portion of travel from Air to Rail with HS2

The introduction of HS2 will improve rail journey times on many corridors across the UK making a domestic journey by rail more time competitive than air. This will lead to a reduction in some point to point air demand between some cities within the UK – specifically for Manchester, Edinburgh and Glasgow to London. This could have the effect of releasing some existing capacity at London airports.

Continuing importance of key air routes

Even with HS2 and other planned rail improvements, there is still a need for a strong UK domestic aviation network for point to point connections over longer distances that are not feasible by road or rail for example over sea connections between Great Britain and Northern Ireland. These air routes will continue to provide the main form of union connectivity between locations which are not efficiently connected by other means.

Interlining at the UK Hubs

Domestic connections into key international hubs (especially Heathrow) provide UK regions with access to the rest of the world. Maintaining, and where feasible improving, connections into Heathrow for effective transfers onto longer distance routes is an important part of the UKNET and cannot easily be replicated by improvements to the rail network. If these connections are not maintained into international hubs, then the role of the UK in international connectivity will be weakened as demand will shift to other European or Gulf airports which do have direct connections into UK regions.

Key priorities for the future of UK air connectivity

Safeguard sufficient airport capacity, particularly in South-East England

Air capacity is secured through a combination of airport capacity; airspace capacity and airline capacity working as part of an integrated system. Traditionally in the UK, airport and airspace capacity in South-East England has been a constraint on domestic air routes to/from London (which accounts for a significant amount of UK domestic air demand). Outside of the south east, capacity has not been a significant constraint on growth – here the challenge has been more focused on maintaining the viability of domestic routes.

In the short-term released capacity from the delayed recovery of long-haul aviation demand should relieve pre-existing capacity pressures at UK international hubs in South-East England. This should allow for additional domestic air connectivity to be provided to/from London from domestic regional centres.

In the medium to long-term it will be important to continue to support regional connectivity to major international hubs at Heathrow and Gatwick by ensure there remains sufficient capacity that these domestic routes do not get restricted to as the demand for international travel recovers.

Ensuring a price competitive market on key domestic routes

The UK aviation market is private sector led and fares are set by the airlines, however it will be important going forward to ensure that all nations of the UK are able to maintain affordable air connectivity between the nations. By ensuring there is sufficient capacity to enable competition on key regional routes (for example: London ↔ Belfast) Government can support and ensure there is a competitive market to provide passengers with the greatest flexibility of price and prevent monopolised pricing that could restrict connectivity between key regions.

Supporting routes where a competitive market is not viable through route support

There are key routes in the UK where sufficient demand may not exist to allow for a viably competitive aviation market. The existing PSO mechanism provides one effective way of securing domestic air routes that are economically and socially valuable but not viable without Government and local authority support. For example, this is the case with the UK's 3 existing PSO routes.

- Londonderry/Derry ↔ London
- Dundee ↔ London
- Newquay ↔ London

It is important for the government to continue to support strategically important routes like these which provide connectivity for more remote regions into the UK capital region as well as provide connectivity to hub airports that enable onward journeys. The government should continue to evaluate the performance of regional routes and provide support along key routes that are not commercially viable to support the continued, regional, national and international connectivity of those areas.

Encouraging a shift to rail where possible

With the forthcoming arrival of HS2 and other major rail investments across the country Government should continue to support the transfer of trips to more sustainable modes and away from fossil fuel aviation where feasible. As indicated above, this is most realistic for point-to-point journeys between cities in Great Britain rather than interlining journeys or journeys across the Irish Sea. The additional burden of transferring from surface to air relative to airside connections makes the transition of interlining passenger unlikely in the medium term.

Further data collection and analysis is required to understand which aviation routes are likely to be able to transfer the greatest number of passengers to rail. However, it is anticipated that even services duplicated by HS2 (ie: London ↔ Manchester), some capacity will need to be maintained to serve interlining passengers, who cannot easily transfer to the rail network. This mirrors the reality of other large nations like France, who have banned domestic point-to-point journeys below two-and-a-half hours but will continue to provide services for interlining passengers (*Source* - *France moves to ban short-haul domestic flights*).

For point-to-point journeys within Great Britain in particular Government should consider opportunities to further encourage the transition of passenger journeys to

rail. This requires close consideration of journey times, fares, and local surface connectivity to major rail stations within UKNET cities.

Accelerate the decarbonisation of flights

Supporting and invest in the development and fastest possible transition of aviation to low/zero emission technologies reflecting should be a key sustainability priority for government. With the inclusion of international aviation emissions in the UK's carbon emissions target it is now even more essential to find long term solutions to transition aviation to low/zero emission technologies (see 'UK enshrines new target in law to slash emissions by 78% by 2035') [95]. This transition is likely to be feasible in short-haul aviation before it is feasible for long-haul international routes[96].

Better surface access to airports

Challenges around surface access to airports can broadly be subdivided into two categories.

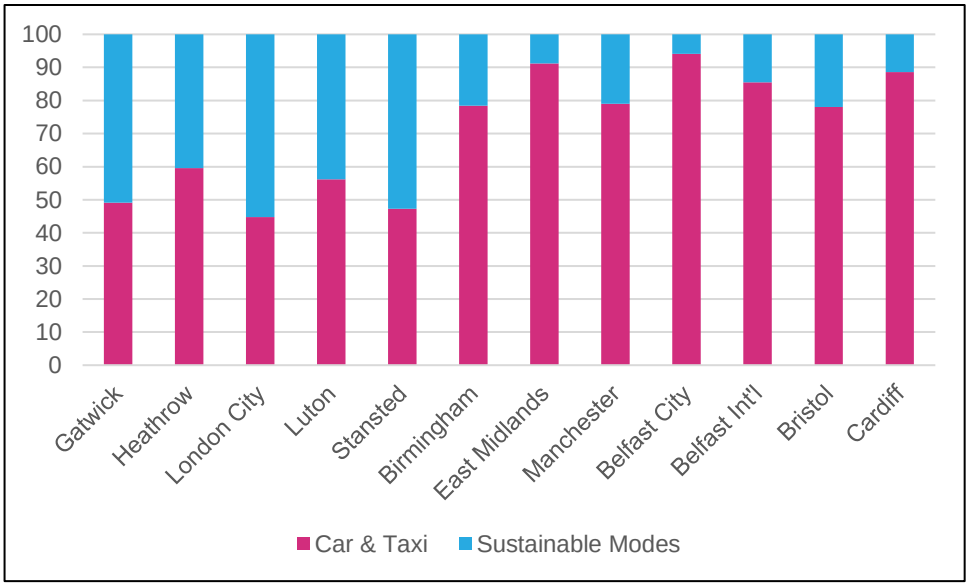
1. Local surface access, including local public transport connectivity between city centres and airports to enable public transport mode shift.

2. Regional surface access to airports, particularly longer distance connections (e.g., North Wales to Manchester; Cardiff to Heathrow)

While reviewing the local surface access constraints to each of the strategic airports identified on the UKNET is beyond the scope of this report, it is important to note that based on 2019 passenger survey data, surface access to airports, particularly those outside London, remains heavily dominated by personal vehicle traffic (see figure below). Ensuring there are good connections to airports by public transport will help reduce the volume of car-based trips. The responsibility for overseeing the planning and delivery of airport surface access routes can often fall between the airport, the city region and the transport body responsible for that part of the network. Having a more integrated surface access strategy for airports that is fully locked into both the local city wide and strategic UKNET will help support this transformation to greater use of public transport for airport access trips.

[95] UK enshrines new target in law to slash emissions by 78% by 2035 - GOV.UK (www.gov.uk)
[96] deloitte-nl-future-of-mobility-europe-future-aviation-landscape-2040.pdf

Figure 62 – Percentage of surface access trips made by sustainable modes to select strategic airports



Source – Civil Aviation Authority, Passenger Survey 2019, Table 7

As part of the road and rail improvements sub-chapters, we considered and identified key regional surface to air links (ie: Heathrow Western Access Rail, and North Wales Cost Main Line etc) which play a key role in providing regional surface access to strategic airports. The role these surface routes play in providing connectivity into strategic airports was considered as part of the evaluation, supporting their case to be included in our recommendations.

8 Summary

The shortlisted improvements set out in Chapter 7 would deliver a range of benefits across the proposed UKNET in line with the objectives of this review, better connecting the Union and unlocking economic potential across the four nations.

Figure 63 shows the recommended priorities for improvement to achieve the objectives set out in the Union Connectivity Review Terms of Reference. Note that this excludes those improvements which are recommended for the broader goal of improving connectivity across the whole proposed UKNET, but which are not critical for connectivity of the Union.

Figure 63 – Network improvements to the proposed UKNET that are important for Union connectivity

Infrastructure	
Road	**Rail**
• Improvements to capacity on the A75 • Improvements to capacity on the A77 • Severn Resilience package to the east of the Severn Crossings • Improvements to the A1 (north of Ellingham to Edinburgh)	• Improvements to track capacity and journey times on the West Coast Mainline north of Crewe • Improvements to track capacity on the East Coast Mainline north of Northallerton • Rail-led 'network of alternatives' to alleviate M4 congestion • Improvements to line speeds on the North Wales Coast Line • Improvements to direct connections between Cardiff and the Midlands, north-east England, and Scotland • *Re-opening and upgrading of the line between Dumfries and Stranraer**
Policy	
Road	**Rail**
• Continue to encourage shift to electric vehicles and more sustainable modes of transport • Consider road pricing to account for loss of excise duty on petrol and diesel • Decarbonisation of freight	• Rail industry changes underway with release of the 'Williams-Shapps Plan for Rail: Great British Railways' • Golden opportunity for fares reform
Aviation	**Maritime**
• Safeguard sufficient airport capacity for domestic connections, particularly in south-east England • Ensure a price competitive market on key domestic routes • Support routes where a competitive market is not viable through the PSO mechanism • Encourage modal shift to rail where possible • Accelerate the decarbonisation of flights • Improve surface access to airports	• Resilience, reliability, and flexibility of strategic routes • Improve surface access to seaports • Ensure customs and taxation policy aids competitiveness

**Only recommended if a Fixed Link is constructed between Stranraer and Northern Ireland*

Appendix A

Policy Review

A1 UK Government Policy

Build Back Better: our plan for growth (2021)[97]

'Build Back Better: our plan for growth' sets out the Government's plans to support growth through significant investment in infrastructure, skills and innovation, and to pursue growth that levels up every part of the UK, enables the transition to net zero, and supports the vision for Global Britain.

The Plan notes that much of the reason for this gap in productivity across the UK lies in part due to historic low levels of investment in physical capital - from underinvestment in. The Plan recognises that the UK has historically underinvested in infrastructure, with a smaller capital stock than comparable countries and ranking 11th globally for infrastructure quality, behind both France and Germany. However, historic levels of investment will be required in UK infrastructure in the coming years, to maintain and upgrade networks to meet the UK Government's objectives for economic growth and decarbonisation.

Within the UK itself, the Plan notes that there are large disparities both across and within nations and regions, with only London and the South East with productivity above the UK average – this has implications for the relative prosperity of people living outside of those regions. The Government has stated that its commitment to levelling up means tackling these disparities, which are some of the widest of any advanced economy and have been getting wider over time. In 1998, London accounted for 20% of UK GVA, but by 2018 this had risen to 24%. Important explanations for these differences are the distribution of skills between regions, and cities outside London not fully capturing the benefits of their size.

The Plan also recognises that the quality of the UK's infrastructure is lower than many other countries. The Plan references that the UK Government has already announced a record amount of capital and infrastructure investment at the Spending Review 2020[98] and in the National Infrastructure Strategy[99]. The Plan sets out how this investment will help the economy to recover, tackle our long-standing productivity gap, and lay the foundations for our long-term sustainable growth. It also recognises how delivering improved infrastructure, skills and innovation will be a joint endeavour between local authorities, combined authorities, the devolved administrations, and the UK Government.

Specifically, for infrastructure, the Plan states that high quality infrastructure is crucial for economic growth, boosting productivity and competitiveness. Infrastructure helps connect people to each other, people to businesses, and businesses to markets, forming a foundation for economic activity and community prosperity. Well-developed transport networks allow businesses to grow and

[97] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/968403/PfG_Final_Web_Accessible_Version.pdf

[98] https://www.gov.uk/government/publications/spending-review-2020-documents/spending-review-2020

[99] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938539/NIS_Report_Web_Accessible.pdf

expand, enabling them to extend supply chains, deepen labour and product markets, collaborate, innovate and attract inward investment. The government is committed to transforming the UK's infrastructure and increased investment is also a central part of economic recovery. The Plan states that the Covid-19 pandemic has introduced enormous short-term disruption and may have long-term effects on the way people live, for instance with less daily commuting. However, this does not undermine the long-term arguments for infrastructure.

National Infrastructure Strategy (2020)[100]

In 2020, the Government published the Strategy, which brought together the government's long-term infrastructure priorities with the short-term imperative to build back fairer, faster and greener following the Covid-19 pandemic. The NIS committed to the following.

- Boosting growth and productivity across the whole of the UK, levelling up and strengthening the Union through investment in rural areas, towns and cities, from major national projects to local priorities.
- Putting the UK on the path to meeting its net zero emissions target by 2050 by taking steps to decarbonise the UK's power, heat and transport networks – which together account for over two-thirds of UK emissions – and take steps to adapt to the risks posed by climate change.
- Supporting private investment by providing investors with clarity over the UK Government's plans, so they can look to the UK with confidence and help deliver the upgrades and projects needed across the country.
- Accelerating and improving delivery through wide-ranging Project Speed reforms including streamlining the planning system; improving the way projects are procured and delivered; and greater use of cutting-edge construction technology.

The Government also stated that as a part of Project Speed, they will rigorously review the cost and delivery times of infrastructure projects, with the aim of transforming the way new infrastructure is delivered.

10 Point Plan for Decarbonisation (2020)[101]

As set out in the Plan, infrastructure investment is fundamental to delivering net zero emissions by 2050 and supporting 90,000 jobs across the UK within this Parliament, and up to 250,000 by 2030.

Specifically, on transport, the Plan states that as well as decarbonising private vehicles, there must be an increase the share of journeys taken by public transport, cycling and walking. The Government therefore plans to accelerate the transition to more active and sustainable transport by investing in rail and bus services.

The Government have stated it will invest tens of billions of pounds in enhancements and renewals of the rail network, including electrifying more

[100] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938539/NIS_Report_Web_Accessible.pdf

[101] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution/title

railway lines. This also includes expanding rail routes around big regional cities, including Manchester. The Government's long-term aim is to improve public transport in city regions to make it as good as London's, which would save thousands of tonnes of carbon.

The Ten Point Plan also seeks ensures that the recovery from Covid-19 will be green, generate jobs and bolster the economy, whilst continuing to drive down emissions both now and in the future. In the coming year, the Government will set out further plans for reducing emissions across all the UK's major economic sectors as outlined below, including our overall Net Zero Strategy, which will clearly set out our pathway to achieving net zero emissions by 2050.

The forthcoming Transport Decarbonisation Plan will set out how the Government's plans to move further and faster to decarbonise the entire UK transport system. Alongside delivering the technical measures required, the Transport Decarbonisation Plan is expected to seek to maximise the benefits of decarbonisation through place-based solutions and developing the UK as a green transport leader.

Transport Investment Strategy (2017)[102]

The Strategy states that by maintaining and upgrading transport infrastructure communities and businesses can be better connected and can deliver balanced growth across the country. The Transport Investment Strategy set out how the Government will respond realistically and pragmatically to today's challenges and put the travelling public at the heart of the choices we make. The Strategy recognises the transport network is a powerful national asset and a cornerstone of prosperity.

The Strategy states that through investment, the Government can and must seek to do the following.

- Create a more reliable, less congested, and better-connected transport network that works for the users who rely on it; Our intensively used networks are ageing and face increasing demands, creating delays and undermining reliability. In places they don't provide the connections people and businesses need.
- Build a stronger, more balanced economy by enhancing productivity and responding to local growth priorities; Our national productivity lags behind other countries and prosperity hasn't been shared evenly between different places, leaving some communities feeling left behind.
- Enhance our global competitiveness by making Britain a more attractive place to trade and invest; Our long term success in a globalised world will depend on our ability to attract job-creating investment in our industrial strengths and to trade as frictionlessly as possible with partners old and new.

102 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918490/Transport_investment_strategy.pdf

- Support the creation of new housing. There is an immense challenge to provide the houses that people need in the places they need them. As the Government's Housing White Paper recognises, transport infrastructure is one of the keys to unlocking development and delivering places people want to live.

Taken together this will mean investing in our transport network in different ways, most fundamentally by addressing the network's core capability – its condition, capacity and connectivity – but also improving the user experience and adapting the network to safeguard our environment and health.

The Strategy notes that investment in the rail network has been, and in many respects will continue to be, centred on how we can get more out of the existing network. There have been improvements to increase capacity or improve service performance, by lengthening trains and platforms, constructing flyovers and underpasses to remove bottlenecks, and adding new track. More of this will be needed, but for growth to continue in the future, there must be easing in some of the pressure on the busiest parts of the network.

The Strategy recognises that the national rail network is already highly integrated, with different types of rail services – commuter, regional, inter-city and freight – all sharing the same infrastructure; also responding to the unique challenges of a railway in which passenger journey numbers have doubled in twenty years. However, unlike some comparable European countries, the historical development of the UK's national network has fostered a complex and interdependent set of rail services, and there are many routes and services where it would be challenging to develop effective devolved bodies in line with the principles set out above.

The Strategy notes that the railway faces a huge challenge to meet the demand for travel, especially on the busiest routes into major cities. Where lines are already running at capacity the closely packed timetable means that when there is disruption, the effects reach further and last for longer. Additional services cannot be fitted onto the network, meaning that those existing services get overcrowded. These capacity constraints can be addressed through investment in a number of ways, including through upgraded signalling to improve the capability of the network as a system and run trains closer together, lengthening trains by investing in new rolling stock and the supporting infrastructure, and remodelling track layout.

Additionally, it is noted in the Strategy that the Government's Rail Freight Strategy, published in September 2016, signalled the ambition to support a greater shift from road to rail. Each tonne of freight moved by rail reduces CO2 emissions by 76% compared to road so shifting more freight from road to rail has potential to make a real contribution to meeting the UK's emissions reductions targets, as well as improving safety by reducing lorry miles.

Williams-Shapps Plan for Rail (2021)[103]

[103] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/994603/gbr-williams-shapps-plan-for-rail.pdf

The Plan sets out how the Government intends to deliver wider changes to the railway network. The seven key areas of the plan are as follows.

- **Bring the railways back together, delivering more punctual and reliable services –** A new public body, Great British Railways, will run and plan the rail network, own the infrastructure, and receive the fare revenue. It will procure passenger services and set most fares and timetables. This will bring the whole system under single, national leadership with a new brand and identity, built upon the famous double arrow. This will mark the end of a quarter century of fragmentation.

- **Make the railways easier to use –** Simplify the confusing mass of tickets, introducing far more convenient ways to pay using a contactless bank card, mobile or online. We will end the uncertainty about whether you are travelling with the right train company. Trains will be better planned with each other and with other transport services, such as buses and bikes. Affordable 'turn up and go' fares and capped season tickets will continue to be protected.

- **Rebuild public transport use after the pandemic –** In line with the Covid-19 roadmap, continue to work closely with the sector on measures to enable people to have confidence to travel again and to support their new working patterns. New flexible season tickets will be introduced to begin this journey.

- **Maintain safe, secure railways for all –** The safety and security of passengers, staff, partners and members of the public is critical. Great Britain has one of the safest networks in Europe and that must continue. Current safety and security roles will remain in place across the rail network.

- **Keep the best elements of the private sector that have helped to drive growth –** Great British Railways will contract with private partners to operate trains to the timetable and fares it sets, in a similar way to London's successful Overground service. The contracts will include strong incentives for operators to run high-quality services and increase passenger demand. Contracts will not be one size fts all, so as demand recovers, operators on long-distance routes will have more commercial freedom to help attract new passengers in partnership with Great British Railways. Freight is already a nimble, largely private sector market and will remain so. It will benefit from national co-ordination, new safeguards and a rules-based access system that will help it to grow and thrive.

- **Make the railways more efficient –** Simpler structures and clear leadership will make decision making easier and more transparent, reduce costs and make it cheaper to invest in modern ways to pay, upgrade the network and deliver new lines. The adversarial blame culture will end, and everyone across the sector, including train operators, will be incentivised to work towards common goals, not least managing costs. The value generated will be shared with the customers of the railways and the taxpayers who invest billions each year.

- **Grow, not shrink, the network –** investing tens of billions of pounds in new lines, trains, services and electrification. At a time of deep challenge for public transport, increasing flexibility and productivity will secure the future of the railways and the jobs of those who work on it right across Great Britain.

Integrated Rail Plan for the North and Midlands (forthcoming in 2021)[104]

In February 2020, the Government published the terms of reference for the Integrated Rail Plan for the North and Midlands. In this document, the Government stated that it is fully committed to providing better rail connectivity between London, the Midlands and the North, ensuring all parts of the country benefit from opportunities for economic development and prosperity. As well as committing to deliver HS2, the government remains strongly committed to Northern Powerhouse Rail, improving connectivity between northern cities, as well as between London, the Midlands and the north.

The document stated that the Government, working with HS2 Ltd and local leaders, will draw up an Integrated Rail Plan for the Midlands and the North which is framed by the Government's commitment to bring forward transformational rail improvements along the HS2 route as quickly as possible. This work will be informed by an assessment from the National Infrastructure Commission (NIC) looking at the rail needs of the Midlands and the North, and the available evidence on Northern Powerhouse Rail, Midlands Rail Hub, HS2 Phase 2b and other proposed Network Rail projects. This was published in December 2020.

The Plan will consider the following, based on the NIC's assessment and taking into account value for money, levelling up, affordability and deliverability considerations.

- How best to integrate HS2 Phase 2b and wider transport plans in the north and Midlands, delivering benefits from investments more quickly. This should include a recommended way forward on scoping, phasing and sequencing delivery of HS2 Phase 2b, Northern Powerhouse Rail, Midlands Rail Hub and other proposed rail investments. This should take into account: government commitments; the current state of development for different projects; the transformational and capacity benefits of these schemes; fiscal and supply chain capability constraints; network integration; consenting routes (including legislation); and, in line with the Oakervee Review conclusion, the appropriate mix of high speed line and upgrades of conventional network, and the sequencing of these, on any elements of the investments under consideration.
- How best to reduce cost, including opportunities to reconsider HS2 Phase 2b scope and design standards to prevent over-specification, improve efficiency and reduce costs, drawing on the Phase One lessons learnt work to be led by the Infrastructure and Projects Authority.

[104] https://www.gov.uk/government/publications/high-speed-north-an-integrated-rail-plan-for-the-north-and-midlands-terms-of-reference/terms-of-reference-for-an-integrated-rail-plan-for-the-north-and-midlands

- The recommended approach to sponsorship and delivery, including governance and delivery models, and how to take account of the views of local leaders, consistent with delivering on the objectives of the scheme and value for money. This will include exploring options for new delivery vehicles with northern leaders for the relevant rail enhancements including new lines that may form part of the delivery of HS2 and Northern Powerhouse Rail.

The Integrated Rail Plan is expected to be published in the summer of 2021.

National Infrastructure Commission – Rail needs for the Midlands and the North (2020)[105]

As mentioned above, the NIC's *Rail Needs Assessment* will inform the outcomes of the Integrated Rail Plan. It assessed current and future travel demand needs and made a series of recommendations for infrastructure improvements. These were grouped into packages which provided government with a series of strategic options. It recommends that the government consider regional links as well as identifying that transport alone cannot solve the economic problems faced by these regions.

National Policy Planning Framework (2019)[106]

The Framework states that the purpose of the planning system is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

There are three key objectives:

- Economic – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;

- Social – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

- Environmental – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

[105] https://nic.org.uk/app/uploads/RNA-Final-Report-15122020.pdf
[106] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/810197/NPPF_Feb_2019_revised.pdf

Some specifically related sections of the Framework relevant to connectivity are as follows.

- Section 6 - Planning policies and decisions should help create the conditions in which businesses can invest, expand and adapt. Significant weight should be placed on the need to support economic growth and productivity, taking into account both local business needs and wider opportunities for development.
- Section 7 - Planning policies and decisions should support the role that town centres play at the heart of local communities, by taking a positive approach to their growth, management and adaptation.
- Section 9 - the potential impacts of development on transport networks can be addressed; opportunities from existing or proposed transport infrastructure, and changing transport technology and usage, are realised – for example in relation to the scale, location or density of development that can be accommodated; opportunities to promote walking, cycling and public transport use are identified and pursued

A2 Scottish Government Policy

Transport Scotland – National Transport Strategy (2020)[107]

Transport challenges differ across regions of Scotland. The transport barriers facing those living in towns and cities in the Central Belt, for example, will not necessarily be the same as those living in towns and cities in other parts of Scotland or remote, rural and island communities. In addition, different areas of the country may have their own transport requirements to meet their inclusive growth objectives. These challenges will need a range of solutions and models of governance to deliver them.

Rural Scotland accounts for 98% of the land mass of Scotland and only 17% of the population are resident there. Those living in remote and rural areas face many different transport challenges when carrying out their daily lives compared to, for example, those living in less rural areas of the mainland and urban areas.

Transport is crucial for our trade and competitiveness, within Scotland, across the UK and internationally. Improving gateways (such as airports, ports and major transport hubs) and the surface access to these gateways supports exporters to grow in existing markets and explore opportunities in new ones.

Aviation will continue to play a key role in Scotland's connectivity, both in international terms and within Scotland and the UK. They recognise the importance of regional airlines operating between Scotland's islands and its cities, and between Scotland and places where rail is not an effective alternative for businesses, such as to the south west of England.

[107] https://www.transport.gov.scot/media/47052/national-transport-strategy.pdf

Between 2016 and 2018, 13% of total car driver journeys were delayed. For journeys made for commuting or business purposes, the figure rises to 22% and 18% respectively.

The regions of Scotland have different characteristics - economic, physical, social and cultural - and also have different requirements from the transport system. A single approach will therefore not be the solution to addressing the challenges faced by different geographies. Our cities, towns, remote rural and island areas will need a targeted approach to meeting their needs.

Tourists from within the UK (the main market, including from Scotland itself) mainly arrive or travel by road. Travel by aeroplane is by far the most prevalent mode of transport for international visitors to Scotland. Since 2002, the number of international visitors travelling to Scotland by air has more than doubled (+150%), while travelling by sea and via the Channel Tunnel have remained fairly stable over the same period, although there has been a marked increase in the number arriving by cruise vessels, rising from 369 calls with 268,481 passengers in 2010 to an estimated 912 calls with 920,000 passengers during 201981. While travel to Scotland by rail for international visitors is also relatively low, for those travelling within the UK it is higher.

To maintain Scotland's competitive position, the Scottish Government states the need to make it as easy as possible for Scottish firms to do business abroad and for foreign firms to do business here. They want to make Scotland an attractive place for the rest of the world to visit, live and work. Trade and connectivity with EU and global markets is impacted by uncertainty around Scotland's future relationship with the EU as a result of the UK EU Exit. There is a particular challenge with the lack of direct freight and logistics routes to the continent, with Scotland currently being dependent on routes via England for the vast majority of imports and exports. The Government will continue to work with partners in the freight industry to understand their needs and provide a framework that enables Scottish firms to be competitive and succeed across the globe, including getting their goods to markets.

To ensure Scotland continues to welcome a growing number of international visitors, Scotland needs to retain important air links and also develop new routes, while also taking measures to minimise the environmental impacts that international tourism generates.

It is not just passenger transport that will need to adapt to the challenges around our changing climate and adopt low and zero carbon vehicles, the freight industry will also need to change considerably. The freight sector will have to respond to the increasing need to decarbonise through the use of new technologies and business models, as well as adapting to changing demands of consumers. The scope for electrification in freight is the subject of ongoing research and innovation, and automation is likely to be another significant shaping force.

Planning and development have a major influence on our transport system. The Government will continue to work collaboratively to ensure that, when planning decisions are made, as a priority they will consider the impacts on transport.

The National Transport Strategy presents the strategic framework for our transport system over the next 20 years. Clear priorities have been set out which provide a strong focus on ensuring transport contributes to reducing inequalities faced by people in Scotland, takes action to protect our climate, supports the delivery of inclusive economic growth and improves the health and wellbeing of our citizens. The Delivery Plan will report annually on performance in addressing the challenges and achieving the Outcomes using the monitoring and evaluation framework.

A3 Welsh Government Policy

Welsh Government - Llwybr Newydd: A New Wales Transport Strategy (2021)[108]

Published in 2021, the Strategy sets out the Welsh Government's plan for the transport system over the next 20 years. The vision for an accessible, sustainable and efficient transport system. These are our three headline priorities for the next five years. There is more detail about these priorities in the mini-plans. The Welsh Government will review these priorities as circumstances and technology change.

The three priorities of the Strategy are described below.

Priority 1: Bring services to people in order to reduce the need to travel: planning ahead for better physical and digital connectivity, more local services, more home and remote working and more active travel, to reduce the need for people to use their cars on a daily basis. This includes ensure a joined-up approach to infrastructure investment decisions across Welsh Government and in regional planning and maximising the use of land close to transport hubs including railway stations and ports, as sites for investment and growth

Priority 2: Allow people and goods to move easily from door to door by accessible, sustainable and efficient transport services and infrastructure: aim to achieve a shift away from private car use to more sustainable transport modes for the majority of journeys. The Welsh Government plans to invest in low-carbon, accessible, efficient and sustainable transport services and infrastructure that enable more people to walk, cycle and use public transport, and low-emissions vehicles. This includes improve the reliability, safety, and frequency of public transport services, setting standards for what communities can expect and working towards those over time extend the geographical 'reach' of public transport into every community, especially in rural Wales, involve public transport users in the design of new services, continue to make best use of existing transport infrastructure by maintaining it and managing it effectively and efficiently adapt existing infrastructure to climate change by addressing issues such as flooding upgrade our existing infrastructure to meet our legal obligations on accessibility and safety and to address issues such as congestion, and changes to vehicle standards adapt our infrastructure to support modal shift, and explore future infrastructure improvements that reduce carbon emissions, including infrastructure for new fuels such as hydrogen, technology that facilitates more

[108] Welsh Government - Llwybr Newydd: A New Wales Transport Strategy

sustainable aviation and cargo operations, and materials innovation that improves service life, speed of construction and maintenance and reduces environmental impacts.

Priority 3: Encourage people to make the change to more sustainable transport: encourage people to change their travel behaviour to use low-carbon, sustainable transport. The Welsh Government plans to do this by making sustainable transport more attractive and more affordable, and by adopting innovations that make it easier to use. This includes developing a range of behaviour change projects to encourage people to make smarter travel choices to reduce congestion and increase use of sustainable modes of transport, use new revenue sources to fund large improvements in public transport services and active travel facilities, develop a framework for fair and equitable road-user charging in Wales and explore other disincentives to car use, taking into account equality issues including needs of people in rural areas, people who share protected characteristics and people on low incomes, and transform the customer experience of public transport including reliability, punctuality and training for staff and drivers, so people are more confident about using services.

The Welsh Government will develop the following.

National Transport Delivery Plan (NTDP) - Transport for Wales will develop a detailed five-year National Transport Delivery Plan (NTDP), setting out the specific transport interventions financed by the Welsh Government. The plan will identify expenditure, based on the priorities in Llwybr Newydd, including the delivery of projects that are already underway. The NTDP will support the implementation of Future Wales – the National Plan 2040 and be aligned with the Wales Infrastructure Investment Plan and will be reviewed every five years. The NTDP will need to take into account the movement of both people and goods.

Regional Transport Plans - Regional Corporate Joint Committees will also prepare Regional Transport Plans for transport in their area. These will be shaped by Llwybr Newydd and aligned with Future Wales – the National Plan 2040 and the emerging regional development plans. Regional Transport Plans will include both policy and the supporting regional transport delivery plan.

South East Wales Transport Commission (SEWTC) - Chaired by Lord Burns, has been looking at solutions to congestion on the M4 in south east Wales. The findings from the Burns commission are aligned with Llwybr Newydd and the interventions proposed will be included in the 'National transport delivery plan' and in 'Regional transport plans'.

Working in partnership, the Welsh Government will work effectively with the UK Government on shared responsibilities, pressing for a Welsh voice in critical decisions that affect Wales. Through a mixture of reserved and devolved powers, they share transport responsibilities in Wales with the UK government, who play a critical role in rail operations and investment, in aviation and ports and in regulation. In future the Welsh Government will expand the role of TfW, the delivery partner for Welsh Government, building on their initial role in managing and delivering the Wales and Borders Franchise in Wales to explore opportunities to play a role in delivering an integrated transport system for people in Wales. The Welsh Government will involve transport users in developing high level policy

and on taking this strategy forward, working with a range of user groups including people who share protected characteristics. They will also gather better use data on travel behaviours and make it easier to gather real-time feedback from all users.

Modal shift

The Climate Change Committee has proposed a carbon reduction pathway for Wales that means emissions from surface transport must be roughly halved between 2020 and 2030 from 6 to 3 million tonnes CO2. Whilst electric vehicles may provide the biggest emissions savings, this is unlikely to be the main source of savings until the late 2020s and possibly later. Therefore, the Welsh Government will need to look at other measures. Carbon savings from more people working remotely will help, and Wales has set a target of 30% of the workforce to work remotely on a regular basis. Our priority on reducing demand will help achieve this. However, Welsh Government will also need to achieve mode shift with more people using public transport, walking and cycling. Based on our current analysis, we have set a target of 45% of journeys to be made by public transport, walking and cycling – by 2040. This represents an increase of 13 percentage points on the estimated current mode share of 32%. The Welsh Government have also committed to keeping this under review if justified by the evidence. The Welsh Government's plans include measures within our evaluation framework to track progress against this target and make sure that in achieving this target they do not have a negative differential impact on people who share protected characteristics and who rely on public transport.

Mini-plans

These plans will set out how individual transport sectors and modes will deliver the priorities in Llwybr Newydd. They do not replace the need for more comprehensive sector and modal strategies, particularly in fast-changing areas such as aviation, logistics and freight. The below focuses on areas most relevant to the Union:

Rail

Vision - to achieve the efficient and accessible passenger and freight rail services that people and businesses in Wales need, in order to better support our wider well-being ambitions.

Priorities over the next five years include:

- deliver public transport Metro systems in all parts of Wales to improve services and better integrate other public transport and active travel with the rail system;
- make rail services more attractive and improve customer experiences;
- work with the UK Government to develop the rail element as part of the wider solution to congestion on the M4;
- work with Network Rail and the UK Government to improve rail infrastructure across Wales, including rolling out rail electrification across

Wales, delivering network improvements and extensions, developing new stations and re-opening stations in Wales;

- maintain and manage existing infrastructure under the control of Welsh Government, including upgrades to existing stations and improving the resilience of rail infrastructure to flooding and extreme weather; and
- press for a stronger voice in rail investment decisions that affect Wales, and ultimately for the full devolution of rail services and infrastructure in Wales and a fair funding settlement.

Roads, streets and parking

Vision - ensure that roads and streets are safe, well-maintained and managed for all road users, and also support sustainable transport options including active travel and public transport.

Priorities over the next five years include:

- maintain and operate the Strategic Road Network in a way that meets our statutory obligations, minimizes adverse environmental impacts, promotes active travel, sustains and creates employment in Wales and reduces the backlog of maintenance;
- deliver a strategy for fair road-user charging in Wales as part of a broader package of measures to improve travel choices;
- upgrade, improve and future-proof our road network, addressing congestion pinch points and investing in schemes that support road safety, journey reliability, resilience, modal shift and electric bike, motorbike and vehicle charging;
- improve asset management for road infrastructure to reduce the maintenance backlog, operate more efficiently, free up funding for improvements and maintain and enhance biodiversity, ecosystem resilience and protect historic environment assets on the soft estate;
- work with Natural Resources Wales to manage the impact of climate change on road infrastructure by improving surface water drainage, managing flood risks and ensuring that new developments do not create harmful surface water discharges;
- enhance the Intelligent Transport System to improve real-time and open-source information for users and developers; and
- deliver an Electric Vehicle Charging Strategy and encourage the use of motorbikes and powered light vehicles instead of cars where there are no other transport choices.

Freight and logistics

Vision - A competitive, responsive and resilient network of freight and logistics distribution services across Wales that contribute to our wider well-being ambitions.

Priorities over the next five years include:

- integrate freight and logistics provision into new development, marine planning, industrial zoning and regeneration and co-locate manufacturing, energy, leisure, and tourism with ports and freight hubs;
- develop a policy response to the significant growth in last-mile and express delivery, understanding how best to manage this alongside our ambitions to reduce congestion and tackle decarbonisation;
- promote the importance of freight and logistics and the contribution it makes to the well-being of Wales;
- work with the UK Government, the sector and other partners on a Logistics and Freight Plan for Wales;
- support interventions that shift freight from road to rail and water-based transport, and future innovations that will make the sector more sustainable;
- work with the sectors to better understand the complex interactions between freight, logistics and the wider network, and set meaningful targets for decarbonisation; and
- work with the sector to harness improvements in technology for more efficient movement of goods.

Ports and maritime transport

Vision - adopt a more strategic approach to Welsh ports and nearby development sites, recognising their role as a catalyst for co-location of manufacturing, energy, leisure, distribution and tourism.

Priorities over the next five years include:

- invest in projects that deliver more sustainable ports infrastructure and which contribute to decarbonisation in the sector, including further consideration of the positive environmental impacts that modal shift towards coastal shipping could support;
- work with the Welsh Ports Group and other partners on a Welsh Ports and Maritime Strategy for Wales which reflects the challenges and opportunities of the new post-EU exit context that ports – and the businesses which are reliant upon them – must now operate within;
- working with ports in Wales to identify opportunities for future economic development such as offshore renewable energy and innovations in decarbonisation;
- acknowledge ports and maritime transport as a key facet of a wider policy on freight and logistics;
- work with the UK Government and other decision makers on shared objectives for ports; and

- support the contribution of our ports to the visitor economy across Wales.

Aviation

Vision - committed to maintaining an aviation capacity in Wales, because of the benefits that it brings to the Welsh economy as a whole, whilst recognising the challenges this creates for meeting our targets on decarbonisation.

Priorities over the next five years include:

- develop Cardiff Airport to enable Welsh-based passengers to fly from closer to home;
- work with the UK Government and the Jet Zero initiative, as well as with Cardiff Airport, to reduce the environmental impacts of aviation;
- support Cardiff Airport to recover from the impact of Covid-19 on the business and wider industry;
- engage with UK airports and other devolved administrations to improve regional connectivity to Wales as part of the regional planning process;
- continue to work with the UK Government on levelling up UK-wide aviation policy specifically for Wales, including continuing the pursuit of devolution of Air Passenger Duty (APD) to Wales and via the introduction of new Public Service Obligation (PSO) air services; and
- continue to explore opportunities to better connect Cardiff and Wales with the rest of the UK and Europe.

A4 Northern Ireland Policy

Regional Development Strategy (RDS) (2012)[109]

The RDS 2025 guides the development of Northern Ireland up to 2025 and beyond. The importance of the RDS is underpinned by Article 5 of the Strategic Planning (Northern Ireland) Order 1999 and was recognised in the Northern Ireland Executive's Programme for Government.

In recognition of the changing challenges facing the region, the NI Executive agreed that the RDS 2025, published in 2002 and reviewed in 2008, needed to be revised. Following public consultation, the RDS 2035 was published in 2012. Whilst many of the objectives of the previous strategy are still valid, this document now replaces it.

The RDS sets out important gateways and corridors. These gateways are strategically important transport interchanges which are important for economic development, freight distribution activities and additional employment generation. The gateways are:

- Belfast (including the sea port and George Best City airport);

[109] https://www.infrastructure-ni.gov.uk/publications/regional-development-strategy-2035

- Belfast International Airport;
- Larne;
- Londonderry / Derry (including the sea port and the regional airport);
- Newry (including Warrenpoint); and
- Enniskillen.

Economic corridors have been identified based on the RSTN. This network has a fundamental role to play in regional growth. It can help strengthen economic competitiveness, increase the attractiveness of Belfast and Derry / Londonderry and provides access to the air and sea ports. Rapid intra-regional connections, particularly between main towns, are key to economic activity. The network also increases the potential to incorporate a strong public transport element and to accommodate infrastructure necessary to improve Northern Ireland's energy and telecommunications.

The key and link transport corridors, as defined on the RSTN are also essential for providing access to the gateways. Economic Corridors connect Belfast and Londonderry and main centres of economic activity and the external gateways. Accessibility of the road network between cities and towns will open up opportunity for economic development across Northern Ireland to support regional growth. Cross-border co-operation and collaboration provide opportunities to boost the economic performance and competitiveness across the island.

The Regional Transportation Strategy (RTS) (2012)

This supports the RDS 2025 and makes a significant contribution towards achieving the longer-term transportation vision contained within the RDS. The strategic direction and underlying principles of the RTS were agreed by the NI Assembly in 2002.

A revised strategy document, 'Ensuring a Sustainable Transport Future - A New Approach to Regional Transportation', was published in 2012. This compliments the RDS 2035 and aims to achieve its vision for transportation. One of its main Strategic Objectives is to 'improve connectivity within the region' by completing the work identified in the current RSTN TP and Strategic Road Improvement Programme.

Investment Strategy for Northern Ireland (ISNI) 2011-2021 (2012)[110]

ISNI 2011-2021, published in 2012, updates the Investment Strategy. It highlights the progress made to date and sets out the next phase of investment in key projects and programmes. The scale of and focus on investment reflects the current economic climate, with a shift in focus to protecting jobs, fostering economic recovery and protecting public services. The strategy is focussed on prioritising infrastructure programmes that will deliver the best return in the period ahead.

[110] https://isni.gov.uk/home/

A new Northern Ireland Investment Strategy is expected to be published in 2021.

A5 English Sub-National Policy

This section draws on evidence in Sub-national Transport Bodies with a cross-border focus.

Transport for the North (TfN)(2019)[111]

Transport for the North is England's first sub-national transport body. As set out in their Strategic Transport Plan and building on the outcomes of the Northern Powerhouse Independent Economic Review[112], the North could increase its GVA by an extra £100 billion by 2050 through investment in infrastructure and other areas of the economy.

TfN's vision is of "a thriving North of England, where world class transport supports sustainable economic growth, excellent quality of life and improved opportunities for all." Supporting this vision are four pan-Northern transport objectives, which have informed the development of the Strategic Transport Plan and TfN's work programmes.

1. Transforming economic performance.
2. Increasing efficiency, reliability, integration, and resilience in the transport system.
3. Improving inclusivity, health, and access to opportunities for all.
4. Promoting and enhancing the built, historic, and natural environment.

Key work programmes to improve connectivity are around Northern Powerhouse Rail, the Major Road Network, and the Strategic Rail Network.

As set out in the Plan, over the last two decades the North's railway has experienced substantial growth in passenger numbers. Much of that growth has been accommodated within pre-existing capacity. The North's rail network lacks sufficient capacity for growth and is severely constrained by on-train congestion, low journey speeds and poor punctuality.

Rail accounts for a very small share of trips in the North, with only 1.1% share of total trips, but around 7.4% by distance travelled. The number of people using the railway network in the North is nearly three times the number 20 years ago, which is a greater increase than other regions over the same period.

Also, over the past 20 years, the number of rail passengers travelling entirely within the North has grown at a rate of 6.3% per annum, which is greater than the national growth rate of 4.2%

Pre-Covid trends showed that five Northern cities have seen rail passenger growth of more than 20% over the last 5 years to 2019 – for example Leeds by 31%, and

[111] https://transportforthenorth.com/wp-content/uploads/TfN-final-strategic-transport-plan-2019.pdf
[112] https://transportforthenorth.com/wp-content/uploads/NPIER-Core-Messages.pdf

Manchester by 24%. In terms of other constraints that have been seen on the North's rail network:

- 8.8% of all trains into Leeds and Manchester are overcrowded during the morning peak period;
- 12% of all rail passengers arriving into Leeds station during rush hour (8-9am) have to stand; and
- Average speeds of rail travel across the Pennines and between the major northern cities are below 50mph.

Since 2010, capacity on trains, measured as morning peak seats, has decreased while morning peak demand has also increased. This has led to significant overcrowding on most routes in the North.

Additionally, TfN's Long Term Rail Strategy, published in 2018, sets out TfN's guiding principles for rail and is an integral part of the Strategic Transport Plan. It sets out why TfN believe change is needed, what that change should be and how that change should be delivered, with an ambitious vision for the transformation of the North's rail network based on five themes.

- Connectivity – a step-change in connectivity including frequency and journey time improvements for both passenger services and freight, combined with better integration of services.
- Capacity – providing longer trains and additional services to meet existing and future passenger demand, with improvements to the infrastructure and signalling capability to accommodate these additional services.
- Customer – a passenger network that is easy to navigate, accessible and predictable, with consistent information available before and throughout journeys.
- Community – a railway that supports the social fabric of the communities it serves, providing journey opportunities which enable access to education, training and leisure opportunities as well as employment, and plays a full part in addressing transport poverty, isolation, and deprivation across the North.
- Cost Effectiveness – growing revenue and minimising the unit cost of operating and maintaining the North's railway without compromising the quality of the services offered.

On the road network, TfN note that Highways England's Strategic Road Network, which includes motorways and the majority of major 'A' roads, covers just 2% of the road network in the North. Although it accounts for a significant amount of traffic flow and economic value, it is the whole road network – including the 'last mile' of a journey and the vital connections with key railway stations or other transport hubs.

TfN has developed seven Strategic Development Corridors. Each corridor represents an area where evidence suggests investment in transport infrastructure

will enable transformational economic growth. The proposals for improvements in the Strategic Development Corridors consider the needs of people and businesses and align with local transport investment. Key areas of focus are east-west, north-south connectivity, housing and jobs, ports and airports, intra-city travel, active travel and public transport, and environmental impacts.

Specifically, for strengthening cross-border movements, there are four corridors:

West and Wales – This corridor links densely populated economic centres and assets, including some of the North's largest cities such as Liverpool and Manchester. Improvements in this corridor will also strengthen the North's cross-border connections with North Wales and the Midlands.

East Coast – Scotland – This study will build on work done by Network Rail to identify the requirements for current and future passenger, freight rail movements, and the consequent implications for the transport network within the broad area and encompassing links from the Midlands, through the North, and to Scotland. It will also strengthen and complement the Yorkshire to Scotland road corridor.

Yorkshire – Scotland – This corridor is looking at the case for strengthening road connectivity between the Midlands, Sheffield City Region, West Yorkshire, North Yorkshire, North and North-East Lincolnshire, East Riding, Hull and Humber, Tees Valley, the North East and Scotland to better connect the economic centres in this corridor. This will build on the existing road investment commitments and will integrate with the east-west focused Strategic Development Corridors. It will also strengthen and complement the East Coast Corridor to Scotland rail corridor.

West Coast – Sheffield City Region – The corridor looks to strengthen the growing assets in advanced manufacturing, health technology, digital businesses, and research centres in the Sheffield City Region and those in Lancashire and Cumbria. The potential economic links between the two areas are not served well by the existing rail network, and so this corridor needs to integrate with future high–speed rail connections as well as complement investments being pursued in road improvements in the North West and across the Pennines. There is also strong demand for growth on this corridor through to Scotland, for passengers and freight.

Midlands Connect (2017)[113]

Midlands Connect published its first transport strategy in 2017, and since then has made progress researching, developing and progressing schemes that will bring the biggest social, economic and environmental benefits to the Midlands. They are currently in the process of refreshing our strategy to ensure we overcome these unprecedented challenges. This updated strategy will be published in late 2021.

The context for the refreshed strategy will focus on the following.

- **Economic recovery and growth:** Transport's role in helping the region's economic recovery from Covid-19 and, beyond this, supporting the jobs, development and regeneration essential to our regional prosperity.

[113] https://www.midlandsconnect.uk/publications/midlands-connect-strategy-march-2017/

- **Levelling-up:** Funding transport projects to boost the life chances of our communities, boosting social mobility, productivity and quality of life.
- **Climate change and carbon:** Focusing on decarbonising transport by increasing use of public transport, reducing congestion on our roads, and supporting technology and innovation.

The existing strategy established a spatial framework for investment based on four strategic economic hubs and six intensive growth corridors which are critical to both the Midlands and the UK as a whole.

Strategic Economic Hubs

- Birmingham, Solihull and the Black Country
- Nottingham and Derby
- Leicester and Coventry
- North Staffordshire.

Intensive Growth Corridors

- Birmingham – Coventry/Leicester – Northamptonshire – Milton Keynes and the South, and includes connections to Kettering, Corby and the East of England
- Birmingham – Black Country – Staffordshire and the North, and includes connections to Telford, Shrewsbury and North Wales
- Nottingham and Derby – the North
- Humber Ports – Lincoln – Nottingham – Derby – Birmingham and Nottingham – Derby – North Staffordshire
- Nottingham – Leicester – Coventry – Warwick and Thames Valley, and includes connections from Leicester to Birmingham
- Birmingham – Worcester – Hereford and the Marches with connections to Wales and the South West.

Specific schemes / early priorities of Union focus set out in the Strategy include the following.

- Development of Birmingham to Nottingham (including HS2 Hub Station) and Birmingham to Leicester rail services
- Work with partners to develop schemes including Hereford bypass to improve connectivity to the South West and Wales UK Connected
- Delivery of Midland Mainline upgrade & electrification • Development of a business case for the Midlands Rail Hub - creating capacity for an additional 10 train paths per hour into Birmingham from across the Midlands; improving east - west connectivity

- Development of a business case for the Midlands Motorway Hub - developing a long-term plan for the nation's motorway crossroads
- Development of a business case for upgrading the A1(M) Resiliently Connected
- Strategic study for potential expressway route on A46 between M5 and M40
- Development of business cases for the M6 Junction 15 to 16 Smart Motorway scheme and Junction 15 upgrade
- Development of business cases for use of HS2 released capacity and classic compatible services
- A52 Corridor Multi-Modal Study (Derby, Nottingham, HS2 Hub Station and East Midlands Airport)
- Development of a business case to upgrade the A50 at Uttoxeter Globally Connected
- Delivery of the A14 Cambridge to Huntingdon improvement scheme to improve connectivity to the Haven Ports from the Midlands
- Development of business cases for improving connectivity to Birmingham International Airport and East Midlands Airport (through A52 Corridor Multi-Modal Study) Intelligently Connected

Western Gateway (2020)[114]

Published in 2020, the Strategic Transport Plan sets out the short-term plan covers the period from 2020 to 2025 and outlines the strategic challenges facing transport, setting out important transport investment priorities across the Western Gateway area within the Government's existing funding programmes. It lays the ground for a long-term strategic plan to be produced covering the 25-year period through to 2050. The Plan identifies four key strategic corridors, considers the main transport issues for each and how they will contribute towards the long-term strategic plan. The strategic corridors are as follows.

- South East to South Wales - This corridor focuses on the strategic movements along the M4, M32, M48 & A4 and the Great Western and South Wales mainlines.
- South East to South West - This corridor focuses on the strategic movements along the A303, A31/A35 and the West of England line and South Western mainline.
- Midlands to the South West - This corridor will focus on strategic movements along the M5, A38 and A46 (Midlands Connect Trans-Midlands Trade Corridor). It will also include the CrossCountry Route and Bristol to Exeter line.

[114] https://westerngatewaystb.org.uk/strategy/2020-2025-western-gateway-strategic-transport-plan/

- Midlands to the South Coast - This corridor focuses on the strategic movements along the: A36, A37, A338, A350, A354 and A358. This corridor benefits from a number of railway lines including the Golden Valley Line, the Heart of Wessex Line and the TransWilts rail link.

The production of a multi-modal corridor plan which, once completed, will form part of the Western Gateway's long-term Strategic Transport Plan. The aim is to agree the plan by March 2023.

Appendix B

Review of Geographic Corridor

B1 Review of proposed UKNET by geographical corridor

1 – Northern Ireland Corridor

Key economic centres - Belfast, Craigavon Area, Newry

Key transport infrastructure –

Road: M1/A1 Belfast - Newry, M2

Rail: Belfast – Dublin Mainline, Belfast – Larne Line

Ports: Belfast, Larne, Derry / Londonderry, Warrenpoint

Airports: Belfast City, Belfast International, City of Derry

Interconnecting corridors -

North Channel, Central Northern

Transport context

The main rail network in Northern Ireland broadly follows the coast, connecting Derry-Londonderry, Belfast, Newry and Dublin. There are low line speeds, and in some cases no direct services, from key economic centres. The western and southern parts of Northern Ireland are less well served by rail. Rail links to Belfast from the south are significantly faster than those from the north. Passengers can access Belfast in just over 2 hours from Dublin, and less than an hour from Newry. However, the capacity on the existing line between Belfast and Dublin is compromised by frequent commuter services and limiting line-speed. Work is being undertaken to explore high speed rail for between Derry, Belfast, Dublin, Limerick and Cork.

On the road network, the Belfast - Dublin corridor is not fully dualled, with longstanding safety concerns raised in the Call for Evidence, with improvements required to enhanced connectivity and journey time reliability.

A recent report found that the UK domestic aviation sector to the Northern Ireland economy was around £2 billion per annum. In 2018/19 almost 18,000 students, 23% of the NI student population, went on to study in GB and 5,000 people were traveling to GB weekly for work.[115]

Economic context

The corridor connects the main economic and population centres of Northern Ireland, with the Belfast and Dublin. The corridor has varied levels of deprivation, with higher levels deprivation in the north west and the south east, as well as parts of central Belfast, to areas of lower deprivation surrounding Belfast[116]. Belfast has the highest GDP on the corridor, with lower levels to the south east and north[117]. The Port of Belfast is also a key economic hub (the largest UK port by domestic goods), with significant passenger and goods flows between Belfast and Stranraer. Analysis by the NI Department for the Economy indicates there could be a 5.6% reduction in imports from GB over the next 15 years, even under the UK-EU Free Trade Agreement.

[115] https://media.londoncityairport.com/business-air-travel/
[116] *Source – NIMDM17 – SOA Level Results, Northern Ireland Statistics and Research Agency, https://www.nisra.gov.uk/publications/nimdm17-soa-level-results*
[117] GDP / capita by UK Local Authority, 2018

2 – Central Scotland Corridor

Key economic centres - Edinburgh, Glasgow

Key transport infrastructure -

Road: M8

Rail: North Clyde Line, Falkirk Line

Ports: Forth, Clyde

Airports: Edinburgh, Glasgow, Dundee, Aberdeen, Inverness

Interconnecting corridors -

West Coast, North Channel, East Coast

Transport context

This corridor is an important corridor for connecting Scotland's largest cities, but also facilitating movements from the rest of Scotland and other nations. For the rail network within the corridor, there tends to be low to average rail line speeds of between 50km/h to 70km/h, lower in comparison to the mainlines heading south towards England. There is a W12 gauge clearance between Edinburgh and Glasgow, along large shipping containers to connect from the West and East Coast Mainlines[118].

On the road network there are strong HGV flows between Glasgow and Edinburgh, and along the eastern coast towards Aberdeen[119].

Economic context

The corridor connects Scotland's largest population and economic centres, Glasgow and Edinburgh, a population of around 1.1 million. There are also large concentrations of population in North Lanarkshire, Renfrewshire and West Lothian. Edinburgh has highest levels of GDP in the corridor, with mid-level GDP around Glasgow and the rest of the Central Belt[120]. There are pockets of deprivation located around Glasgow and Edinburgh[121]. Employment growth, and GDP growth is also higher within this corridor, then other areas of Scotland.[122]

3 – Scottish Coast Corridor

Key economic centres

Edinburgh, Glasgow, Dundee, Inverness, Aberdeen

Key transport infrastructure:

Road: M73, M74, M80, M876, M90, M9/A9, A90, A985

Rail: East Coast Mainline, Falkirk Line, Edinburgh – Aberdeen Line, Aberdeen – Inverness Line, Highland Mainline, Glasgow – Dundee Line

Ports: Forth, Aberdeen, Clyde

Airports: Edinburgh, Glasgow, Dundee, Aberdeen, Inverness

Interconnecting corridors

West Coast, North Channel, East Coast, Central Scotland

[118] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[119] Government Office for Science - Understanding the UK Freight Transport System (2019)
[120] GDP / capita by UK Local Authority, 2018
[121] *Source – Scottish Index of Multiple Deprivation 2020, Scottish Government https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/*
[122] EY Scottish ITEM Club report

Transport context

The rail routes within the corridor tend have low to average rail line speeds of between 50km/h to 70km/h, compared with the faster routes towards England. There is also no W10 or W12 gauge clearance along the corridor for the movement of large containers by rail[123].

On the road network there are strong vehicles and HGV flows between Glasgow / Edinburgh, and the eastern coast towards Aberdeen[124].

Economic context

The corridor connects Scotland's largest centres of Glasgow and Edinburgh to Dundee, Inverness and Aberdeen. There are greater concentrations of population between Glasgow – Edinburgh – Dundee. GDP is also higher in Edinburgh and Aberdeen, with mid to low levels in areas around Glasgow and the wider northern section of the corridor[125]. Areas of deprivation are located in and around Glasgow, surrounding Edinburgh, and the Highlands, with lower levels around Aberdeenshire.

4 – West Coast Corridor

Key economic centres:

London, Birmingham, Liverpool, Manchester, Preston, Lancaster, Carlisle, Glasgow, Edinburgh

Ports: Liverpool, Manchester, Heysham, Clyde, Forth

Airports: Liverpool, Manchester, Birmingham, Glasgow, London Airports

Key transport infrastructure:

Road: M6, M6(Toll), M73, M74, A74(M), A702, A720

Rail: West Coast Mainline, Glasgow South Western Line

Interconnecting corridors

West Coast, North Channel, East Coast, Central Scotland

Transport context

This is a strategically important national, regional, sub-regional corridor. It is enables journeys from across the UK to connect with the North Channel corridor to Cairnryan, the North Wales corridor towards Holyhead, and the South Wales corridor towards Cardiff and Fishguard.

The West Coast Main Line is the key rail artery for this corridor and the UK. The Line has seen growth of over 100% on 2008/09 levels[126]. Rail journey times generally take between London – Glasgow take around 4hrs 45mins, compared to 6hrs 52mins by road. There is also a strong demand on the corridor by rail between Manchester Airport and Scotland and the North West, as well as between Birmingham International and the North West and Midlands. There are a large number of inter-model freight terminals located in both Scotland and England along the corridor. For rail freight, there is W10 Freight clearance on WCML, with strong current and future demand, with increased capacity required to meet industry demand and forecasts[127]. There is also a strong freight presence on the Glasgow South Western Line.

[123] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[124] Government Office for Science - Understanding the UK Freight Transport System (2019)
[125] GDP / capita by UK Local Authority, 2018
[126] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/480647/annex-demand-and-capacity-pressures.pdf
[127] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

On the road network, the M6, M40, M74, M74(M), M8 form the key road network. The road corridor does suffer from regular and severe congestion, especially in key areas of economic and population concentration, such as the M6 in the North West, as well as the M40 towards London[128]. The M6 and A74(M) have strong demand for HGV trips[129]. The M6 is the only motorway connection between Scotland and England; it has a high proportion of freight trips (24,000 per day).

The corridor is also an important air link between Glasgow, Edinburgh and Manchester and London airports, both for domestic trips and international flights.

Economic geography

This corridor connects six of the Union's largest cities and city regions. Along the corridor, connectivity supports economic clusters, such as Penrith - Carlisle – Dumfries / Glasgow – Edinburgh (Central Belt) / Lancaster – Preston – Warrington) / Stafford – Wolverhampton – Birmingham – Coventry.

The corridor also serves long distance trips, but also local, short distance trips in the Lancashire / Cumbria region. There are a large number of cross border trips from Scotland to England for work, with Census data suggesting between up to 3,000 per day[130].

There is a varied economic geography along the corridor, with large cities and smaller towns and cities. GDP is higher towards the south of the corridor and part of the North West, in Cheshire, with medium to low levels seen in areas of the North West and Scotland[131]. The corridor has high levels of deprivation, mainly in the city regions, but also in some English and Scottish rural / borders communities, as well as in the North West and Midlands of England.[132]

The Port of Liverpool is one of the largest ports in the centre of the corridor, with high levels of road delays currently connecting the port. There are also regular intermodal services both north and south from the Port on the West Coast corridor, with rail access to the Port currently being upgraded.

5 – East Coast Corridor

Key economic centres

London, Leicester, Derby, Nottingham, Sheffield, Leeds, York, Darlington, Newcastle, Edinburgh

Key transport infrastructure

Road: M1, A1(M), A1, A19

Rail: East Coast Mainline, Midlands Mainline, Wakefield Line

Ports: Tynes, Teeside

Airports: Teeside, Newcastle, East Midlands

Interconnecting corridors

West Coast, North Channel, Central Northern, Central Midlands

Transport context

[128] National Policy Statement for National Networks Page 94 (2014)
[129] Government Office for Science - Understanding the UK Freight Transport System (2019)
[130] https://www.nomisweb.co.uk/census/2011/wu03uk
[131] GDP / capita by UK Local Authority, 2018
[132] *Source – Indices of Multiple Deprivation (IMD) 2019, Ministry of Housing, Communities & Local Government Open Data, https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3*

This corridor is a strategically important national, regional, sub-regional connectivity corridor. The corridor also supports a large number of cross border trips from Scotland to England for work along this corridor.

There are high levels of road congestion around South and West Yorkshire on the corridor, and in the North East[133] – which are forecasted to get worse without intervention[134]. There are high levels of HGV traffic on the M1 in the south, Midlands and Yorkshire, with high levels on routes towards ports, and north towards Scotland. HGV levels are lower towards the border and along the south east Scotland area. 15% of all HGV traffic between England and Scotland use the A1[135].

On the rail network, the East Coast Main Line has the highest levels of cross border trips by rail, and has seen growth of 40% since 2008/9. There are also future opportunities from HS2 along this corridor for improved connectivity and capacity to the road and rail network. The corridor has a large number of W12 freight routes including London – Peterborough – Leeds - Newcastle – Edinburgh[136]. However, the present power supply is inadequate for enhanced electrified freight use in parts.

By air, the corridor connects an important air corridor, with Heathrow – Edinburgh the busiest domestic UK internal flight route with 1.2m passengers per year pre-COVID.

Economic context

This is an economically important corridor, connecting six of the UK's largest cities and city regions. The corridor provides connectivity for intra-corridor economic clusters such as, Newcastle – Durham – Tees Valley, York – West Yorkshire – South Yorkshire, Derby – Nottingham – Leicester. One-third of the UK population lives within 20 minutes catchment of an East Coast Main Line station, an economic corridor area accounting for 47% of the UK's economic output[137].

There is a varied economic geography with some of the UK's largest cities, which have higher levels of GDP[138]. It also connects areas of high deprivation, mainly in the city regions but also in some rural / borders communities mainly in the North East and Midlands[139].

East Midlands Airport is also at the heart of the corridor, which is already an important logistics hub, and a potential future freeport. Port of Tyne and others serve Scotland with logistics. There is also the potential for greater coastal shipping which would potentially further strengthen this relationship and connectivity.

6 – North Channel Corridor

Key economic centres

Newcastle-Gateshead, Middlesbrough, Glasgow, Carlisle, Dumfries, Ayr, Belfast

Key transport infrastructure:

Road: M6, A66, A77/M77, A75, A69, A19

Ports: Cairnryan, Loch Ryan, Tyne, Clyde, Teesside, Larne, Belfast

Airports: Lake District, Teesside, Newcastle, Belfast International, City of Derry

Interconnecting corridors

[133] National Policy Statement for National Networks Page 94 (2014)
[134] National Policy Statement for National Networks Page 95 (2014)
[135] Government Office for Science - Understanding the UK Freight Transport System (2019)
[136] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[137] https://investineastcoast.co.uk/wp-content/uploads/2020/11/ECMA-Research-doc.pdf
[138] GDP / capita by UK Local Authority, 2018
[139] *Source – Indices of Multiple Deprivation (IMD) 2019, Ministry of Housing, Communities & Local Government Open Data, https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3*

Rail: West Cast Mainline, East Coast Mainline, Glasgow South Western Line, Tyne Valley Line	West Coast, Central Scotland, East Coast

Transport context

This corridor is critical for connectivity for passenger and freight between England, Scotland and Northern Ireland, with Loch Ryan – Belfast being the second highest passenger ferry route, with 1.3 million passengers annually.

On the road network, there is high demand including via the A66, a key east-west transport route. The corridor has higher levels of congestion in the urban areas around Glasgow and the Tees Valley[140]. There are strong HGV flows on the A66 and A69, a key east-west road route[141].

The Tyne Valley Line and Settle – Carlisle Line provide east-west rail links, but there is no direct rail connectivity for passengers or freight to Cairnryan, with passenger rail links to Stranraer. The Glasgow South Western Line does provide connectivity between Stranraer – Ayr – Glasgow.

There are no W10 or 12 gauge cleared east-west routes along the corridor, and there is no rail line between Dumfries and Cairnryan adjacent to the A75 corridor and connecting to the West Coast corridor[142].

Loch Ryan also serves 1,300 passengers daily to Belfast with 12 sailings per day (the second busiest ferry route in the Irish Sea), and a lesser extent from Cairnryan to Larne[143]. Access to Cairnryan is currently by the A75 from the M6, and by the A77 / M77 from Glasgow, with the roads facing several issues relating to safety, facilities, and longer journey times compared to competitor ports. A study has commenced to explore a fixed connectivity link that would connect this corridor to the Northern Ireland corridor.

Economic context

Although an important connectivity corridor, there are relatively low levels of population density. Glasgow, Middlesbrough and Newcastle are the largest population and economic centres in this corridor, with Carlisle, Ayr and Dumfries being other larger centres. There is also a strong economic geography between Carlisle – Dumfries, with up to 3,000 people crossing the border to England for work each day.

There are average levels of GDP across the corridor, with lower levels in the North East of England and Dumfries and Galloway[144]. Areas to the West of Dumfries and Galloway have higher levels of deprivation then areas towards the Border, with higher levels of deprivation in England areas along the Border in Carlisle and in the North East of England[145].

Cairnryan is Scotland's busiest port for the handling 2,705,000 tonnes of domestic cargo annually and serving demand from England as the shortest ferry trip between Great Britain and Northern Ireland[146]. This corridor also connects to ports in the Tees Valley, the location of a potential future freeport.

[140] National Policy Statement for National Networks Page 94 (2014)

[141] Government Office for Science - Understanding the UK Freight Transport System (2019)

[142] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

[143] *Routes and passenger numbers have been extracted from Department for Transport Statistics - Table SPAS0102 and Table SPAS0201. These tables have also been used to calculate the CAGR from 2009-2019 (10 years)*

[144] GDP / capita by UK Local Authority, 2018

[145] *Source – Indices of Multiple Deprivation (IMD) 2019, Ministry of Housing, Communities & Local Government Open Data, https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3 / Source – Scottish Index of Multiple Deprivation 2020, Scottish Government https://www.gov.scot/collections/scottish-index-of-multiple-deprivation-2020/*

[146] UK and RoI freight traffic data provided by DfT

7 – Central Northern Corridor

Key economic centres

Liverpool, Warrington, Manchester, Preston, Bradford, Leeds, Sheffield, York, Hull

Key transport infrastructure:

Road: M61, M62, M18, M1, M60, M56, A616, A628, A63, M57, M58, M621, M67

Rail: Diggle Line, Hope Valley Line, Calder Valley Line, Chat Moss Line, CLC Line, South Humberside Line, Selby Line, East Coast Mainline, West Coast Mainline

Ports: Liverpool, Salford, Immingham, Grimsby, Hull, Goole

Airports: Manchester, Liverpool, Leeds Bradford, Doncaster Sheffield

Key interconnecting corridors

West Coast, East Coast, North Wales, Welsh Marches

Transport context

The corridor connects some of the UK's largest economic centres. It is the physical challenging with the Pennines a key barrier for east-west connectivity

There is a mixed-use, predominantly two-track railway with capacity limitations, with many rail routes cross through congested rail network of Manchester and Leeds. East–west rail connectivity across the Pennines is particularly constrained, with low average speeds and frequencies. Rail schemes are planned to improve rail connectivity across the corridor, including the Transpennine Route Upgrade and Hope Valley Line Upgrade, with plans in development for Northern Powerhouse Rail, which could significantly reduce journey times and increase frequencies between the North's largest cities. There is also no East-West rail freight gauge clearance for W10 and W12 clearance, with low levels of freight trains on other east-west routes[147]. There are however W12 rail links to the Port of Immingham, one of the UK's busiest ports.

On the road network, the M62 carries half of all Trans-Pennine traffic, including the majority of road freight which is forecast to increase by 23% by 2050, with other Trans-Pennine routes having lower flows[148]. There are also challenges of the Manchester – Sheffield road links, which serve key strategic role. Woodhead road links suffer more average delays, along with sections of the M60 / M62 between Manchester – Liverpool – these sections are forecast to worsen, along with sections of the M56, M6 and M1 in the corridor.

Economic context

The corridor has a population of around 8.7 million people, and 4 million jobs which generate between 40-50% of the North of England's economic output. There is lower productivity attributed to areas such as Greater Manchester, Lancashire and West Yorkshire[149]. The GDP across the corridor is generally average, with higher levels towards Cheshire and North Yorkshire.[150] The corridor has two of the UK's largest ports (Liverpool and Humber (Grimsby, Immingham), with the Port of Liverpool having strong trade links to the Republic of Ireland and Belfast.

[147] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[148] National Policy Statement for National Networks Page 94 (2014)
[149] https://transportforthenorth.com/wp-content/uploads/Executive-Summary-Central-Pennines-Strategic-Development-Corridor-February-2019-min.pdf
[150] GDP / capita by UK Local Authority, 2018

8 - North Wales Corridor

Key economic centres

Holyhead, Wrexham, Chester, Liverpool, Warrington, Manchester, Crewe

Key transport infrastructure

Road: A494, A55, A550, M53, M56, M60, M62

Rail: North Wales Coast Line, Manchester – Liverpool Line, Chester – Warrington Line, Crewe – Liverpool Line, Borderlands Line, Welsh Marshes

Ports: Holyhead, Liverpool, Salford

Airports: Liverpool, Manchester

Key interconnecting corridors

West Coast, Central Northern, Welsh Marches

Transport context

On rail, the North Wales Coastline is a key route for communities and businesses to the North West of England, with rail connections for accessing Manchester and Liverpool Airports. Many trips from North Wales - South Wales involve entering England (Holyhead – Chester – Wrexham – Shrewsbury – Newport – Cardiff). with interchange at Chester or Crewe for West Coast Mainline services to the north and south. There is no East – West W10 and 12 freight gauge cleared rail routes[151]. Transport for Wales and Growth Track 360 have been developing plans for a North Wales Metro and improvements to the North Wales Coast Line. This includes line speed and capacity upgrades, Wrexham-Bidston-Liverpool upgrades, Chester Station Enhancements, a Crewe Hub interface, and service amendments.[152]

On the road network, there is high levels of traffic on the A55, M56, M6 and M60, with congestion levels currently high in sections of the M56 towards Greater Manchester[153].

Sea passenger numbers between Holyhead and Dublin the highest of the Irish Sea routes. Holyhead is the only major UK port (cargo volumes of at least 1 million tonnes annually) in the North of Wales. It has significant freight crossings across the Irish Sea, and so access to and from Holyhead by the A55 is an important consideration for freight connectivity. There are 4 routes which have seen a growth in passenger numbers over the past 10 years, including Liverpool-Belfast, and Holyhead-Dublin. Holyhead has a large Ro-Ro freight presence, Liverpool has a large Ro-Ro / Liquid bulk, and dry bulk presence[154].

Economic context

The English – Welsh / Mersey Dee area is a large employment area, generating around £25bn GVA per annum with an overall population of 940,000 of which 380,000 are in employment. The area is in the process of delivering a £670m investment programme enabled by the North Wales Growth Deal. The Cheshire and Warrington LEP area has a population of 920,000, a GVA of £29.3bn produced by 42,000 businesses with a workforce of 488,000 people.[155]

This results in a high level of intra corridor movements (Chester, Wrexham, Liverpool) as well as inter corridor movements (long distance through trips). Over 80% of commuting journeys in the area start and

[151] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[152] http://www.merseydeealliance.org.uk/wp-content/uploads/2020/05/Mersey-Dee-Growth-Prospectus.pdf
[153] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*
[154] *Routes and passenger numbers have been extracted from Department for Transport Statistics - Table SPAS0102 and Table SPAS0201. These tables have also been used to calculate the CAGR from 2009-2019 (10 years)*
[155] http://www.merseydeealliance.org.uk/wp-content/uploads/2020/05/Mersey-Dee-Growth-Prospectus.pdf

finish within the area, one of the highest rates in the country. The workforce for the area's key sectors is located in large cross-border clusters, and supply chain linkages to the wider North of England.

There are areas of deprivation are also present along the corridor, mainly in communities along the North Wales Coastline, areas of the Liverpool City Region, Greater Manchester[156]. Cheshire has lower levels of deprivation. This is also the case when looking at levels of GDP (Anglesey and Conwy are low, but higher levels in Cheshire, Greater Manchester)[157]

9 – Welsh Marches Corridor

Key economic centres

Swansea, Cardiff, Hereford, Worcester, Birmingham, Shrewsbury, Wrexham, Chester, Crewe, Liverpool, Manchester

Key transport infrastructure

Road: A49, M5, A5, M50, A40, A44, A48, A449

Rail: South Wales Line, Welsh Marshes, Borderlands Line

Ports: Fishguard, London, Milford Haven, Port Talbot, Newport, Bristol, Swansea

Airports: Liverpool, Manchester, Cardiff

Key interconnecting corridors

West Coast, Central Northern, North Wales, South Wales

Transport context

The corridor connects communities within Wales, but also communities and trips between England and Wales. There are high levels of population in Wales that cross the border for work and education. Many trips between South and North Wales, by road and rail, involve travelling via England. There are a number of key border roads that cross the English – Welsh border, including the A483, A49, A5, A48 and A40.

The A5 and A49 have strong demands from HGV vehicles, as well as on the M50, M54, A40 crossing the English – Welsh border[158]. Road routes on this corridor however suffer from road delays, mainly the A5 and A49. There are also strong road traffic flows on the A480 between Chester and Mid-Wales. Between South Wales – West Midlands (M50/A40) there are high levels of trips in the peak period[159].

On the rail network, the Welsh Marches line provides a key rail corridor between South and North Wales with the Cambrian Line connecting Mid-Wales to England. The corridor has no W10 or 12 freight gauge clearance[160].

Economic context

The main population centres are around South Wales (Swansea, Cardiff, Newport), Midlands (Greater Birmingham), and North Wales / West (Wrexham, Chester, Liverpool, Manchester). There are higher levels of deprivation in communities in urban areas in South Wales, and coast towns of North Wales, with mid to

[156] *Source – Indices of Multiple Deprivation (IMD) 2019, Ministry of Housing, Communities & Local Government Open Data, https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3 / Source – Welsh Index of Multiple Deprivation (WIMD) 2019, Welsh Government http://lle.gov.wales/catalogue/item/WelshIndexOfMultipleDeprivationWIMD2019/?lang=en*

[157] GDP / capita by UK Local Authority, 2018

[158] Government Office for Science - Understanding the UK Freight Transport System (2019)

[159] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*

[160] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

low levels in other parts of the Corridor[161]. There are higher levels of cross border trips from Wales to England for work seen in North Wales then those seen across Mid and South Wales. GDP is at UK average across the Corridor, with lower levels towards Mid Wales.[162]

10 – South Wales and Western England Corridor

Key economic centres

Swansea, Cardiff, Bristol, Swindon, Reading, Heathrow, London, Bath

Key transport infrastructure

Road: M4, M48, A48, A40, A449, A4076

Rail: South Wales Line, Welsh Marshes, Great Western Line

Ports: Fishguard, London, Milford Haven, Port Talbot, Newport, Bristol, Swansea

Airports: Bristol, Cardiff

Key interconnecting corridors

West Coast, Welsh Marches, South West, Central Midlands, Central Southern

Transport context

On the road network, the M4 is strategically important route for accessing to ports and large centres of population. There are around 54,000 trips in each direction, each week on the Severn Crossing between England and Wales. This corresponds with high levels of commuting between South Wales to England. There is an associated high number of HGV flows between England and Wales, with greater focus on the Cardiff – London section of the corridor[163]. This results in severe congestion hotspots on the M4 in Wales.

On the rail network, Cardiff is currently is the UK's least well directly connected major city, with fewer direct services to other major UK cities. There are upgrades to rail capacity in the Bristol – South East Wales area, however there are currently no freight gauge cleared rail routes in South Wales or the West of England[164].

The 84-mile rail journey from Swansea to Bristol Temple Meads takes over two hours and requires interchange at Cardiff. The same journey by car takes around 1hr 40. Both modes significantly hinder opportunities for collaboration and commuting between businesses in the two cities.

Economic context

There are large areas of population around Bristol, Cardiff and Swansea, with other pockets such as Reading towards London[165]. The Inner South Wales corridor suffers from high deprivation, with many areas in

[161] *Source – Indices of Multiple Deprivation (IMD) 2019, Ministry of Housing, Communities & Local Government Open Data, https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3 / Source – Welsh Index of Multiple Deprivation (WIMD) 2019, Welsh Government http://lle.gov.wales/catalogue/item/WelshIndexOfMultipleDeprivationWIMD2019/?lang=en*

[162] GDP / capita by UK Local Authority, 2018

[163] Government Office for Science - Understanding the UK Freight Transport System (2019)

[164] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

[165] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*

England suffering from less deprivation[166]. GDP per is lower in South Wales compared with cross border areas around Bristol and along the wider England corridor towards London[167].

Improvements to the Great Western Main Line, in conjunction with improvements along the wider corridor, give the opportunity to add £614m to the economy through agglomeration improvements.

There are a number of major UK ports concentrated along the corridor, namely Fishguard, Milford Haven, Swansea, Port Talbot, Cardiff & Newport. Of these, Milford Haven has the greatest freight volumes across the Irish Sea, and also serves as an Energy Port.

11 – Central Midlands Corridor

Key economic centres

Felixstowe, Norwich, Cambridge, Peterborough, Birmingham, Shrewsbury, Derby, Leicester, Stoke-on-Trent, Logistics Golden Triangle, Oxford

Key transport infrastructure

Road: A14, M6, A1, A11, A47, A46, A5, A50, A428, M42 / A42

Rail: Great Eastern Main Line, Breckland Line, Chilterns Line, Ely – Peterborough Line, West Anglia Mainline

Ports: Felixstowe, Ipswich, Harwich, Great Yarmouth

Airports: Norwich, Birmingham, East Midlands

Key interconnecting corridors

West Coast, Welsh Marches, South Wales, Eastern, East Coast, South West

Transport context

This corridor is an important economic corridor, connecting large economic centres such as Cambridge, Oxford, and Birmingham, as well as supporting important freight and goods flows to and from Felixstowe.

The A14 is a key HGV corridor, with associated high levels of HGV traffic[168]. High levels of road delays on the A47 and sections of the A14 near Cambridge[169], with potential future delays around Cambridge, the West Midlands and Felixstowe without intervention.

On the rail network, connectivity is stronger between Norwich – Peterborough – Birmingham with more frequent services, with East West Rail forming a central part of the enhancing connectivity in the corridor between Oxford – Cambridge. There are high levels of daily freight trains from Felixstowe across the corridor to and from the Midlands with significant growth expect from freight on this corridor[170]. This corridor, compared with many others, does have W10 freight clearance between Felixstowe – Peterborough – Leicester

[166] *Source – Indices of Multiple Deprivation (IMD) 2019, Ministry of Housing, Communities & Local Government Open Data, https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3 / Source – Welsh Index of Multiple Deprivation (WIMD) 2019, Welsh Government http://lle.gov.wales/catalogue/item/WelshIndexOfMultipleDeprivationWIMD2019/?lang=en*

[167] GDP / capita by UK Local Authority, 2018

[168] Government Office for Science - Understanding the UK Freight Transport System (2019)

[169] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*

[170] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

– Birmingham[171]. Plans are also being developed for Midlands Engine Rail that could add 736 extra services a day, 72 more freight trains per day to the rail network, and integration with HS2[172].

On the road network, there are high usage road corridors, include the M6 and A1 which carry significant trips to, from, within and through the corridor. The A50/A500 corridor suffers from slow average peak time speeds, which may get worse with 30,000 new homes and 17,000 new jobs planned along the route by 2030. The A46 is a nationally significant trade and export route, with 600,000 new residents, 150,000 new jobs and 250,000 new homes expected within the corridor by 2041.

Economic context

The corridor's main population areas are around the West Midlands (Birmingham, Wolverhampton, Coventry) with smaller, dense areas around Cambridge, Oxford, Norwich, and coastal communities such as Great Yarmouth and Lowestoft[173]. The corridor is joining up existing and future growth corridors, such as the Wolverhampton – Birmingham – Coventry, and Oxford – Cambridge.

The levels of deprivation vary along the corridor, with higher levels seen in the West Midland, areas around Kings Lynn, and communities around Ipswich and Felixstowe, with lower levels seen in central areas around Cambridge and Oxford. GDP is higher in areas such as Cambridge, Oxford and the West Midland, with levels as much as half seen in areas of Norfolk and Suffolk in comparison[174]. Levels of productivity are generally higher in areas of Oxfordshire and Cambridgeshire, and areas around Norfolk, with mid to low levels in seen in areas of Norfolk, Suffolk and the West Midlands.

Felixstowe is one of the UK's busiest ports, with large amounts of Lo-Lo, and Ro-Ro – Harwich and Ipswich have smaller liquid bulk and dry bulk freight. The corridor also connects to the heart of the logistics 'Golden Triangle', including Daventry International Rail Freight Terminal (DRIFT). The 'Golden Triangle' collates UK imports and exports for onward distribution. The location of Freeports at international gateways has the potential to influence future international and domestic freight flows, including at East Midlands Airport.

12 – The South West Corridor

Key economic centres

Plymouth, Exeter, Bristol, Birmingham

Key transport infrastructure:

Road: A30, M5, A303, A38

Rail: South Devon Mainline, Great Western Mainline, West of England Mainline, Reading – Taunton Line

Ports: Plymouth

Airports: Newquay, Exeter, Birmingham

Key interconnecting corridors

South Wales, South Coast, Central Midlands, Welsh Marches

Transport geography

The corridor connects Cornwall and Devon to the Midlands. Generally, the strategic road network performs well, however there are congestion issues around Plymouth and towards Penzance. Average delays of 10 to

[171] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

[172] https://www.midlandsengine.org/midlands-engine-rail-could-create-and-safeguard-thousands-of-jobs/

[173] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*

[174] GDP / capita by UK Local Authority, 2018

more than 20 minutes seen on sections of the A38 to Plymouth, worsening on the A30 towards Penzance[175]. There are high levels of HGV use of the M5 and A38 between Birmingham, Bristol and Plymouth, especially accessing ports at Bristol, Plymouth and Fowey[176].

On the rail network, the main economic centres are connected by rail, for short and long-distance trips. There are no W10 or 12 freight cleared routes along the corridor[177].

For air, Newquay and Exeter Airports have high demand to London airports as well as Manchester and Newcastle.

Economic geography

Across the corridor, population density is low compared with other corridors, with population and economic centres following the M5 corridor in Bristol, Taunton, Exeter, Torquay, and Plymouth.[178] The corridor has higher levels of deprivation especially to the north and along the coast. GDP is generally lower than other areas of the UK, apart from in Bristol.[179]

Compared with other ports, the transport of liquid and dry goods is lower out of Plymouth (1.2m tonnes), with slightly high levels seen at Bristol (1.4m tonnes) of domestic cargo.

Leisure and tourism is a key component of the economy, with the South West being the most visited region in the UK with approximately 21 million domestic visitors in 2017 contributing £4.5 billion to the UK economy. With 72% of visitors to the South West originating from outside of the region, the transport system experiences significant seasonal increases in demand which result in capacity issues and congestion on some of the peninsula's most important corridors.

13 – The Kent Corridor

Key economic centres

London, Dover, Canterbury, Ashford, Maidstone, Folkestone

Key transport infrastructure:

Road: M20, M2, M25, A2

Rail: HS1, South Eastern Mainline, Kent Coast Line

Ports: Dover, Medway, Ramsgate

Key interconnecting corridors

West Coast, East Coast, Eastern, South Coast, South Wales

Transport context

The corridor is an important transport corridor for connecting people and goods travelling to Mainland Europe, via the Channel Tunnel Rail Link / HS1, and the Port of Dover.

On the rail network, HS1 provides high speed links to London along the corridor, and population centres in-between. Evidence presented states that additional connection between HS1 infrastructure and the conventional network near the Folkestone area would allow HS1 services from Folkestone and Dover to make more use of HS1 infrastructure, resulting in a 7-minute reduction in journey time delivering end-to-

[175] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*
[176] Government Office for Science - Understanding the UK Freight Transport System (2019)
[177] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[178] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*
[179] GDP / capita by UK Local Authority, 2018

end times of under 60 minutes between Dover and London. Although there is a freight presence in the corridor, there is no W10 or 12 freight clearance for rail routes[180].

For road, the M20 provides a key link to other corridors to the Port of Dover. There are associated high HGV flows on the M20[181]. Currently there are mid-level road delays on key routes towards Dover, with greater average delays (20 minutes +) around Dover and towards the M25[182]. Some sections of the corridor, around the M25 are forecast to worsen.

Economic context

The corridors larger population centres are towards London, with population centres along the M2 and A20 corridors, such as Canterbury and Ashford. There are also areas of population density on the coastlines in Dover, Margate and Folkstone[183]. Levels of GDP are high across the corridor, higher towards London, and areas around Dover, with mid-levels in coastal communities.[184] The central section of the corridor tends to have lower levels of deprivation, with areas of high deprivation located near Folkstone and areas along the Thames.

Dover is one of the UK's most important ports within the corridor, with mainly Ro-Ro (10.9m passengers per year, handling over 20m of tonnes per year). The Port of Medway handles lower levels of liquid and dry bulk freight.

14 – The South Coast Corridor

Key economic centres

London, Southampton, Portsmouth

Key transport infrastructure:

Road: M3, A3 A3(M), M27, A303

Rail: Portsmouth Direct Line, Wessex Mainline, South Western Mainline

Ports: Southampton, Portsmouth

Airports: Bournemouth, Southampton, London

Key interconnecting corridors

Kent, Central Southern, South Wales

Transport context

The corridor connects London, Guildford and Southampton. On the rail network, the corridor between London and Southampton generally has high frequencies and speeds. The rail network has W10 and W12 gauge clearance to Southampton and onwards towards the Midlands and London, however other rail routes do not have this in the corridor[185].

[180] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

[181] Government Office for Science - Understanding the UK Freight Transport System (2019)

[182] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*

[183] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*

[184] GDP / capita by UK Local Authority, 2018

[185] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

On the road network, there are average delays on routes such as the M3 and A303, but currently there are road delays of over 20 minutes on road corridors along the Coast, including the A35 and A30[186]. However, sections of the M3, and road around Southampton are forecast to worsen without intervention. The corridor also has strong North-South demand for HGVs accessing the Solent ports, as well as routes between the South Coast and London, such as the A34 and M3[187].

Economic context

This corridor high population density in areas of west and south London, to economic and population centres along and towards the South Coast, including Winchester, Southampton and Portsmouth.[188]. There are also major transport and freight hubs such as Southampton and Portsmouth for ferries to the Isle of Wight, the Channel Islands, and Europe. The Solent is also a potential new freeport.

The levels of deprivation are low across the corridor, with higher levels seen in areas of coastal communities around Southampton and Portsmouth. The GDP is high compared with other corridors, especially in areas towards London and along the M3 corridor, as well as areas around Southampton[189].

Portsmouth is a key node, with around 1.7 million international passengers per year using the port. Southampton is the UK's 5th largest, with around 30 million tonnes of international trade.

15 – The Eastern Corridor

Key economic centres

London, Chelmsford, Colchester, Stansted, Norwich, Felixstowe, Ipswich

Ports: London, Felixstowe, Harwich, Ipswich, Great Yarmouth

Airports: Stansted, Norwich

Key transport infrastructure

Road: A12, A127, A140, A13, A130, A11, A120

Rail: Great Eastern Mainline, West Anglia Mainline

Key interconnecting corridors

Central Midlands, Kent

Transport context

On the rail network there is strong passenger connectivity between Norwich and London. The rail network has W10 gauge clearance between London – Felixstowe, and towards the Midlands from Felixstowe – Peterborough[190].

The road network performs well, however there are current delays on sections of the A12 around Chelmsford and towards Felixstowe, with some forecasted future increases in delays. The road network also has strong HGV demand, especially high on the A12, A14, A13, A130 for freight, along with the M25[191].

[186] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*

[187] Government Office for Science - Understanding the UK Freight Transport System (2019)

[188] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*

[189] GDP / capita by UK Local Authority, 2018

[190] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)

[191] Government Office for Science - Understanding the UK Freight Transport System (2019)

Economic context

This corridor covers a geography that stretches from London – Stansted – Colchester – Norwich. It connects higher population densities towards London, as well as population and economic centres of Chelmsford, Colchester, Ipswich, and Norwich.[192] There is a population of 3.5 million (excluding London), and is expected to grow by a further 516,000 people to 2041. The corridors economy is around £73.5bn GVA per annum, with particular sectoral strengths in motive technology, higher education, medicine, agri-technology, life sciences and engineering. Levels of GDP are higher towards London, Chelmsford and Norwich, but there are mid to low levels across the rest of the corridor[193]. Levels of deprivation vary along the corridor with higher levels more located in urban areas, however there are lower levels found towards the north of the corridor in Norfolk.

The Ports of London and Felixstowe are key economic hubs along the corridor, but also two of the UK's largest ports. The ports are particularly key for Ro-Ro and Lo-Lo at Felixstowe, and a mixture of liquid bulk, dry bulk, Ro-Ro, and Lo-Lo at London. The Port of London, which includes the Thames ports of Tilbury and London Gateway, handles 10 million tonnes of domestic cargo per year.

16 – The Southern Central Corridor

Key economic centres - Southampton, Portsmouth, Reading, Oxford, Birmingham

Key transport infrastructure –

Road: M40, A34, M3, M27, A303, A34

Rail: South Western Mainline, Oxford-Bicester Line

Ports: Southampton, Portsmouth

Airports: Southampton

Key interconnecting corridors - Central Midlands, South Wales, West Coast

Transport context

On the rail network, the corridor is served by rail services between Southampton – Reading – Oxford – Birmingham. The corridor also connects with planned East West Rail routes from Oxford. The rail corridor has W10 rail freight clearance from Southampton – Reading – Birmingham, with some sections of W12 around Southampton and between Reading and London[194].

On the road network the road network performs well, but there are current delays on sections around the large population centres of Southampton and Birmingham[195]. The road network also has strong HGV demand, especially high on the A34 and A40 north – south[196]. Sections of the Strategic Road Network, such as the M27 and M3, are expected to worsen with severe congestion without intervention[197].

Economic context

[192] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*
[193] GDP / capita by UK Local Authority, 2018
[194] Routeing of rail freight forecasts A study for Network Rail by MDS Transmodal (2020)
[195] *Travel time measures for the Strategic Road Network and local 'A' roads, Department for Transport, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-*
[196] Government Office for Science - Understanding the UK Freight Transport System (2019)
[197] National Transport Model (of Congestion on the Strategic Road Network in 2040, produced in 2014)

The corridor covers a geography that stretches and includes the population centres of London – Reading – Oxford – Birmingham.[198] GVA per filled job is also relatively high across the corridor, along with high levels of productivity[199], with GDP highest in areas around Reading, Oxford and Southampton[200]. The levels of deprivation are low across the corridor, with higher levels seen around Southampton, Portsmouth and Birmingham.

[198] *Source – Table SAPE22DT11, Lower Layer Super Output Area Population Density, Office for National Statistics, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity*
[199] Productivity (GVA per Filled Job) Index by Local Authority, 2018
[200] GDP / capita by UK Local Authority, 2018

Appendix C

Review by Mode

C1 Review of the transport network by mode

This section summarises the current and future networks by mode including:

- rail;
- road;
- sea; and
- air.

C1.1 The rail network

A summary of the rail network is as follows.

- The major towns and cities of the UK are connected by rail.
- Many major cities have excellent direct rail links to London, but links between major cities other than London have some scope for improvement.
- Rail journey times are slower, and capacity and volume are less, the further the lines get from London (or other major cities). This means that cross border services between England and Scotland and England and Wales are often slower, or lower capacity, and less well-used, than other links, which is partly because of matching capacity to demand.
- Journey times are particularly slow in the south west – north corridor, and east – west corridors across England and Wales.
- There is some evidence that cross border rail journeys are increasing in popularity.
- The freight network is already busy, and there are likely to be significant increases in freight demand across the strategic network as we move to net zero

C1.1.1 Ownership and structure

The National Rail network in Great Britain is owned by Network Rail, who are responsible for oversight of the timetable, and upkeep & enhancement of the railway infrastructure. Train services are operated by (mostly) private sector Train Operating Companies (TOCs). Each TOC operates across a defined regional geography; for example, South Western Railway operate services within and between London, Portsmouth, Weymouth, Exeter & Bristol in the South West of England.

These specified geographies are known as ‘franchises’. Until the Covid-19 pandemic struck, franchise contracts were tendered on a competitive basis, with private operators taking on the majority of cost and revenue risk. However, the government recently announced the end of the franchising model and the Williams-Shapps Plan for Rail has now set out the roadmap to the future shape of the industry. A new arms-length body, Great British Railways, will take on many

of the existing responsibilities of Network Rail and the DfT. Private operators will still run the majority of services, but will be procured on National Rail Contracts, no longer taking the revenue or cost risk but receiving a pre-determined fee with incentives for good performance. There is no indication that there will be material changes to network infrastructure or the geographical segmentation as a result of the reforms.

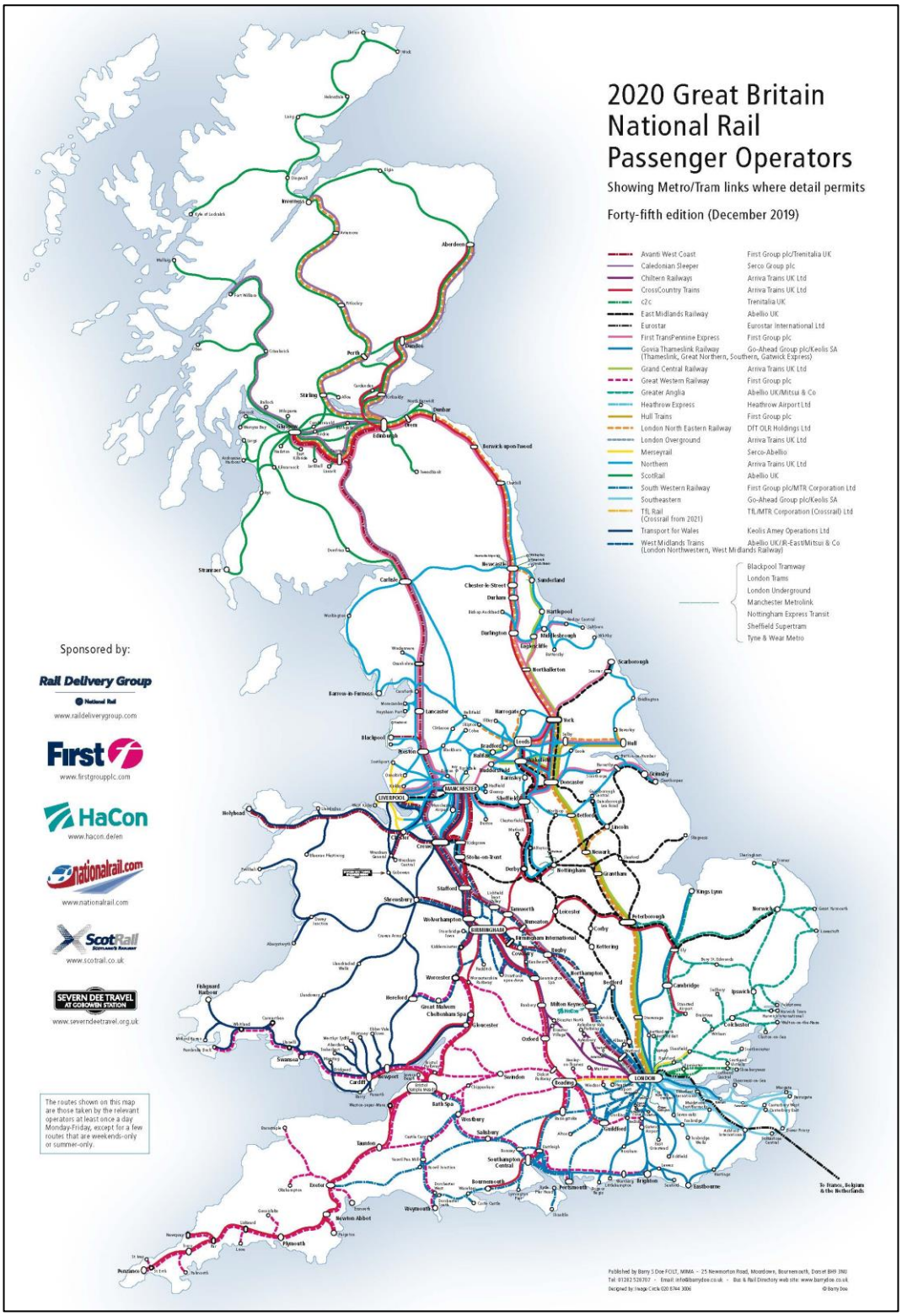
Figure 64 illustrates the coverage of the network and the different franchise operators, as of 2020.

The Northern Ireland rail network, shown in Figure 65, is separate from Great Britain's National Rail network. Note that much of central and western Northern Ireland is not served by rail. The industry in Northern Ireland is fully vertically integrated, with responsibility for maintaining the infrastructure & rolling stock and running services all sitting with Northern Ireland Railways. This is a public sector body; a subsidiary of Translink.

C1.1.2 Completeness of the network

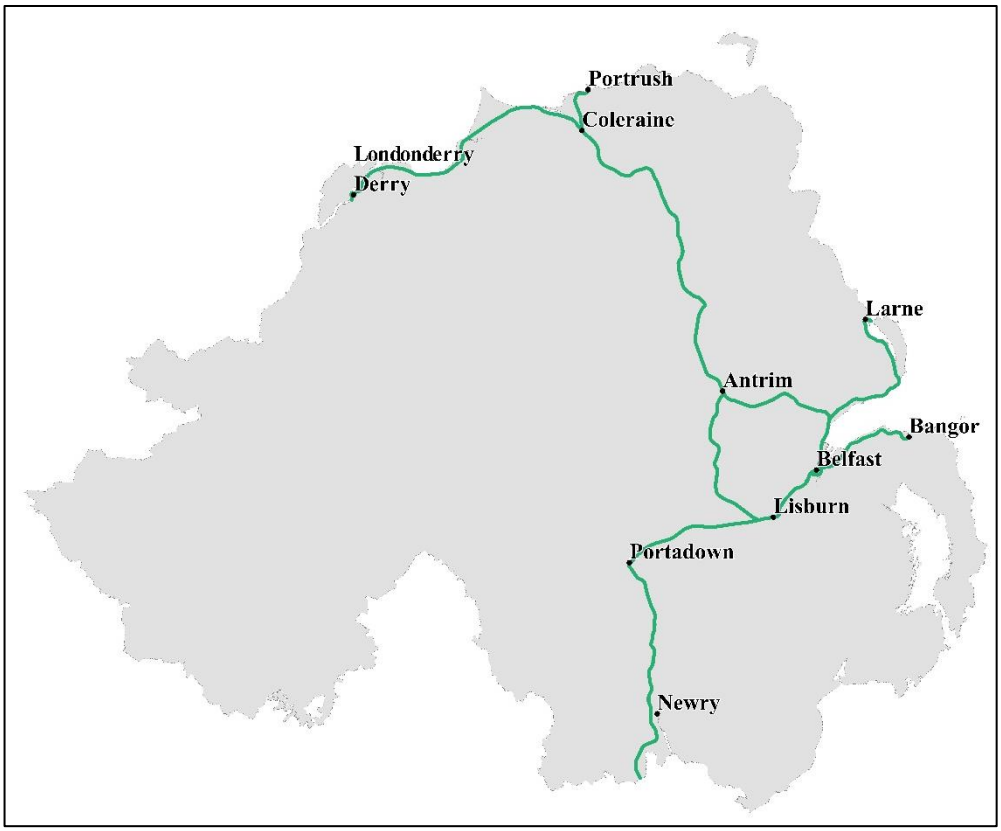
The rail network covers almost every major town and city in Great Britain, and several major airports and passenger sea ports.

Figure 64 – The National Rail network in Great Britain, divided into its franchises



Source – Great Britain National Rail Passenger Operators 45th Edition, Project Mapping (Barry Doe), http://www.projectmapping.co.uk/Reviews/Resources/Barry%20Doe%20railmap%2045.pdf

Figure 65 – The Northern Ireland Railways network (line between Antrim and Lisburn not currently utilised)



Source – Shapefile from Northern Ireland Railways NIR Railway Network, Open Data NI (2015), https://www.opendatani.gov.uk/dataset/northern-ireland-railways-nir-railway-network

C1.1.3 Journey times

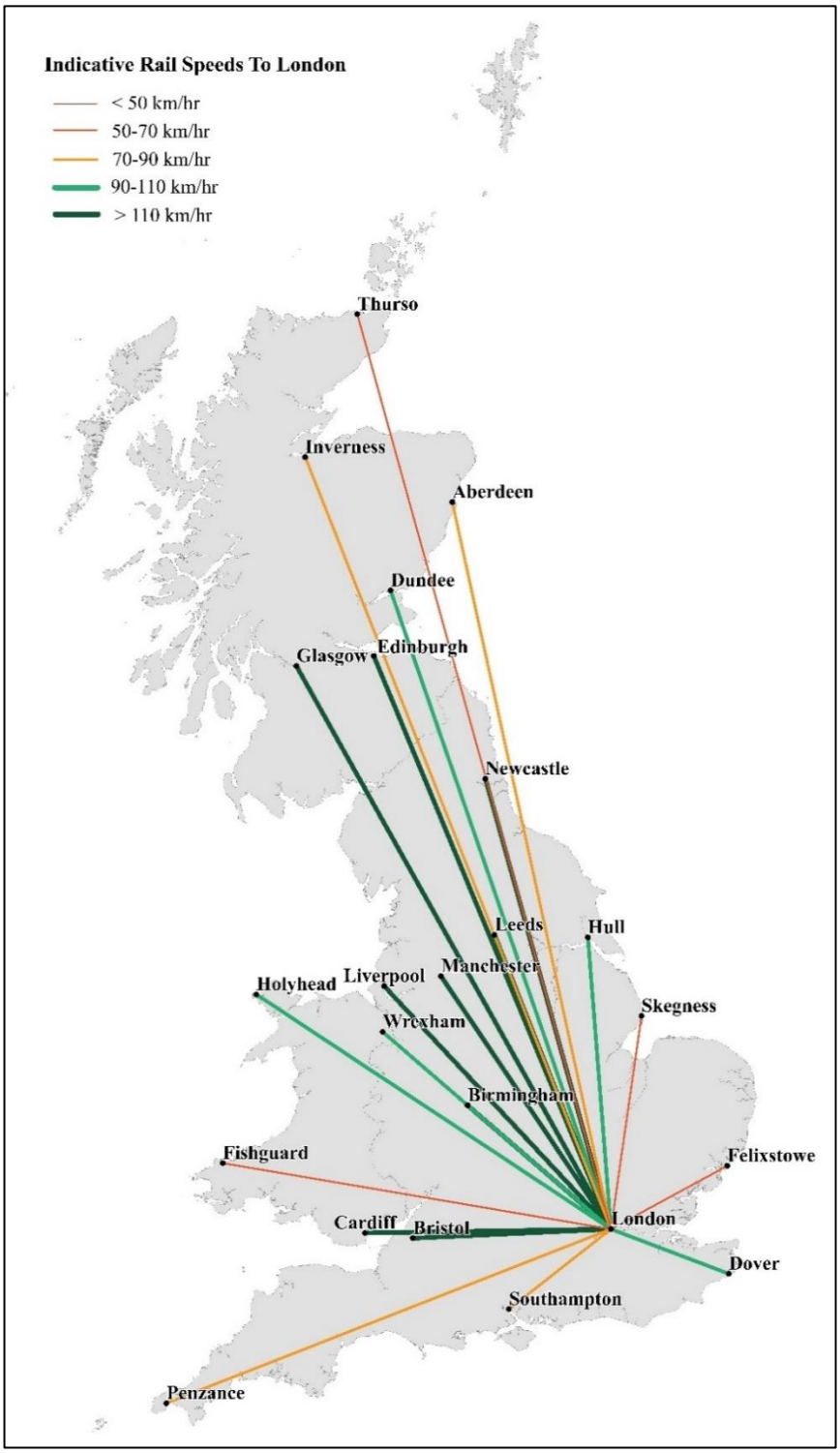
Rail journey times tend to be relatively fast, when compared with other forms of surface transport. Many intercity routes operate at speed of 125mph (200kph), meaning that 'crow flies' average speeds, particularly with London, are high. The following Figures show indicative journey speeds by rail between key strategic locations in the UK. These are calculated by dividing the 'crow-flies' distance between locations by the fastest scheduled journey time available on a given weekday in 2021.

Lower indicative journey speeds are often caused by:

- lower line speeds, or additional stops, particularly away from intercity lines serving London;
- a requirement to interchange;
- the route may only be served by stopping or 'slow' trains; and
- there are geographical barriers which extend route lengths considerably beyond the crow-flies distance e.g. sea or terrain.

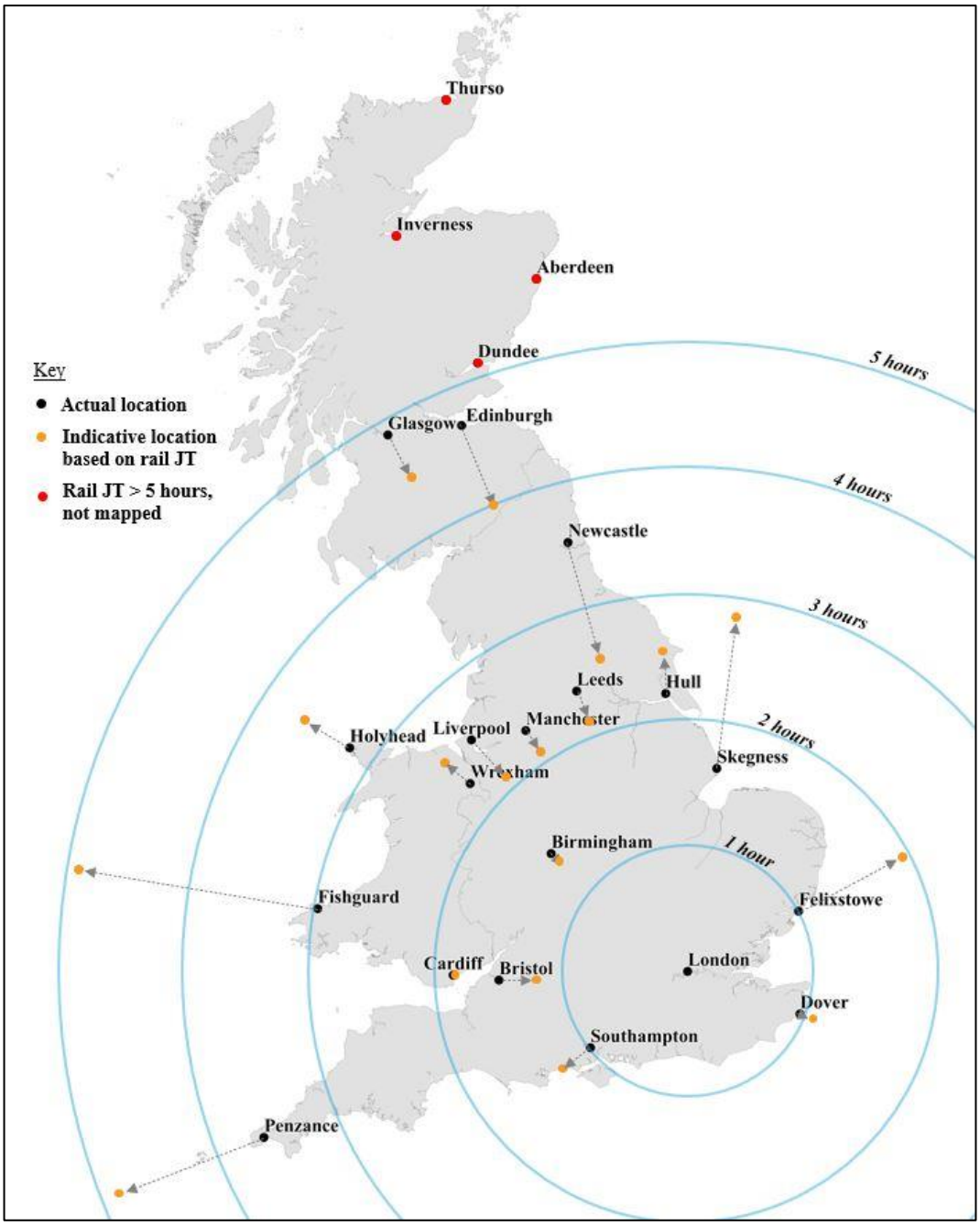
Rail stations are often located in city or town centres, meaning that they are popular with commuters, and with those travelling into large cities, where parking may be restricted. Rail journeys are less popular in rural or semi-rural areas.

Figure 66 – Indicative journey speed by rail from key GB locations to London



Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

Figure 67 – Map showing the relation between the distance to London and the fastest journey time by rail



Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*

Figure 66 illustrates journey speeds to London from across the UK. London is the focus of the rail network in Great Britain, and 64% of all rail journeys started or ended in London in 2017[201]. The East and West Coast Main Lines provide north-south connectivity and direct links to major cities in the Midlands and North of

201

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/663116/rail-factsheet-2017.pdf

England. While frequencies vary by station, journey speeds on these corridors tend to be high, with few stops, and electrified lines. Newcastle, Liverpool, Manchester, Leeds and Birmingham each have indicative journey speeds to London of more than 110km/hr. The East and West Coast Main Lines also provide cross-border connectivity, extending to Edinburgh and Glasgow respectively. The fastest trips from these cities to London take 4-4.5 hours by train, also exceeding an indicative journey speed of 110km/hr.

Journeys between Cardiff and London take less than 2 hours along the Great Western Main Line. This line is now fully electrified to Cardiff. Bristol and Cardiff both have indicative journey speeds to London of more than 110km/hr.

Where the indicative journey speeds are lower in Figure 66, this is largely due to poor onward connections from the mainlines. For example, the connection from Skegness to the East Coast Main Line at Grantham can take longer than the leg from Grantham to London, despite being a fraction of the distance.

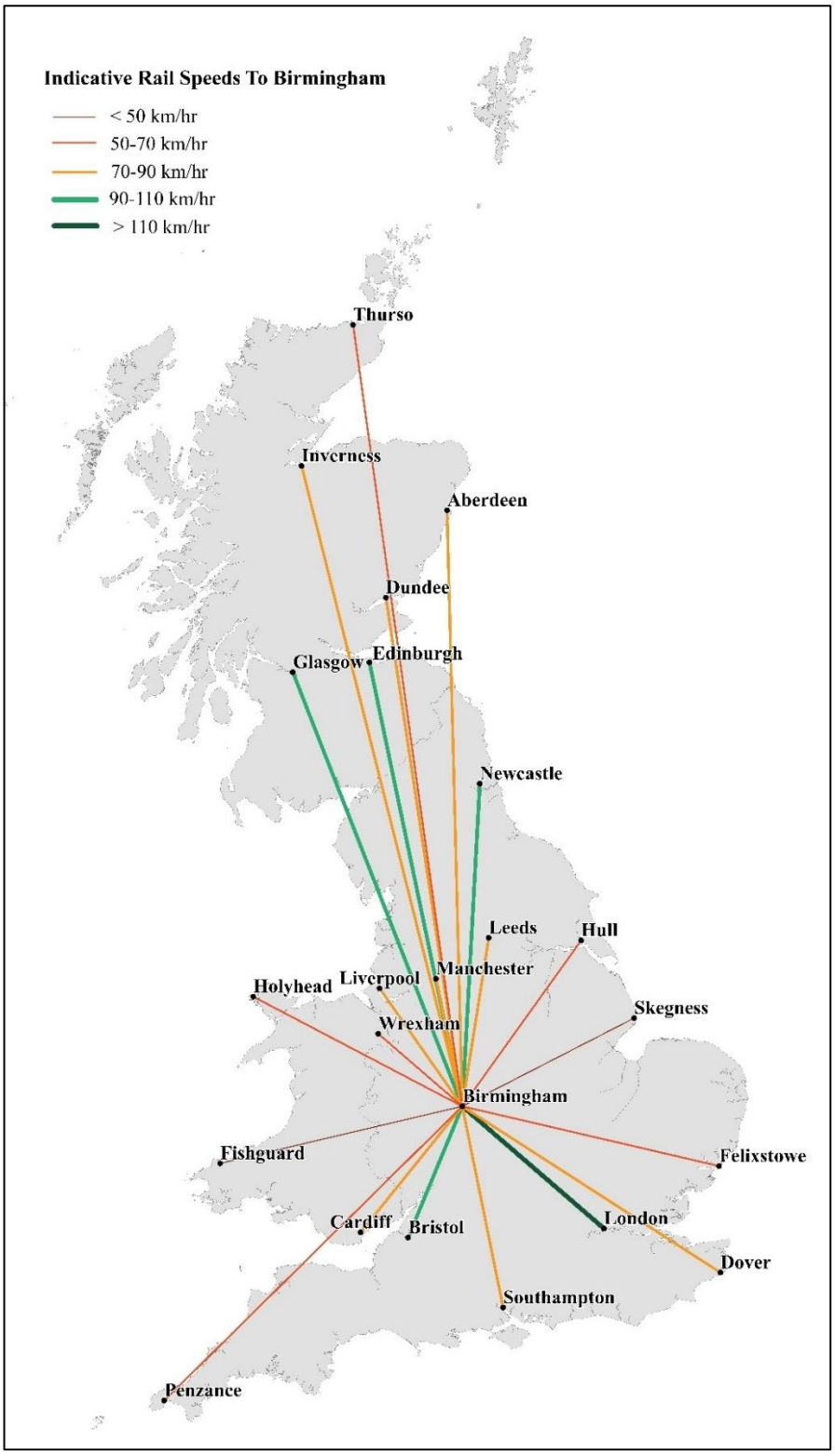
Nevertheless, the major intercity routes have a lower top speed as they get further from London. Figure 68 shows the difference in journey speed between the southern and northern sections of the West Coast Main Line. The northern section between the North of England and Glasgow is considerably slower. This divergence will only be exacerbated by the introduction of HS2 services.

Figure 68 – Comparing speeds on sections of the West Coast Main Lines

From	To	Indicative Journey Speed
London	Manchester	126.2
Glasgow	Manchester	95.2
London	Birmingham	118.9
Glasgow	Birmingham	97.5

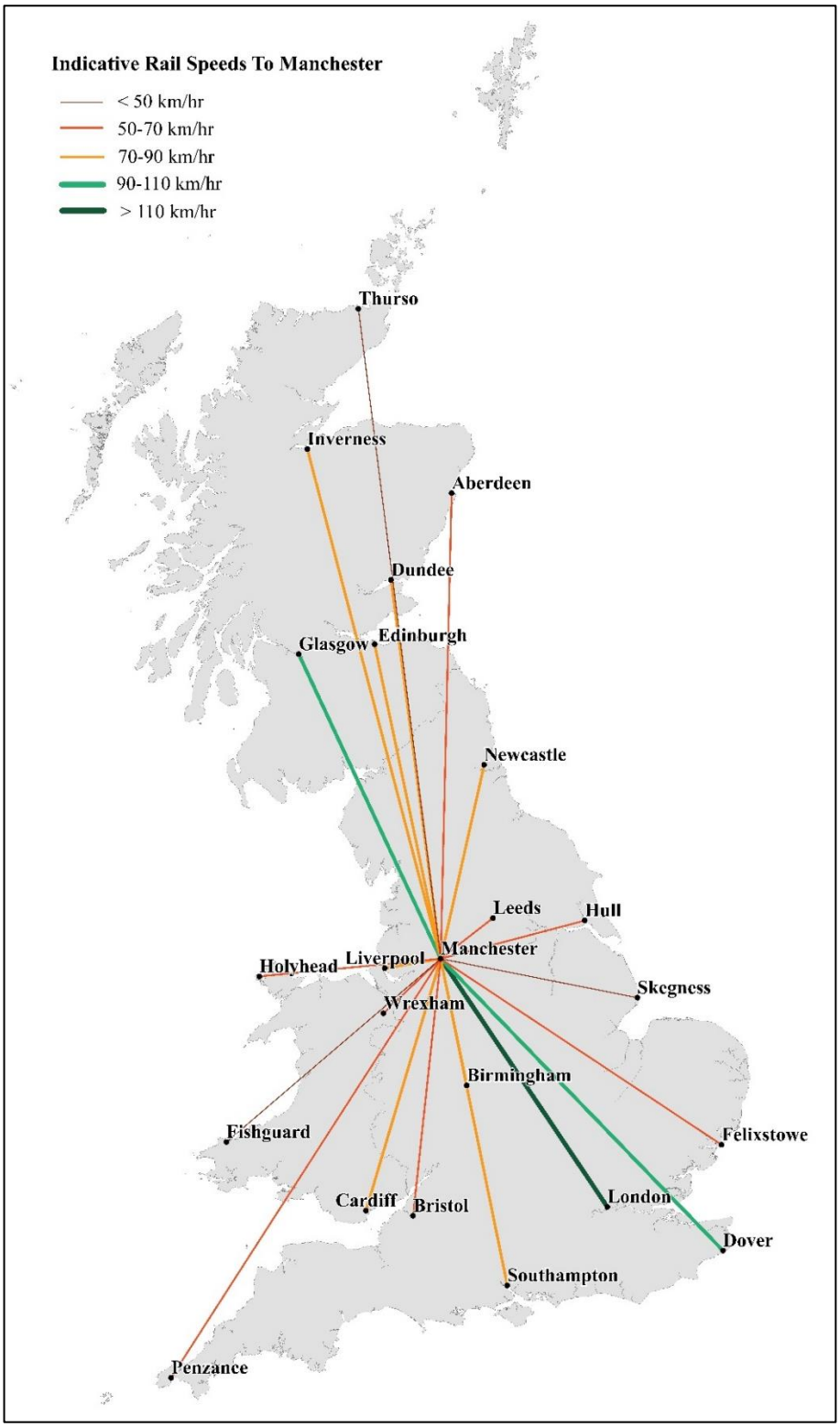
Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

Figure 69 – Indicative journey speeds by rail from key GB locations to Birmingham



Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

Figure 70 – Indicative journey speeds by rail from key GB locations to Manchester



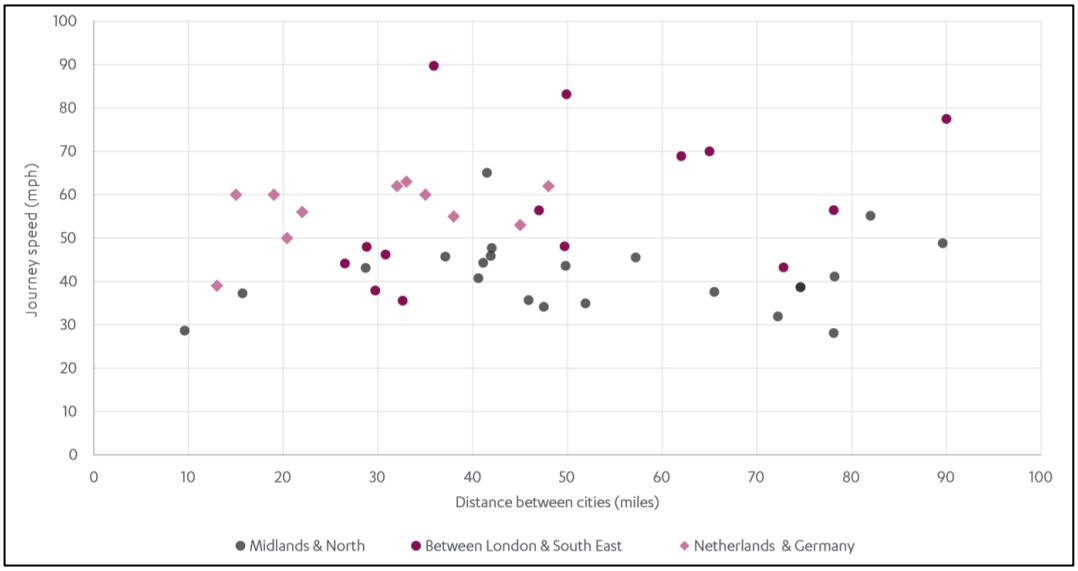
Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

Figure 69 shows the indicative journey speeds to and from Birmingham, and Figure 70 shows the indicative speeds to and from Manchester. These maps show

that whilst journeys on the south east – north corridor are fast, journeys on the southwest – north corridor, and east-west corridors tend to be much slower.

The poor east-west journey speeds between cities in the Midlands and North was picked up in the Rail Needs Assessment report. The graph in Figure 71 benchmarks journey speeds against those in London and international comparators, revealing a marked pattern of lower speeds.

Figure 71 – Rail journey speeds versus distance between cities



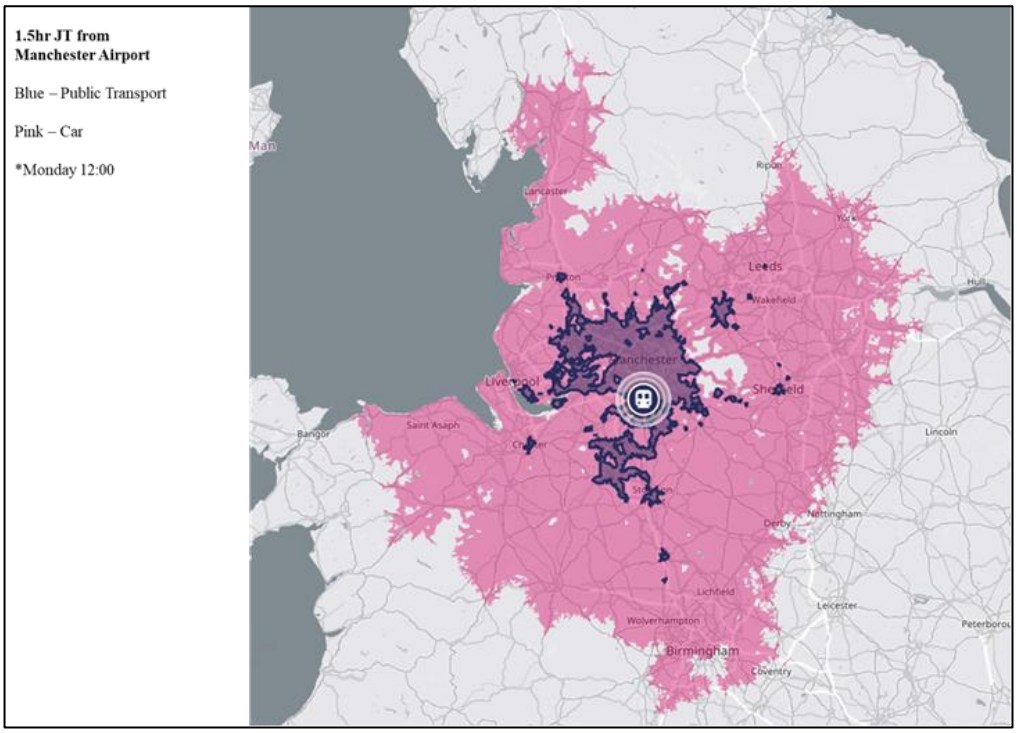
Source – Figure 2.5, Rail Needs Assessment for the Midlands and the North, National Infrastructure Commission (2020), https://nic.org.uk/studies-reports/rail-needs-assessment-for-the-midlands-and-the-north/

The indicative journey speed along the North Coast of Wales from Manchester to Holyhead is also slow. While this is partially driven by the route length (significantly longer than the crow-flies length), this line is not currently electrified and line speeds are low. In their response to the Call for Evidence, the Welsh Government Transport Directorate highlight the problem of low line speeds and modest frequencies on the North Wales Main Line, affecting these journeys across North Wales.

In Figure 69, the connection from Bristol to Birmingham is much faster than the connection from Cardiff to Birmingham, despite the routes being of very similar lengths.

Access from North Wales to international gateways is economically important for people and businesses, in particular Manchester Airport. However, western access to Manchester Airport is limited by public transport, with much better car journey times in comparison. As the maps below show, by public transport you cannot reach North Wales from Manchester Airport within 1.5 hours, a distance of 40 miles.

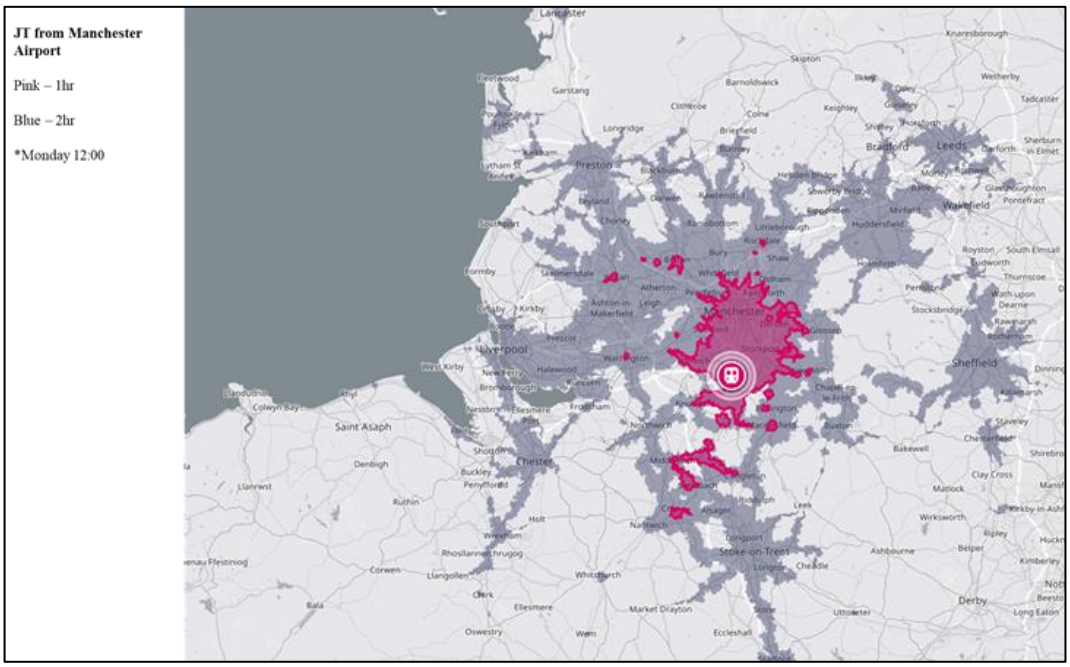
Figure 72 – Accessibility to Manchester Airport by public transport and car



Source – Travel Time

When considering public transport, there are network challenges with a greater public transport reach to the North, East, and areas to the South, than to the West. Figure 73 shows how public transport accessibility increases from a one-hour to a two-hour catchment.

Figure 73 – Public transport accessibility to Manchester airport in 1 hour and 2 hours



Source – Travel Time

Below journey time and distance comparisons have been highlighted for both Manchester and Liverpool airports from economic centres in North Wales. This clearly shows a large variation in journey times by public transport than by private vehicle.

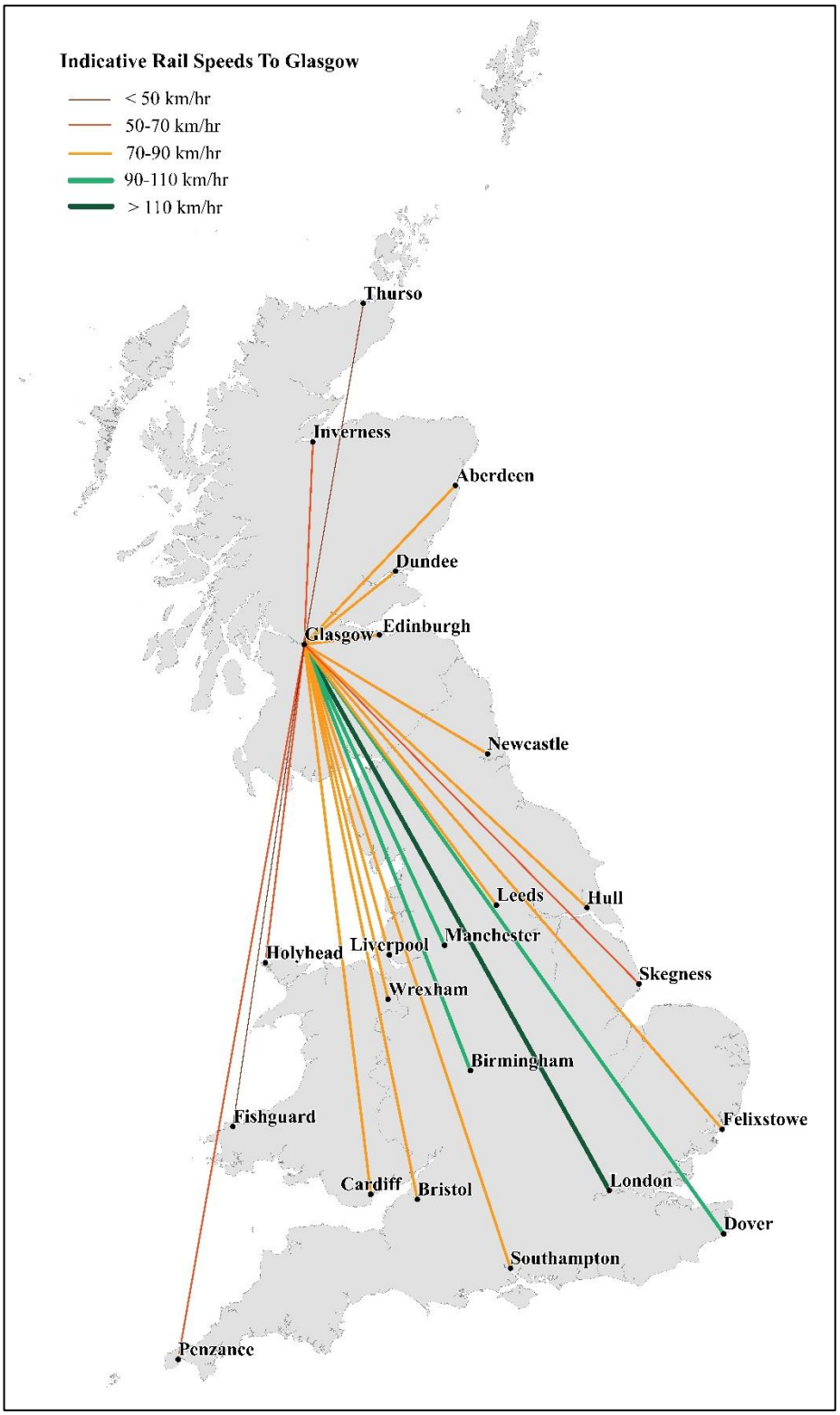
Figure 74 – Travel times to Manchester and Liverpool Airports by private and public transport

To Manchester Airport			
From economic centre	Private Vehicle Travel Time (hrs)	Public Transport Travel Time (hrs)	Distance
Holyhead	1:50 – 2:20	3:08 – 3:18	112 miles
Llandudno Junction	1:10 – 1:30	2:45 – 2:54	73 miles
Wrexham	0:45 – 1:00	2:16 – 2:37	46 miles
Chester	0:35 – 0:45	1:37 – 1:58	33 miles

To Liverpool Airport			
From economic centre	Private Vehicle Travel Time (hrs)	Public Transport Travel Time (hrs)	Distance
Holyhead	1:50 – 2:20	3:09 – 3:42	103 miles
Llandudno Junction	1:05 – 1:30	2:49 - 2:51	65 miles
Wrexham	0:40 – 1:00	2:02 – 2:04	37 miles
Chester	0:30 – 0:45	1:10 – 1:33	24 miles

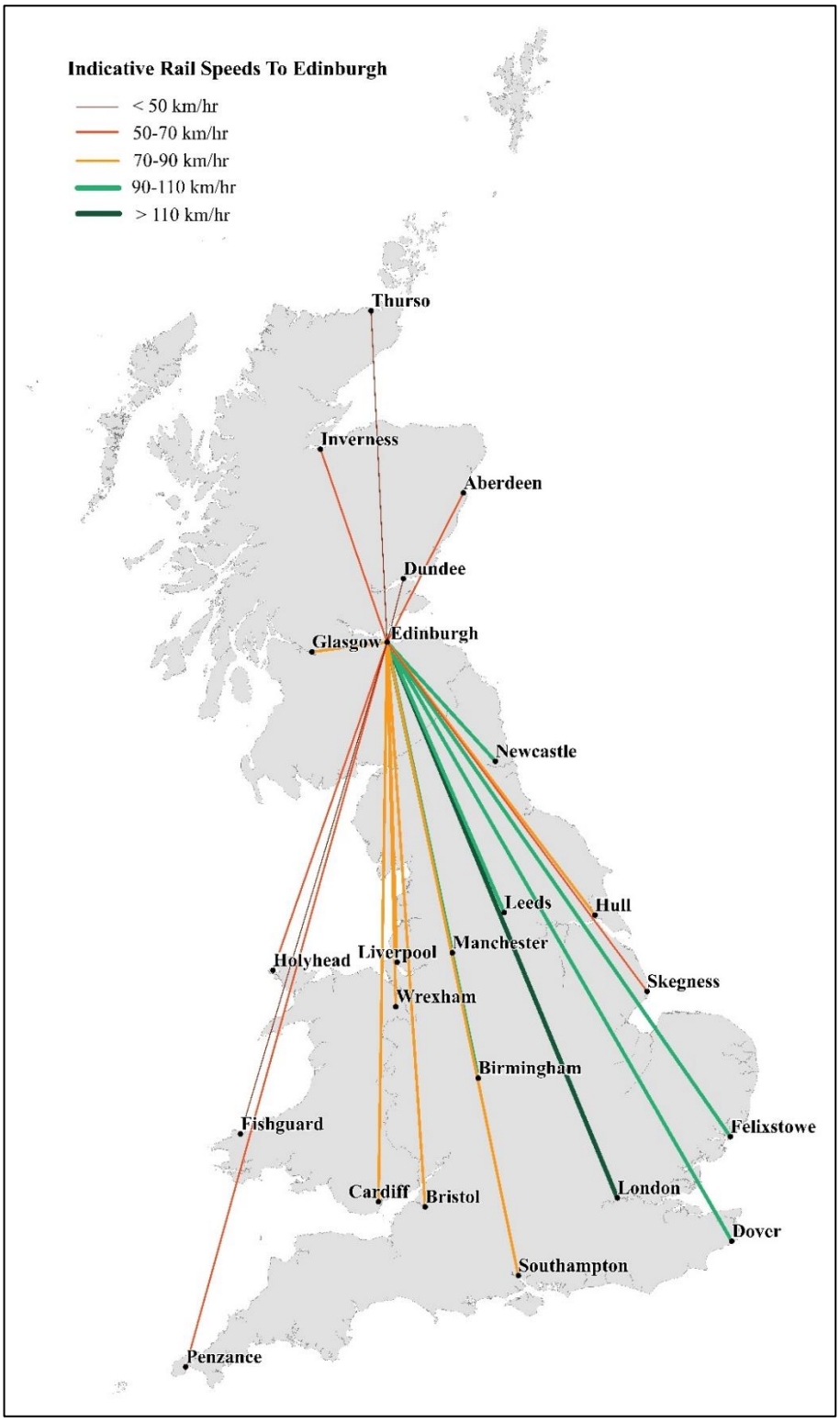
*Source - Google Maps *assumes leaving at 12:00 on Monday*

Figure 75 – Indicative journey speeds by rail from key GB locations to Glasgow



Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

Figure 76 – Indicative journey speeds by rail from key GB locations to Edinburgh



Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

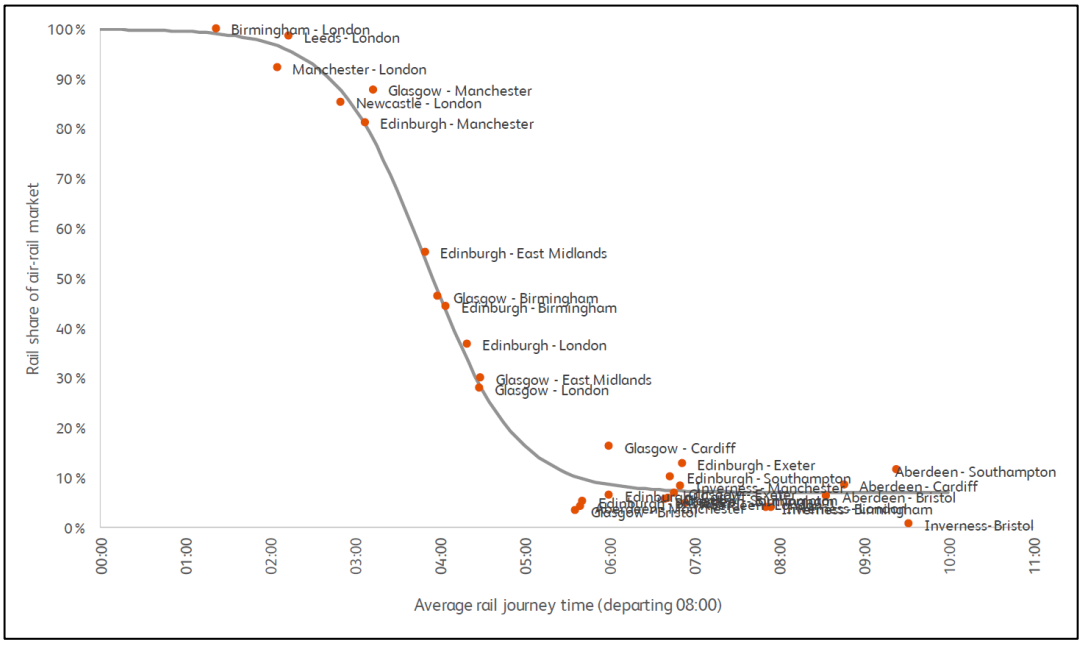
Figure 75 shows the indicative journey speeds to Glasgow, and Figure 76 shows the indicative speeds to Edinburgh. As discussed, inter-urban journeys across the

border to England are primarily served by the East and West Coast Main Lines. The Figures draw this out clearly; Glasgow tends to have very fast connections with cities in the West Midlands, North West and London, while Edinburgh tends to have very fast connections with the North East and London.

In their response to the Call for Evidence, Network Rail provided the graph shown in Figure 77. This shows the relationship between the journey time by rail and rail's share of the rail-air market. If journey time by rail is beneath 2.5 hours, air does not tend to be a strong modal competitor, while the opposite is true if journey time by rail exceeds 5 hours. Between these journey times, and particularly between a rail journey time of 3.25 to 4.25 hours, the graph becomes very steep. A 10-minute reduction in rail journey time can lead to a 7% shift from air to rail.

A number of high-volume routes between England and Scotland lie on the steep section of the graph, including journeys between Edinburgh/Glasgow and London. This indicates significant potential for mode shift from air if rail journey times between the two nations were reduced. As Network Rail mention however, it is important to assess the market specifics of each route. For example, the air passenger market between London and Edinburgh/Glasgow comprises both terminating and inter-liner passengers; the latter demand is more inelastic and so there is less potential for mode shift to rail.

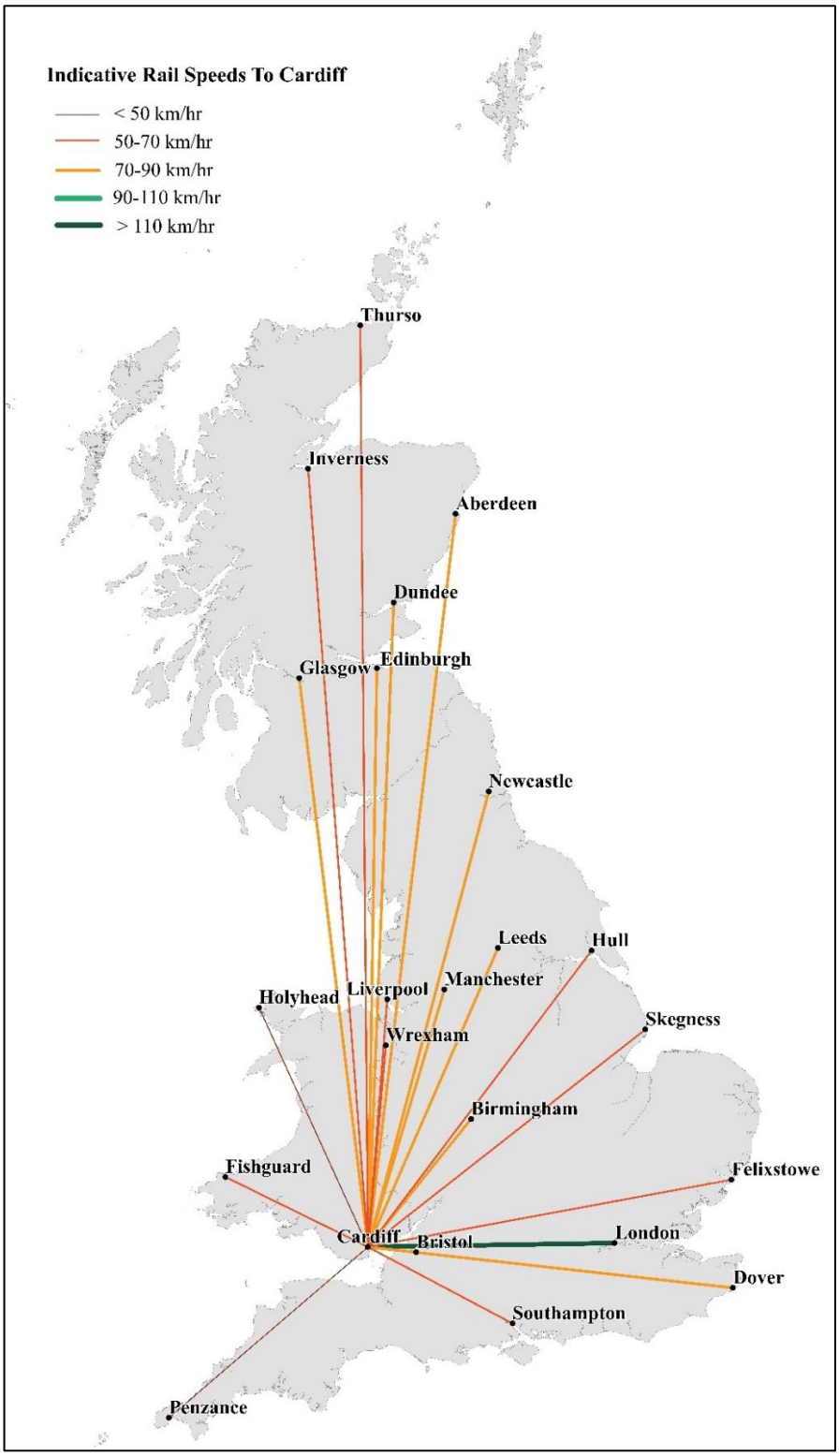
Figure 77 – The relationship between rail journey time and mode share vs aviation



Source – Network Rail Call for Evidence response

Indicative journey speeds within Scotland tend to be poor, although the terrain is a particular challenge here, forcing long, winding routes.

Figure 78 – Indicative journey speeds by rail from key GB locations to Cardiff

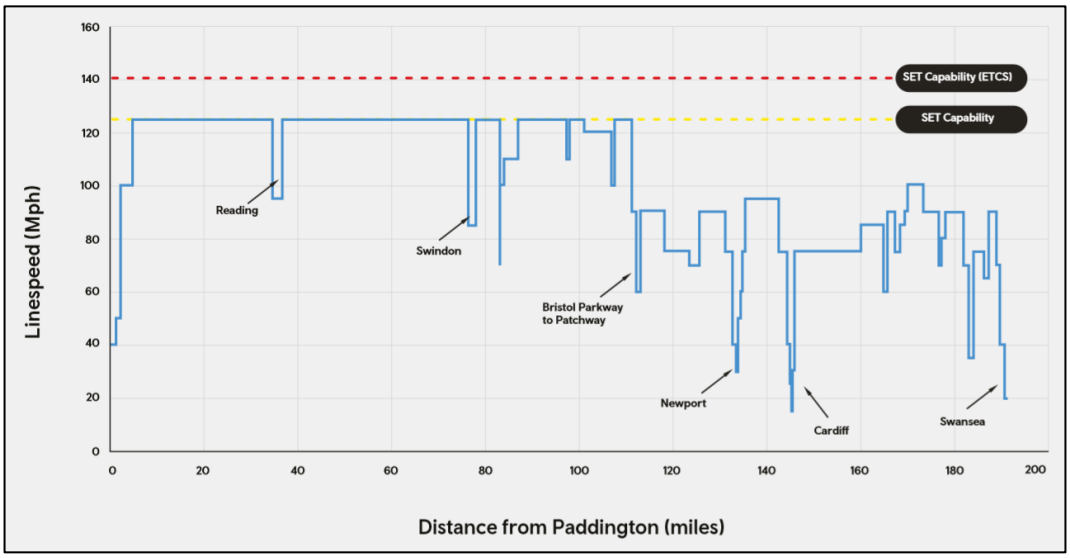


Source – Journey Planner, National Rail Enquiries, https://www.nationalrail.co.uk/
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

Figure 78 shows the indicative journey speeds between London and Cardiff. The Welsh Government Transport Directorate report that Cardiff is the worst rail

connected major city in the UK in respect of direct services to other major UK cities. They explain that rail journey times from west Wales to Bristol and London are poor, with much of the South Wales Main Line a 90mph railway (or less). Figure 79 illustrates the reduction in line speed on the Great Western Main Line as it progresses into Wales. Stakeholders have reported to the Welsh Transport Directorate that rail patronage from the west of Swansea (Milford Haven, Pembroke etc.) to Cardiff, Bristol and London is low, partly because of the poor journey speeds.

Figure 79 – Line speed on the Great Western Main Line to Swansea

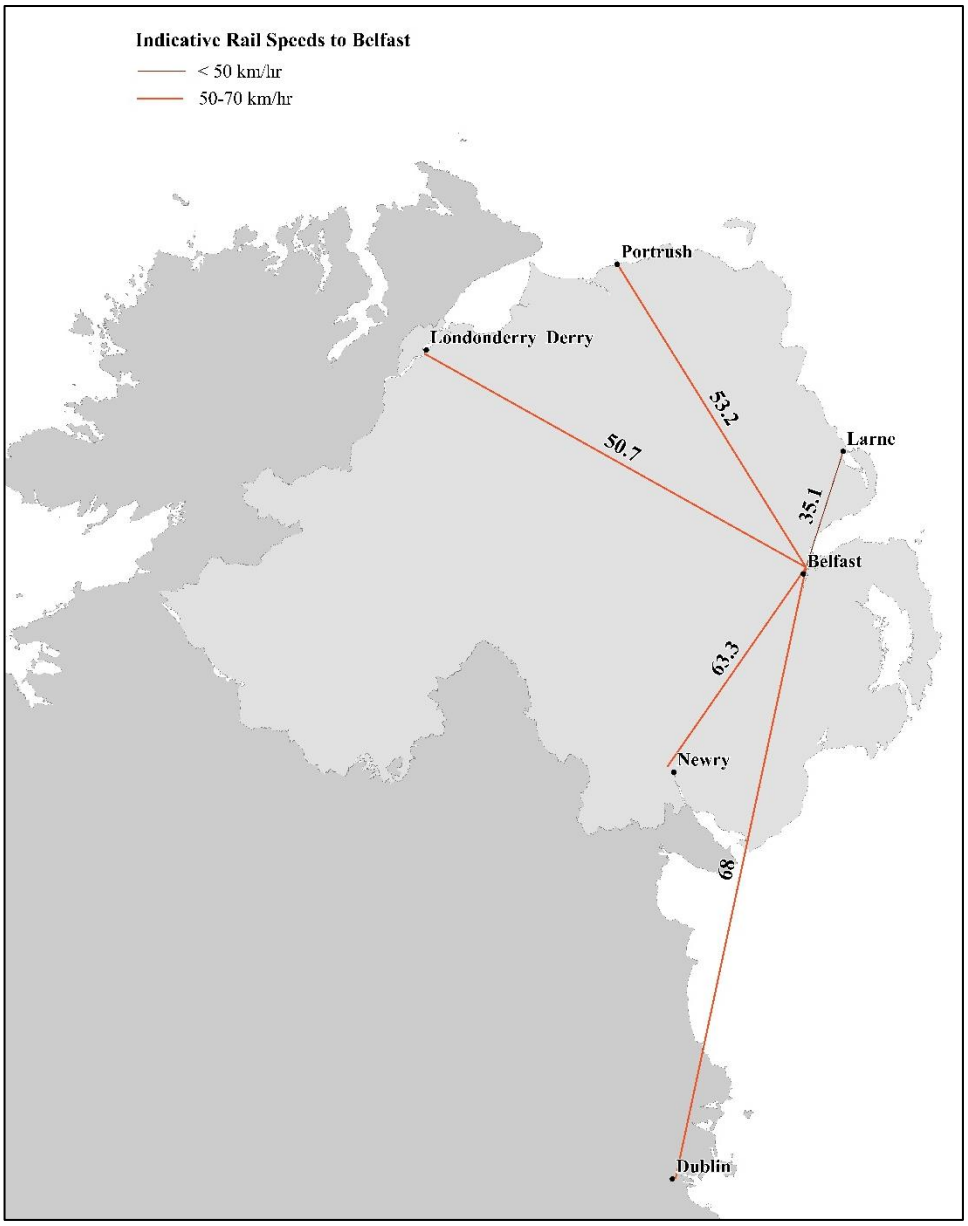


Source – Figure 3, Mainline railway enhancement requirements, Transport for Wales (2020), https://gov.wales/sites/default/files/publications/2020-11/mainline-railway-enhancement-requirements.pdf

In their response to the Call for Evidence, CBI Wales stressed that swift rail links to London, Heathrow, Birmingham and Manchester are all cited by members as essential business routes. They point specifically to connectivity between South Wales and Manchester as 'a weak offer' and report that members wish to see further investment in south-west and north Wales, to improve the service offering.

The Northern Ireland rail network is separately managed to the GB National Rail network. Figure 80 shows that rail links to Belfast from the South are significantly faster than those from the North. Passengers can access Belfast in just over 2 hours from Dublin, and less than an hour from Newry.

Figure 80 – Indicative journey speeds by rail from key locations in Northern Ireland and the Republic of Ireland to Belfast



Source – Journey Planner, Translink, https://www.translink.co.uk/usingtranslink/OurApps/journeyplanner
**Journey time taken from a weekday in Spring 2021*
Google Maps, https://www.google.co.uk/maps

C1.1.4 Passenger demand

Network Rail provided evidence of cross-border rail journey volumes in their response to the Call for Evidence, which is summarised here.

As already discussed, trips between England and Scotland are served primarily by the West Coast and East Coast Main Lines. Figure 81 and Figure 82 show the growth in passenger volumes on these cross-border routes since 2008/09.

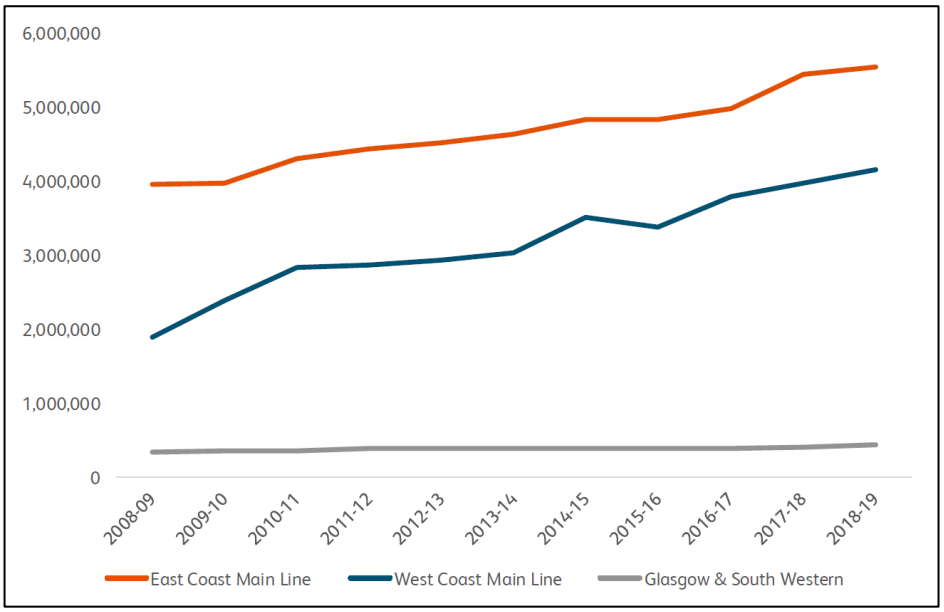
The East Coast Main Line links English cities such as London, York and Newcastle, to Edinburgh. The total volume of cross-border passengers is greater than that on the West Coast main line, owing primarily to Edinburgh's attraction for tourists and the proximity of a major population (Tyne and Wear) to Edinburgh. Growth in cross-border journeys on the East Coast Main Line has been sustained but steady over the last decade.

The West Coast Main Line connects London, the West Midlands and cities in the north-west of England to Glasgow. Cross-border journeys on this line more than doubled in the ten-year period to 2018-19. This is partly due to the introduction of regular hourly services between Manchester and Scotland from 2007.

The Glasgow & South Western Line predominantly serves local flows between the North West and Dumfries & Galloway and Ayrshire. This line handles a much smaller volume of cross-border passenger traffic than the other two lines.

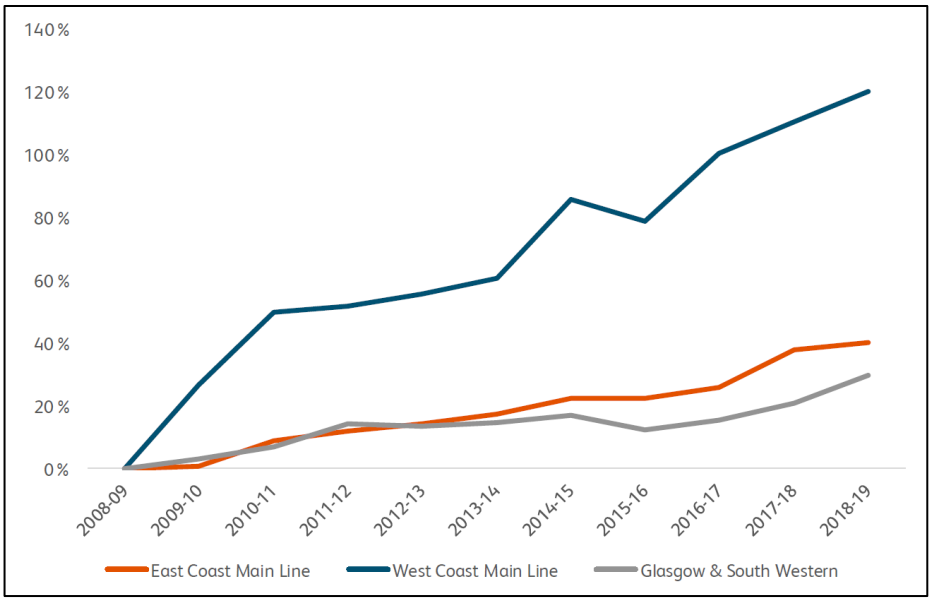
Figure 83 shows the distribution of destinations of passengers crossing the border from Scotland to England. While London and other long-distance demand is clearly a key component, Network Rail emphasise that demand to and from border settlements should not be underestimated. Both Carlisle and Berwick-upon-Tweed generate significant levels of demand as a result of proximity to Scotland rather than population size.

Figure 81 – Annual cross-border rail journeys between England and Scotland by route



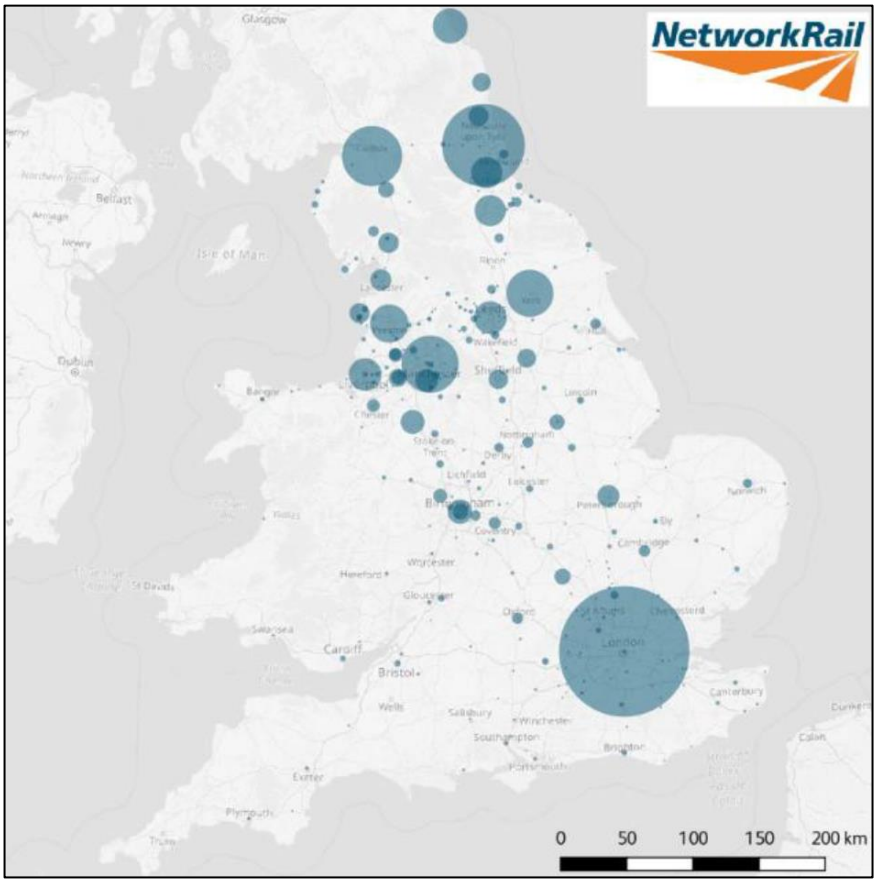
Source – Network Rail Call for Evidence response, using MOIRA1 data

Figure 82 – Growth in annual cross-border rail journeys between England and Scotland by route



Source – Network Rail Call for Evidence response, using MOIRA1 data

Figure 83 – The distribution of rail demand crossing the border from Scotland to England



Source – Network Rail Call for Evidence response, using MOIRA2 data
Only the most significant flows displayed

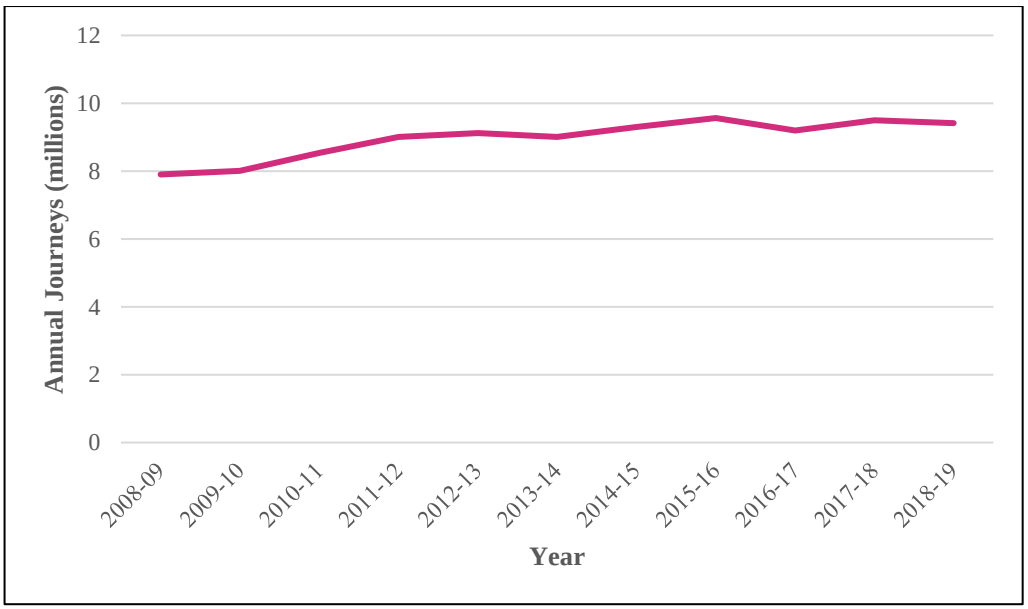
In total, there were 9.4 million passenger journeys between England and Wales in 2018/19. Total rail journeys between England and Wales have grown by nearly 20% over the last decade, as shown in Figure 85. This growth, however, has not kept pace with rail growth within Wales[202] and has stagnated in recent years.

Reflecting the population distribution of Wales, the most prominent cross-border routes are at the far north and far south of the England-Wales border.

The South Wales Main Line is a branch of the Great Western Main Line which extends from Swansea, through Cardiff & Newport to Bristol & Swindon in the south-west of England. From here, the Great Western Main Line continues to London. The North Wales Main Line (or North Wales Coast Line) extends from Holyhead on the north-west coast of Wales through the coastal towns and across the border to Chester. It is important to note that these lines serve both long-distance markets and short-distance commuting markets. For example, the South Wales Main Line is utilised by rail passengers commuting from Cardiff to Bristol as well as passengers travelling from Swansea to London.

The Welsh Marches Line provides north-south connectivity, connecting Newport across the border to Shrewsbury and Crewe. The Wrexham to Bidston (or Borderlands) Line serves shorter distance cross-border flows, linking Liverpool to Wrexham, while the Heart of Wales Line runs north-east from Swansea to Shrewsbury.

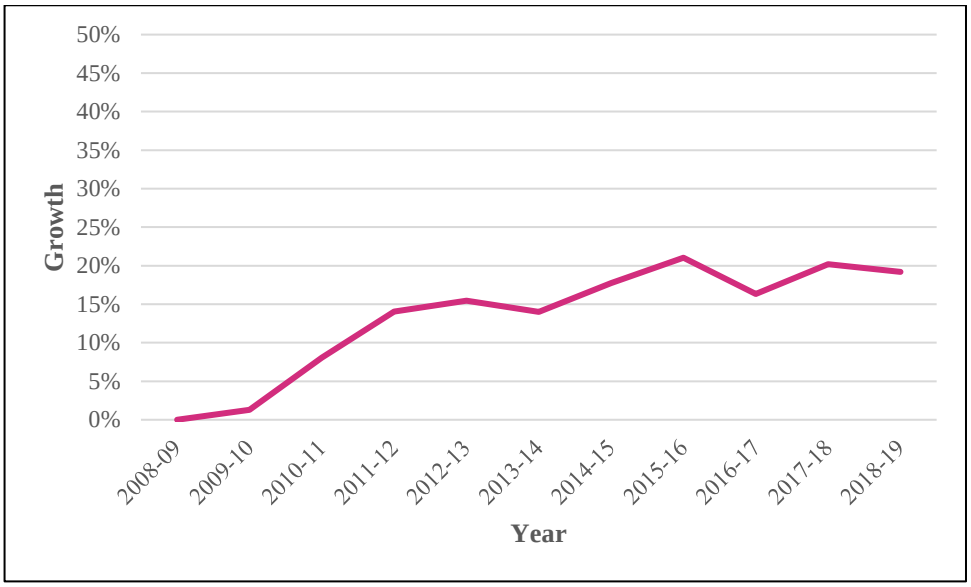
Figure 84 - Annual cross-border rail journeys between Wales and England



Source – Table 1510, Regional Rail Usage (2018-19 Statistical Release), Office of Rail and Road, https://dataportal.orr.gov.uk/statistics/usage/regional-rail-usage/

[202] Rail Travel (Page 10), Supporting Information – Transport Data and Trends, Llwybr Newydd – A New Wales Transport Strategy (2020), *https://gov.wales/sites/default/files/consultations/2020-11/supporting-information-transport-data-and-trends.pdf*

Figure 85 - Growth in annual cross-border rail journeys between Wales and England



Source – Table 1510, Regional Rail Usage (2018-19 Statistical Release), Office of Rail and Road, https://dataportal.orr.gov.uk/statistics/usage/regional-rail-usage/

Figure 86 shows the volume of cross-border journeys between Wales and key regions across the border, as provided by Network Rail. The flow between Wales and South West England is the largest flow - this includes the important route between South Wales and Bristol on the South Wales Main Line.

Figure 86 – Annual rail volumes between Wales and regions across the border

Location	Annual rail journeys
South West England	~ 2.9 million
London	~ 2.15 million
North West England	~ 2 million
West Midlands	~ 1.36 million
Scotland	~ 41 thousand

Source – Network Rail Call for Evidence response

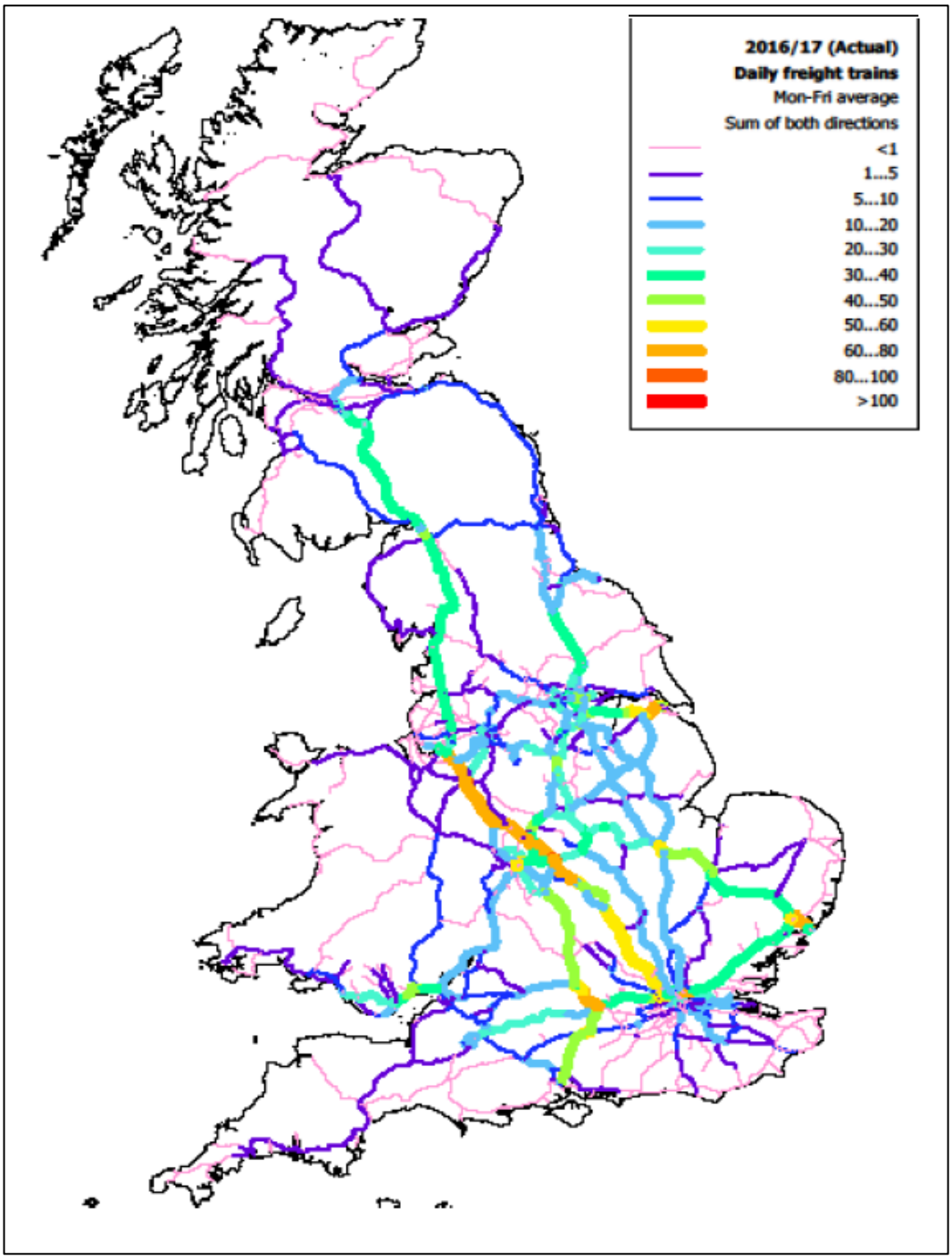
C1.1.5 Freight Demand

Figure 87 illustrates the distribution of freight across the GB rail network. The West Coast Main Line is a very busy freight corridor, particularly through the West Midlands and into the North West.

Rail freight connectivity within England is particularly important for connecting to major ports. Figure 87 shows that links to the Humber ports (including Grimsby and Immingham), Felixstowe and Southampton are particularly busy.

Cross-border routes between England and Wales/Scotland are of key strategic importance for the transport of goods within Great Britain and for connectivity to ports.

Figure 87 – Average daily freight trains on the GB rail network, 2016/17



Source – Figure 3, Identifying the multimodal Strategic Freight Network & the value of improving its operation (2019), MDS Transmodal

Figure 88 shows the total number of freight trains passing through key cross-border junctions.

Figure 88 – Freight trains per weekday in each direction across borders

Border	Location	Total trains per weekday in each direction
England-Scotland	Gretna Junction (West Coast Main Line)	18.3
England-Scotland	Berwick-upon-Tweed (East Coast Main Line)	3.1
England-Wales	Severn Tunnel Junction	17.6

Source – Network Rail Call for Evidence response, data from 'Rail freight forecasts: Scenarios for 2033/34 & 2043/44', MDS Transmodal (2020)

In their Call for Evidence response, Network Rail discuss the critical role that the West Coast Main Line plays in trade between Scotland & England, and in linking Scotland to international markets via Felixstowe, the Port of London and Southampton ports. The West Coast Main Line is the key route in Great Britain for containerised freight, with traffic primarily composed of trains running to and from Scotland's main intermodal terminals at Coatbridge, Mossend and Grangemouth.

Freight traffic between England and Scotland is less extensive on the East Coast Main Line but is still significant. Network Rail explain in their response to the Call for Evidence that regular intermodal services to and from Teesport connect Scotland to short-sea shipping routes to mainland Europe, and the East Coast Main Line offers diversionary capacity for West Coast flows when required.

The Severn Tunnel Junction is the most important crossing for freight between England and Wales. Network Rail explain that metals traffic dominates this flow, with the steel industry accounting for around 75% of Welsh rail freight. Wentloog, between Newport and Cardiff, is the only intermodal freight terminal, but this hosts frequent circulations from Felixstowe, Southampton and Tilbury.

The volumes of freight on the Marches Line, Shrewsbury-Chester Line and North Wales Main Line are smaller. Network Rail note that industry stakeholders see several opportunities to grow the rail market for movements between North Wales and England, focusing on the construction sector in the short to medium term, but in the long-term intermodal flows to/from Holyhead.

C1.1.6 Network capacity and the future

The rail network must have capacity to operate at the required frequencies in a fast and reliable way. Capacity stresses tend to show themselves in poor reliability/performance and crowding on services. Most of the corridors of primary importance for connectivity of the UK are utilised by fast inter-urban passenger services, stopping passenger services and freight services. This presents complex capacity and timetable planning challenges.

West Coast Main Line

In its report 'High Speed Rail and Scotland', Greengauge 21 conclude that the northern section of the West Coast Main Line is operating at its limits, pointing to the 63.5% of services at Lancaster station that did not leave on time between

January 2019 and January 2020[203]. The complex traffic mix on this line, two major summits, and the fact that locations off of the mainline are no longer served by direct connections to London, all combine to bring pressure on this key corridor. The report lists key pressure points, including:

- major stations operating at or close to capacity including Glasgow Central, Carlisle and Preston;
- summit routes where freight loops are of inadequate length and have very low entry/exit speeds;
- very intensively used sections such as Lancaster-Preston;
- approaches to Glasgow through Lanarkshire where there are 9 flat junctions for Anglo-Scottish trains to negotiate, each capable of causing delays; and
- unimproved junctions which inhibit fast running and limit capacity.

North Wales

In their response to the Call for Evidence, the Mersey-Dee Alliance highlighted a number of key capacity issues pertaining to the North Wales corridor.

- Chester Station needs a major upgrade to be able to handle more services to and from northern cities (Liverpool, Manchester, Leeds, Sheffield, York and Newcastle-Gateshead) and enable more through services to North Wales. The Welsh Transport Directorate and Transport for the North also noted the capacity and operational constraints at Chester Station.
- Capacity and line speed improvements are needed between Chester & Warrington, Chester & Crewe and Chester & Shrewsbury
- Significant rail congestion within central and southern Manchester through the Castlefield Corridor limiting access from North Wales to Manchester.

Note that the North Wales Main Line is not electrified.

South Wales Main Line

Network Rail's Route Specification for Wales (2017) describes that the busiest section of the South Wales Main Line for passenger traffic is between Newport and Cardiff. Long-distance trains destined for North Wales, North-West England, London and Bristol all use this section, in addition to local flows.

The South East Wales Transport Commission found that, for intercity services between Cardiff and Bristol, trains are over their seated capacity at peak times on a weekday morning. The Commission noted that there are only 2 trains per hour to and from Bristol Temple Meads and that the four busiest routes on the South Wales Main Line are on this service. The load factor in the morning peak (passengers divided by seated capacity) is as high as 172%, though the cascading of rolling stock should add capacity and relieve crowding.

[203] http://www.greengauge21.net/wp-content/uploads/High-Speed-Rail-and-Scotland.pdf

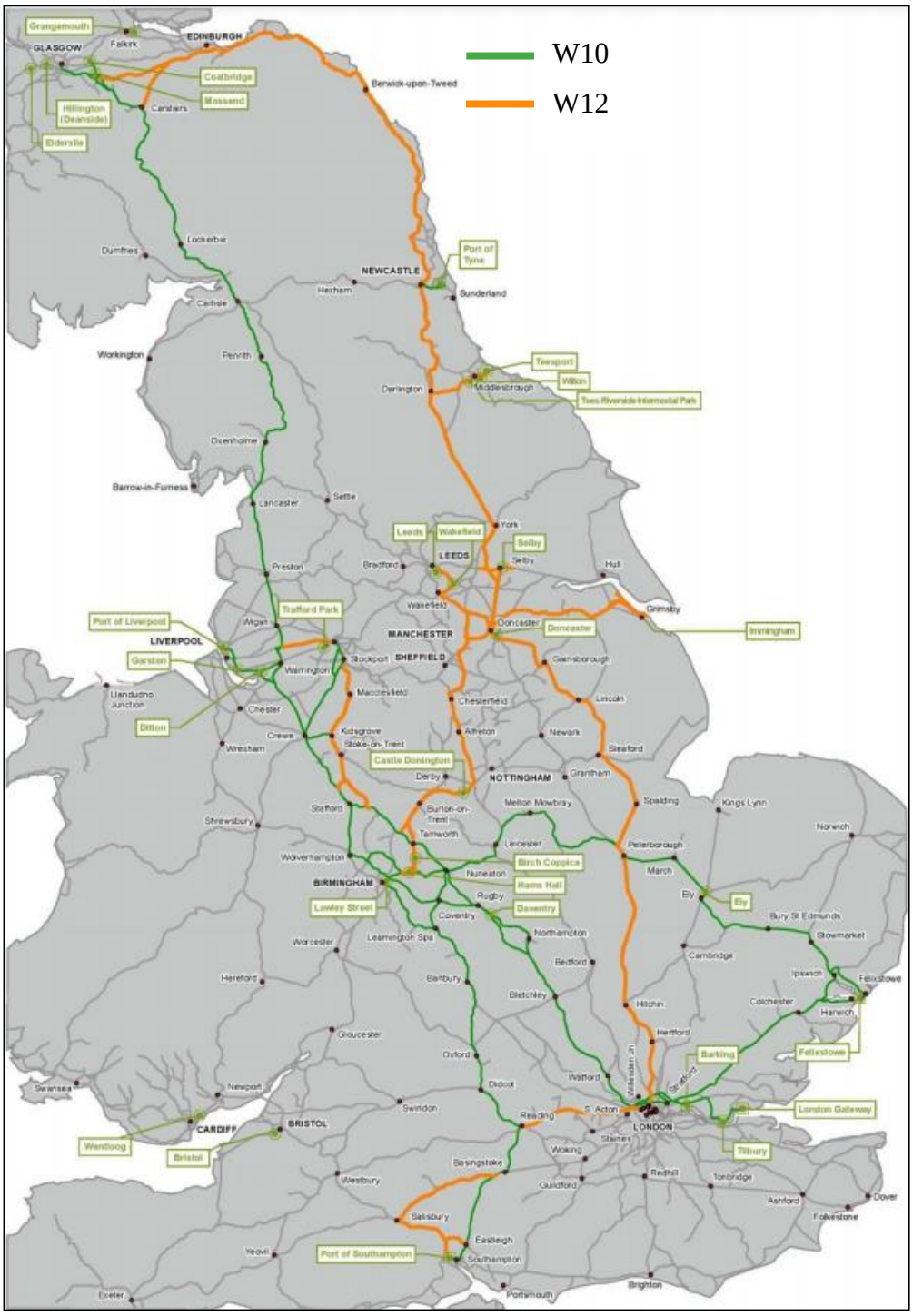
The Welsh Government Transport Directorate note that while the demand for rail travel between Cardiff and Bristol estimated for 2043 is similar to that between Manchester and Leeds, the latter route has 6 trains per hour.

Freight Capacity

The loading gauge available on the network is very important for freight services; According to MDS Transmodal[204], except where well wagons are utilised (which do not use train length efficiently) intermodal services are limited to routes where the loading gauge is enhanced. W8 loading gauge permits the passage of 8'6" containers on metre high wagons or 9'6" containers on 'low-liner' wagons. Metre high wagons can carry 9'6", 2.5m wide containers on W10 routes, which can be up to 2.6m wide if W12 loading gauge is available.

[204] https://www.networkrail.co.uk/wp-content/uploads/2020/08/Routeing-of-rail-freight-forecasts.pdf

Figure 89 – W10 and W12 gauge rail availability



Source – Routeing of rail freight forecasts, A study for Network Rail by MDS Transmodal (2020), https://www.networkrail.co.uk/wp-content/uploads/2020/08/Routeing-of-rail-freight-forecasts.pdf

Figure 89 shows the gauge availability across England. Note that proposed load gauge upgrades, such as west of Didcot, are not included.

Transport for the North refer to the problem of a lack of a W10/12 gauge cleared route across the Pennines preventing intermodal flows through the corridor. They

assess that moving more rail containers via the Diggle route (as part of the Trans Pennine Route Upgrade) would free up capacity via Scotland for other freight or passenger services.

Engaged by the UK Major Ports Group, MDS Transmodal performed an analysis of the road and rail freight networks to understand the bottlenecks across the UK and the economic benefit that would arise from alleviating these. The study, which was supplied to this Review, looked at seven key bottleneck junctions on the rail freight network (as suggested by Network Rail), and the benefit that could be gained from releasing suppressed demand on these junctions.

MDS Transmodal estimated that the average annual suppressed demand in 2023/24 (caused by these bottlenecks) would be 2.9 million tonnes of rail freight, with an estimated cost to the economy of £17.5m per year. The value of the benefits to other road users and the environment from alleviating these bottlenecks (from the mode shift from road to rail) was estimated as £21.5m per year in 2023/24.

In their Call for Evidence Response, Network Rail explain that in most cases, existing routes lack the capacity for all the additional freight movements that are expected to be required in the long term. Network Rail's Freight Network Study has identified capacity gaps on the East Coast Main Line, West Coast Main Line, Great Western Main Line and South Wales Main Line against the forecast freight scenarios. On the East and West Coast Main Lines these constraints are primarily to the north where two-track railway and the need to share capacity with fast passenger services is a significant constraint.

Future freight demand

In their response to the Call for Evidence, Network Rail state that there is a firm consensus among rail freight stakeholders that the government's legal commitment to a target of net-zero greenhouse gas emissions will further drive demand for the movement of freight by rail.

Network Rail also supplied freight forecast scenarios, based upon a study performed by MDS Transmodal. The forecasts allow for a number of different scenarios which could impact freight demand over the next 25 years. Figure 90, Figure 91 and Figure 92 summarise the forecasts for the West Coast Main Line, East Coast Main Line and South Wales Main Line respectively.

Very large growth in rail freight is expected on the West Coast Main Line. Even in the central scenario, the number of services is set to more than double over the period. The combination of HS2 Phase 2b and other passenger services operating alongside freight, will impose further pressure on the line. The 'high market growth, factors favouring rail over road' scenario is credible if government policy were implemented to encourage freight mode shift from road to rail. This may be necessary, given the challenge of decarbonising Heavy Goods Vehicles. While the total volumes are much lower, strong growth in freight is forecast on the East Coast Main Line also, with the potential for the number of freight services to quadruple by 2043/44. Rail freight services across the South Wales border are projected to grow much more modestly.

Figure 90 – Freight trains per weekday in each direction at Gretna Junction

Year	Scenario	Total trains per weekday in each direction
2016/17	Actual	18.3
2043/44	Central	42.9
2043/44	Low market growth, factors favouring rail over road	45.1
2043/44	High market growth, factors favouring rail over road	58.6
2043/44	Low market growth, factors favouring road over rail	32.4
2043/44	High market growth, factors favouring road over rail	41.8

Source – Network Rail Call for Evidence response, data from 'Rail freight forecasts: Scenarios for 2033/34 & 2043/44', MDS Transmodal (2020)

Figure 91 – Freight trains per weekday in each direction at Berwick-upon-Tweed

Year	Scenario	Total trains per weekday in each direction
2016/17	Actual	3.1
2043/44	Central	12.2
2043/44	Low market growth, factors favouring rail over road	12.9
2043/44	High market growth, factors favouring rail over road	15.9
2043/44	Low market growth, factors favouring road over rail	9.0
2043/44	High market growth, factors favouring road over rail	11.2

Source – Network Rail Call for Evidence response, data from 'Rail freight forecasts: Scenarios for 2033/34 & 2043/44', MDS Transmodal (2020)

Figure 92 – Freight trains per weekday in each direction at Severn Tunnel Junction

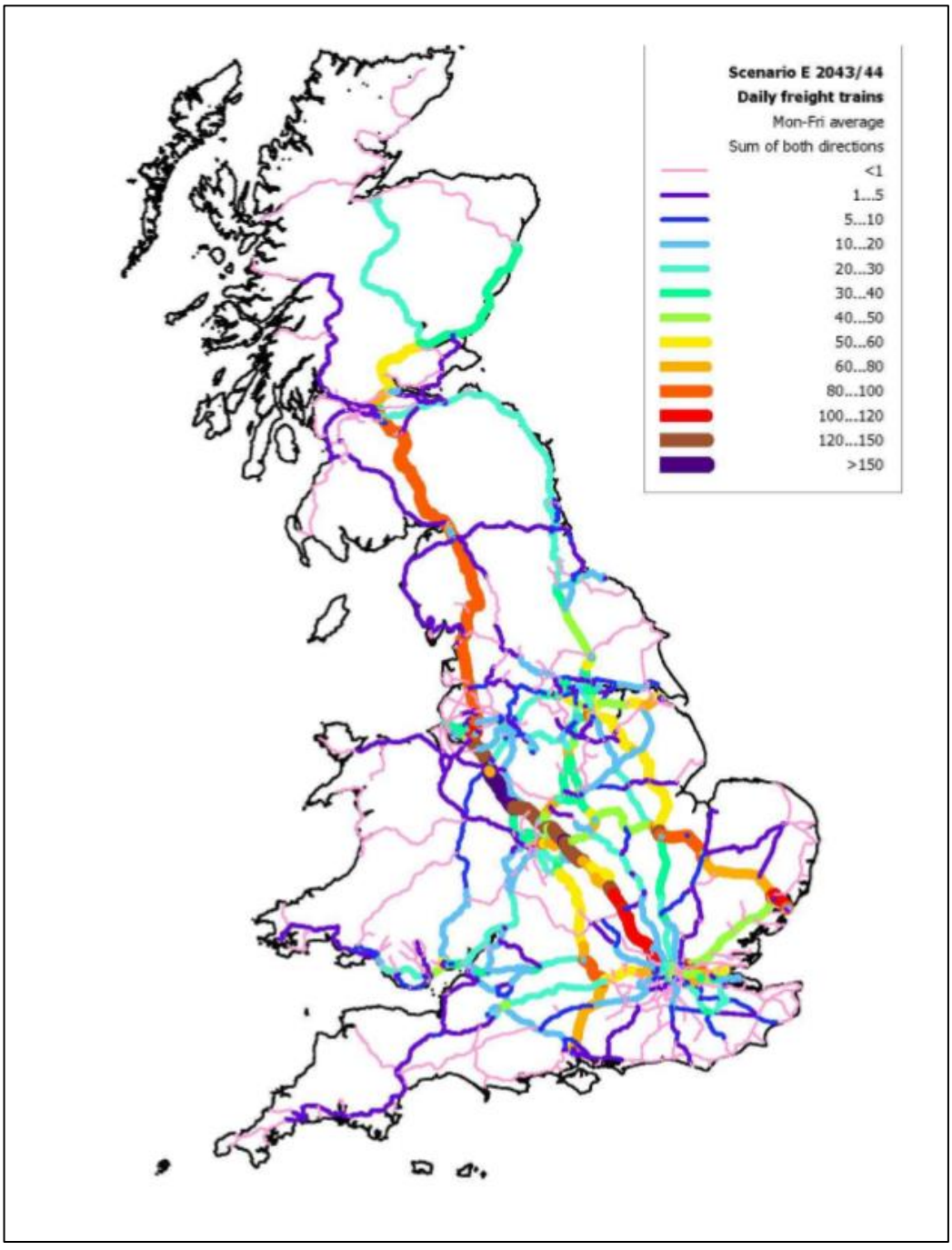
Year	Scenario	Total trains per weekday in each direction
2016/17	Actual	17.6
2043/44	Central	20.0
2043/44	Low market growth, factors favouring rail over road	20.5
2043/44	High market growth, factors favouring rail over road	23.8

2043/44	Low market growth, factors favouring road over rail	17.3
2043/44	High market growth, factors favouring road over rail	19.8

Source – Network Rail Call for Evidence response, data from 'Rail freight forecasts: Scenarios for 2033/34 & 2043/44', MDS Transmodal (2020)

Figure 93 shows the equivalent map to Figure 87 for 2043/44. This highlights the expected growth on the West Coast Main Line and shows the other locations of highest demand across the GB network. In addition to cross-border flows, it is worth noting the growth in rail freight between Felixstowe and Peterborough.

Figure 93 – Forecast daily freight trains in 2043/44, central scenario



Source – Routing of rail freight forecasts, A study for Network Rail by MDS Transmodal (2020), https://www.networkrail.co.uk/wp-content/uploads/2020/08/Routeing-of-rail-freight-forecasts.pdf

C1.2 The road network

A summary is as follows.

- The trunk road network offers very good coverage of the UK, with less focus on London (when compared to rail).
- However, there are areas of significant congestion, which includes many cross-border flows. Delays are projected to get worse as demand increases.
- Cross border travel between England and Scotland includes substantial numbers of freight vehicles. The Wales – England border is more characterised by commuter movements.

C1.2.1 Ownership and structure

The UK Road Network management is devolved issue, with the strategic roads predominantly managed by Highways England; Transport Scotland; the Welsh Government (managed by the North and Mid Wales Trunk Road Agent and the South Wales Trunk Road Agent); and the Department for Infrastructure in Northern Ireland. Strategic roads in London are separately managed by Transport for London.

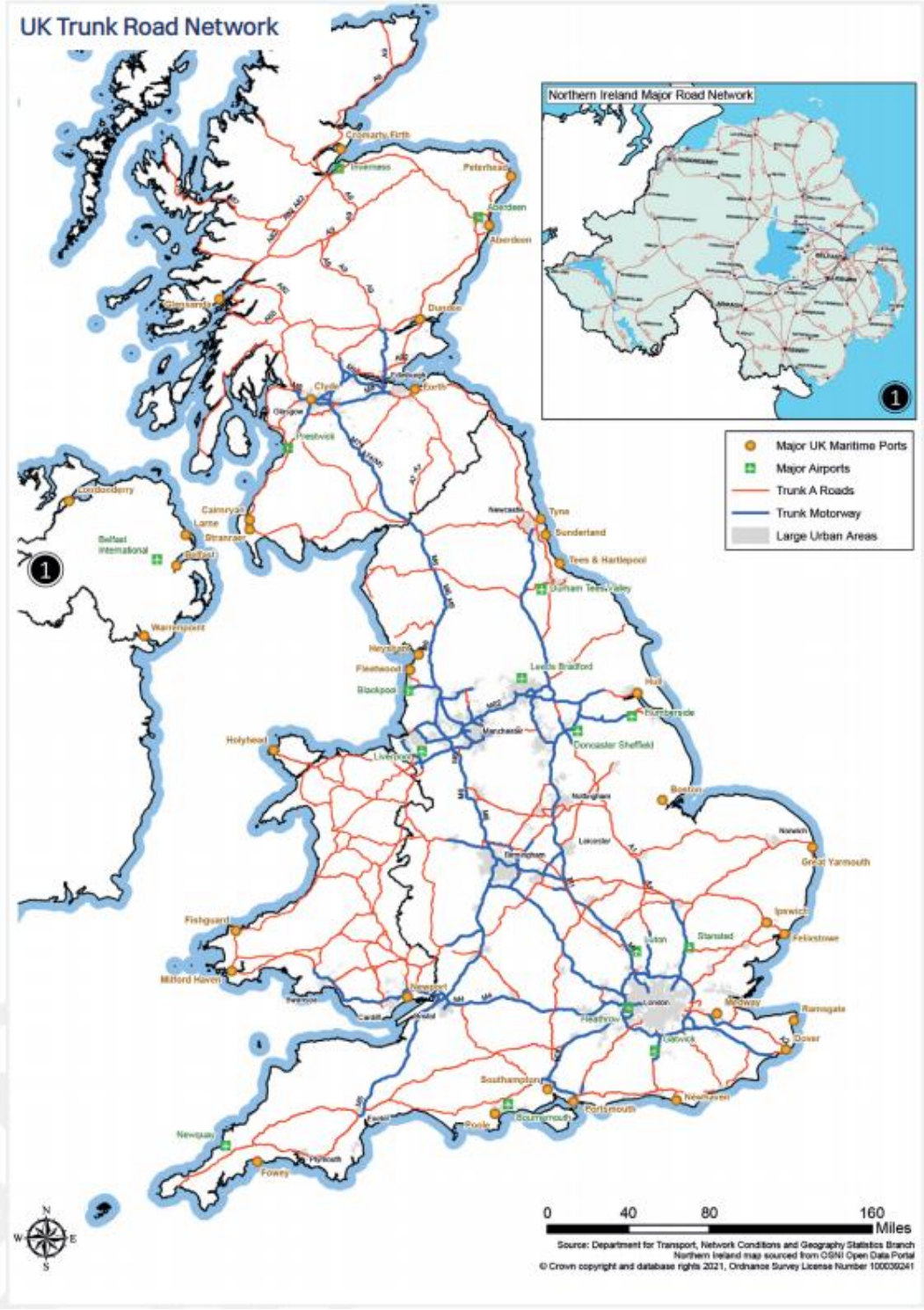
All other roads are the responsibility of the county council or unitary authority in which they lie.

Road connections between Northern Ireland and the rest of the UK rely on ferry crossings and were discussed in the previous section. Northern Ireland however does have significant connections to the Republic of Ireland, with the key road routes being the A6 from Derry / Londonderry (connecting to Donegal via the N13), A1 (most direct route between Belfast and Dublin, via Dundalk) and the A4/N16.

C1.2.2 Completeness of the network

Figure 94 illustrates the coverage of the UK trunk road network

Figure 94 - UK Trunk Road Network



Source – DfT

C1.2.3 Journey times

The following figures show the average typical journey times by road between key locations for Union connectivity on a given weekday in April 2021 (as

collected on 1st April 2021) during the middle of the day. Where more than one route might be a sensible option, the average of these has been taken to provide an average typical time and distance between the two locations. It should be noted that due to the Covid-19 pandemic that these times may be faster and may take a slightly different route than might be expected in urban areas where there may usually be higher levels of congestion. These times may also vary dependent on the time of year as some will be influenced to a greater degree by the levels of holiday traffic.

The average speed for between cities has been calculated as a metric for describing the quality of the route between cities. Figure 95 presents these average speeds from various locations across Great Britain to London, Birmingham, Manchester, Glasgow, Edinburgh and Cardiff. This highlights that some of the shorter distance routes, which will make use of smaller roads, in general have lower speeds than average. Higher speeds are attained on the longer distance routes that might be able to make greater use of motorway routes – in particular routes up to Glasgow and to a slightly lesser degree to Birmingham. Bristol-Cardiff in particular has low speeds, there are known congestion issues westbound on the M4. Liverpool, Leeds, Hull and Fishguard have much lower average speeds travelling to Manchester than the rest of the routes. Holyhead, Fishguard and Wrexham all tend to have lower average speeds.

Figure 95 – Average speeds based on actual distance between cities (mph)

	London	Birmingham	Manchester	Glasgow	Edinburgh	Cardiff
London		50	49	56	51	48
Birmingham	48		45	58	51	49
Manchester	49	45		55	48	50
Glasgow	56	58	56		40	52
Edinburgh	51	51	49	38		52
Cardiff	46	52	50	57	51	
Penzance	45	54	49	57	53	52
Bristol	41	55	53	59	53	44
Southampton	42	55	50	54	54	53
Dover	41	55	54	58	55	53
Felixstowe	40	55	53	55	48	53
Skegness	37	43	45	52	49	47
Liverpool	50	47	29	55	47	50
Leeds	48	55	37	53	50	56
Hull	41	51	35	54	51	43
Newcastle	52	56	50	49	44	56
Holyhead	54	54	49	58	49	39
Fishguard	44	52	39	49	47	46
Wrexham	49	46	43	58	52	40
Aberdeen	55	56	54	47	40	55

Dundee	56	57	56	47	41	56
Inverness	49	55	54	48	44	56
Thurso	54	54	53	49	47	54

Source - Google Maps average typical journey time for 28th April

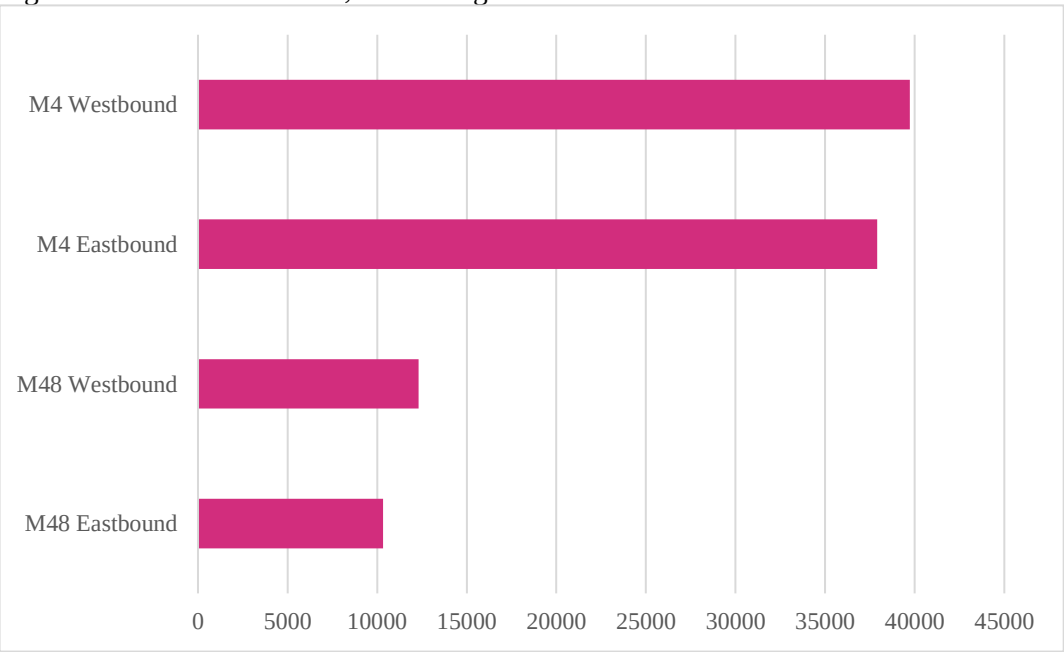
C1.2.4 Passenger and freight demand

DfT counts on the M4 and M48, at the South Wales-England border; and WebTRIS counts M6 and A1(M) on the Scotland-England border have been extracted to provide an indication of the level of demand and growth at these locations. The M4 crossing at the South Wales-England border carries the greater share of the demand (Figure 96), this increased significantly in 2019 following the removal of the Severn Crossing tolls. The level of growth since 2010 at the crossing has otherwise generally been in line with the level of growth on all motorways in Great Britain, Figure 97.

Transport for Wales analysis of 2019 mobile phone data indicated that of 680,000 24hr weekday inter-regional journeys within or partly within Wales, 75% (510,000) are cross-border movements, predominantly from Wales to England in the morning peak period. The largest inter-regional flow (about 30% of these journeys) is between North Wales and North West England.[205]

Growth in cross border demand between England and Scotland has generally been higher than the GB motorway average, Figure 99.

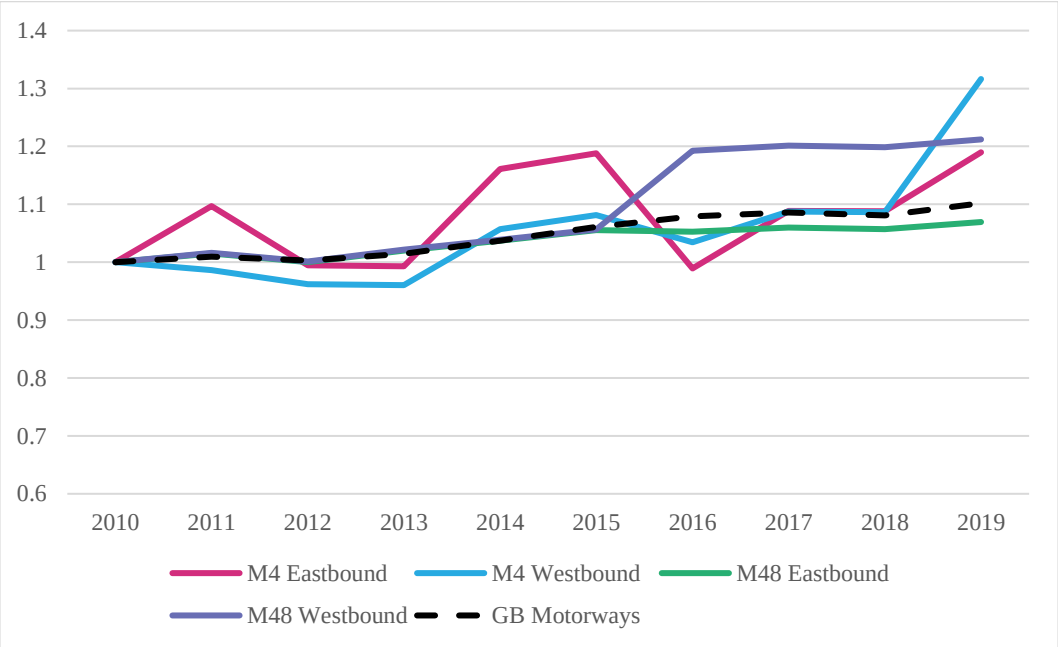
Figure 96 - 2019 24hr AADF, Wales/England border



Source - DfT Count data

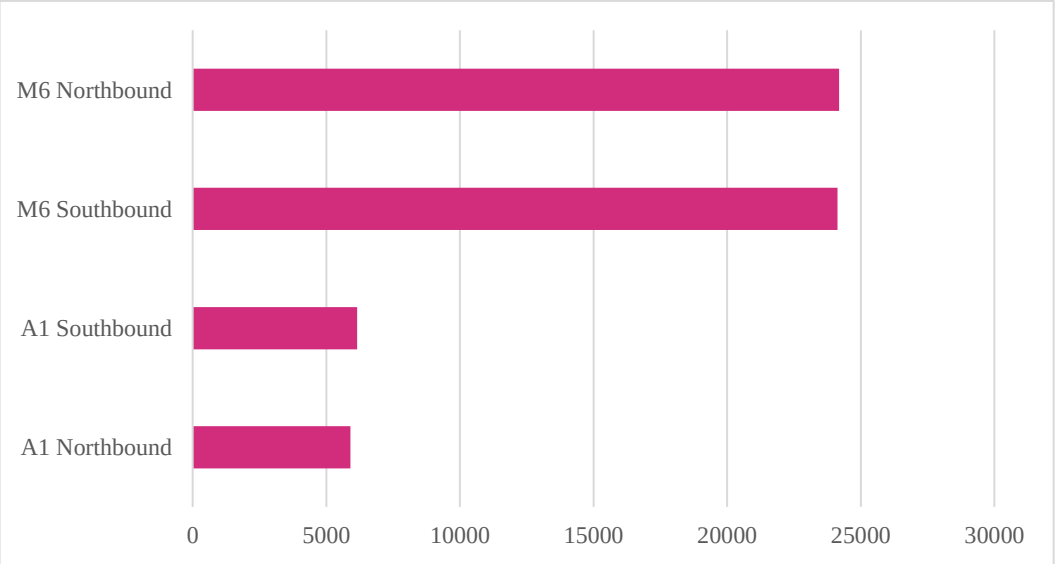
[205] https://gov.wales/sites/default/files/consultations/2020-11/supporting-information-transport-data-and-trends.pdf

Figure 97 - Growth in cross border demand since 2010, England/Wales border



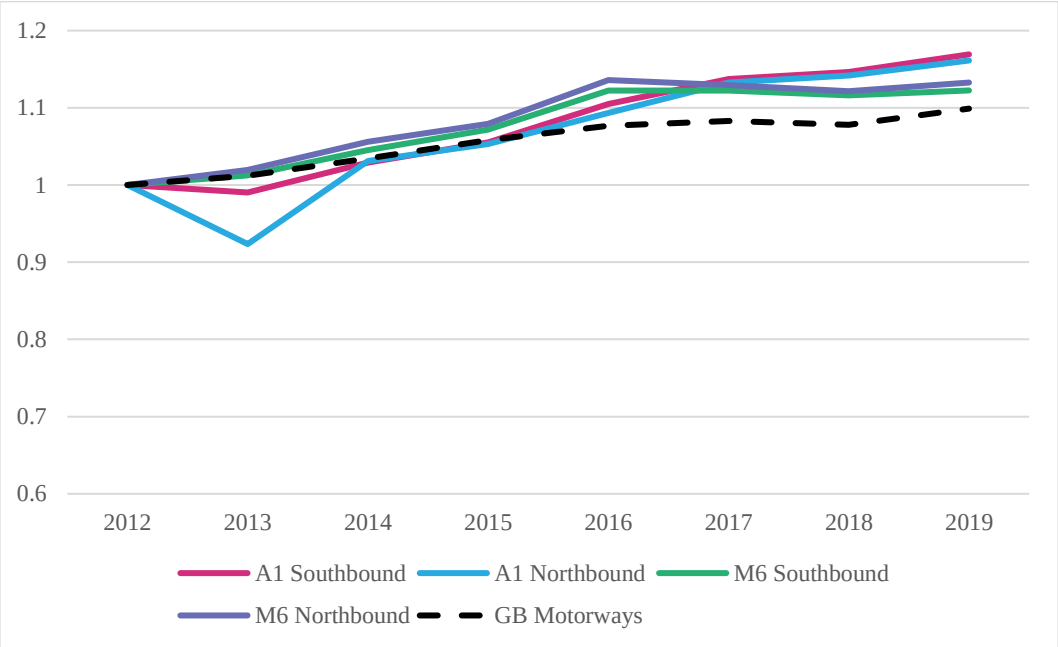
Source - DfT Count data

Figure 98 - 2019 24hr AAWT at Scotland/England border



Source - WebTRIS data

Figure 99 - Growth in cross-border demand since 2012, England/Scotland border

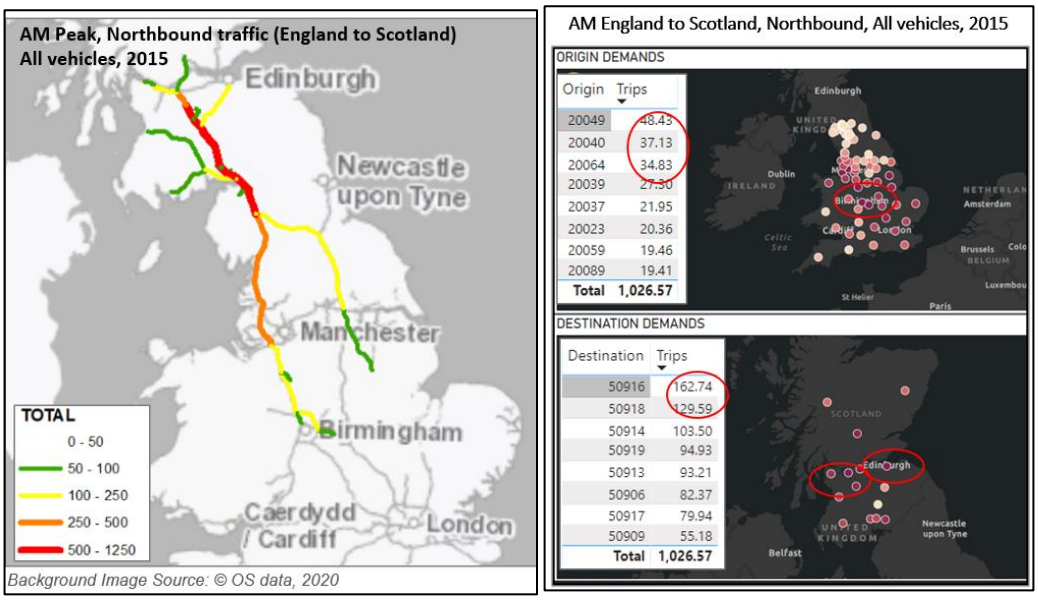


Source - WebTRIS data

The main routes between Scotland and England are the M6/A74 to the west and the A1(M) to the east. In Highways England's submission to the Call for Evidence, they have presented the levels of demand on these corridors by purpose and the key origins and destinations for vehicles crossing the border.

This analysis shows that journeys crossing the border via the M6/A74 are dominated by long distance trips, with the majority of trips longer than 125miles. These are dominated by business trips (~50%) with HGVs making up another 30% of the total demand in 2015. 50% of HGVs entering Scotland start their journey over 100miles away, mostly in the Midlands. The total demand for this corridor is expected to increase by ~40% by 2041. Figure 100 shows the northbound demand on the M6/A74 as presented in Highways England's submission to the call for evidence, southbound trips mainly show the reverse.

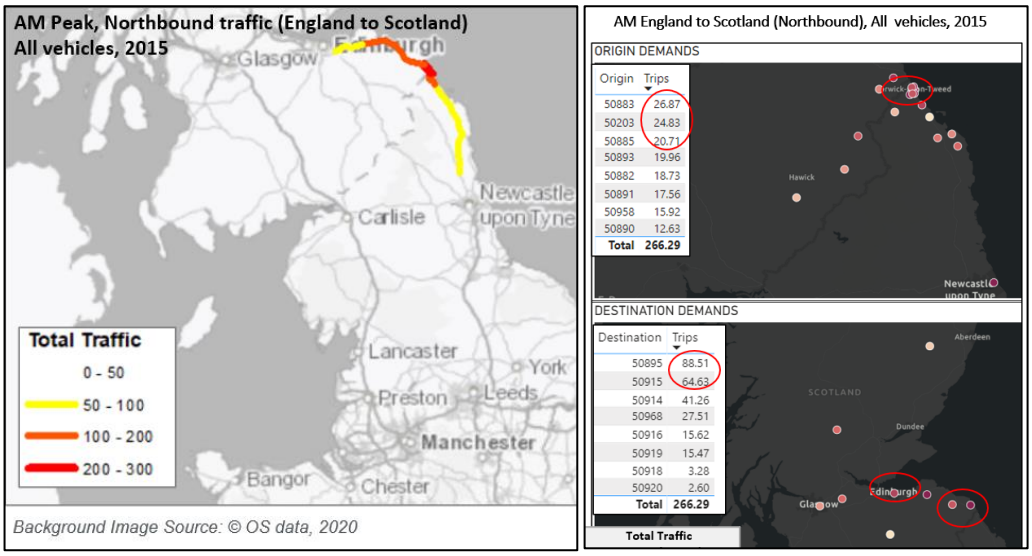
Figure 100 - Midlands to Scotland, western route (M6/A74 corridor)



Source - Highways England's Call for Evidence Response, M6/A74 Corridor

Whilst the M6/A74 corridor tends to be a more strategic route between Scotland and England, the A1(M) serves predominantly local commuter movements, with 27% of trips commuting and business trips accounting for approximately 30%. The majority of this route is dual carriageway A-road standard with four sections with motorway designation, the northern section connecting to Edinburgh, however, is single carriageway. Figure 101 presents the demand on the A1(M) corridor as included in Highways England's Call for Evidence submission. This shows that the majority of cross border trips are between Berwick-upon-Tweed and Newcastle-upon-Tyne in England and Eyemouth, Haddington, and Edinburgh in Scotland. Commuting trips on this route tend to be shorter than 30miles between Berwick-upon-Tweed and small settlements along the corridor north of the border. HGV traffic on the A1(M) is significantly lower (13-19%) than the M6/A74 corridor, the majority of these trips are over 60 miles long.

Figure 101 - Newcastle to Edinburgh, eastern route



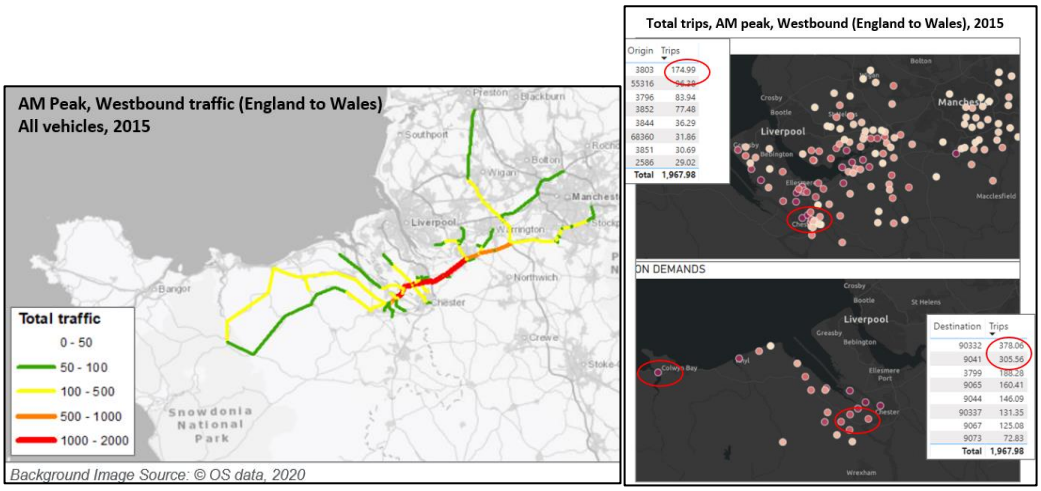
Source - Highways England's Call for Evidence Response, A1 Corridor

The key corridors identified for cross-border journeys between England and Wales are the M56/A494/A55 and A55/A483 corridors to the north, and the A40 and M4 to the south.

Significant numbers of people commute across the England-Wales border – the 2011 census states that 75,900 people commute from Wales into England with 44,400 people crossing the opposite way, the majority of these by either car or van. As such road connectivity across this border is particularly important for access to employment.

Figure 102 presents the demand on the M56/A494/A55 corridor as shown in Highways England's Call for Evidence, this shows the trips along this corridor are predominantly between Deeside and Chester, with further clusters around Manchester, Runcorn and Warrington; and Holyhead and Colwyn Bay. The majority of trips on this corridor are made by commuters (38% of all trips in the peaks). The submission also shows that westbound trips tend to be shorter distance trips, with longer distance trips eastbound. Demand is expected to grow by 21-29% in the AM and PM and 48% in the Interpeak by 2041. Trip lengths are between 30-125miles, suggesting importance of this corridor for both local and regional connectivity

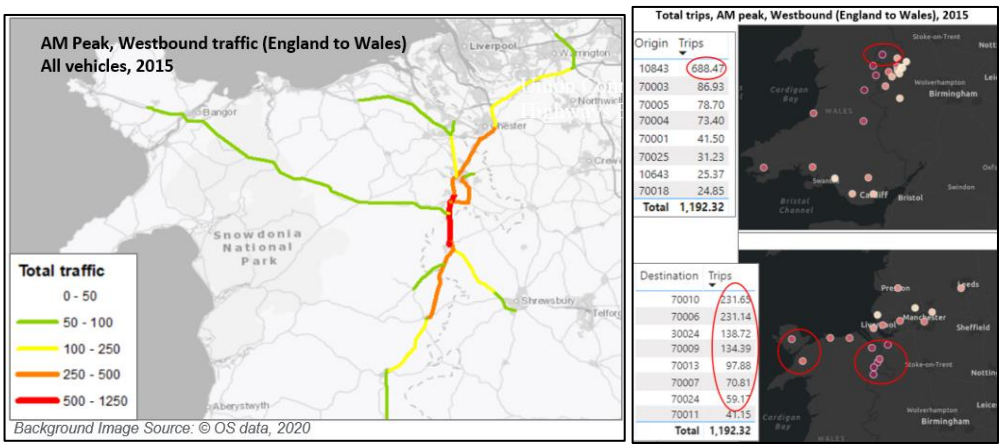
Figure 102 - North Wales - England



Source - Highways England's Call for Evidence Response, M56/A494/A55 Corridor

The A5/A483 connects Oswestry and Wrexham, with longer distance routes to Bangor and Holyhead. Demand on this corridor is shown in Figure 103 as extracted from Highways England's submission to the Call for Evidence

Figure 103 - Welsh Borders

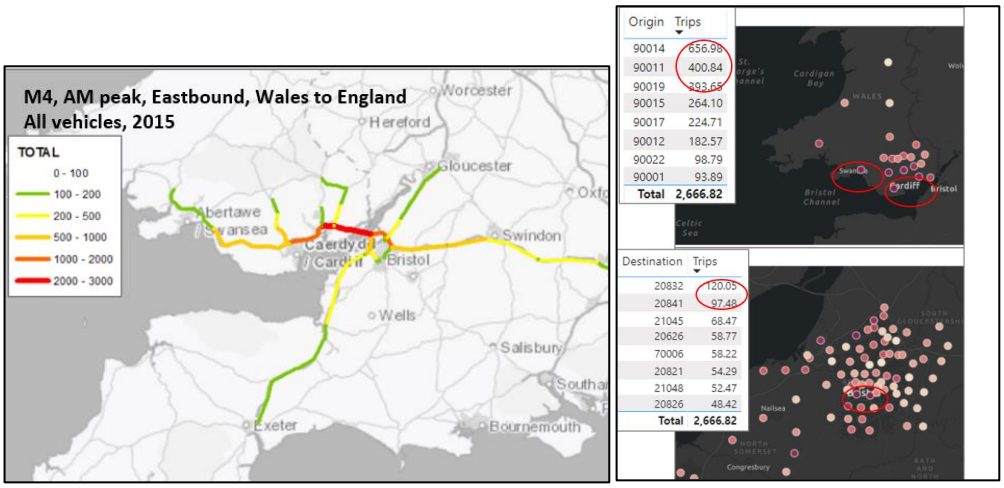


Source - Highways England's Call for Evidence Response, A5/A483 Corridor

The M4 is the key route connecting South Wales with London and the South West of England. It is a key corridor for business and commuting trips in the AM and PM, particularly between Cardiff, Swansea and Newport in Wales, and Bristol, England as shown in Figure 104. Two-way flows are expected to increase by 70-80% by 2041. Freight movements account for 6-9% of the demand in 2015 on this corridor, these tend to be longer distance movements of between 60-125miles.

Following the removal of the tolls on the Severn Crossings in December 2018, westbound flows increased by 21% and 9% eastbound, according to the DfT count data available on the Severn Crossings. The tolls were only payable by those entering Wales, hence the larger increase in westbound flows.

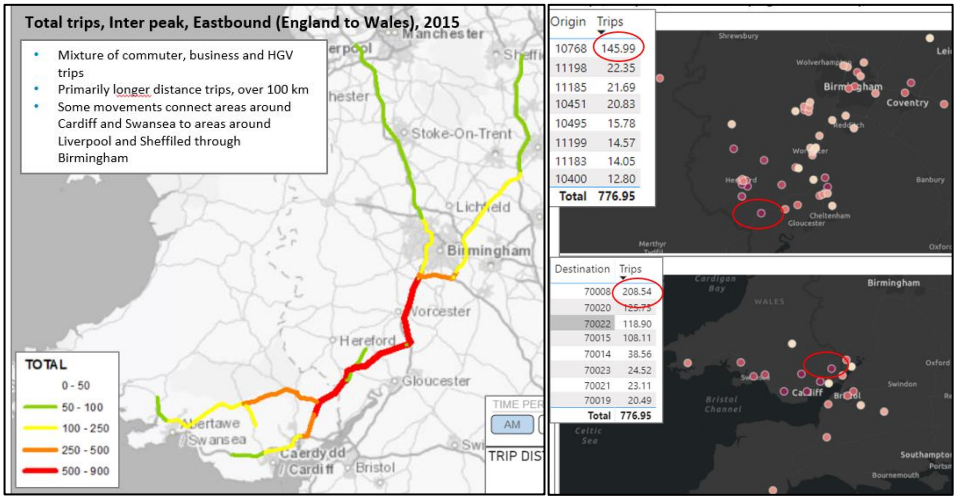
Figure 104 - South Wales - England



Source – Highways England's Call for Evidence Response, M4 Corridor

An alternative route to the M4/M5 for access to the Midlands is via the M50/A40, particularly between Cardiff and Newport towards Hereford and Tewkesbury, with longer distance trips through to Birmingham, Sheffield, and Liverpool. Figure 105 presents the analysis provided in Highways England's Call for Evidence response.

Figure 105 - South Wales – Midlands Corridor



Source – Highways England's Call for Evidence Response, A40 Corridor

The South East Wales Transport model indicates that approximately 50% of trips across the River Severn screenline are between 20 and 50 miles in length, with a further 20-25% between 50 and 100 miles across the day. Trips longer than 100 miles in length make up around 8% westbound and 15% eastbound.[206]

Road connectivity between Great Britain and Northern Ireland is either via the ferry routes between Cairnryan and Belfast / Larne; and Liverpool and Belfast,

[206] https://gov.wales/sites/default/files/publications/2020-07/emerging-conclusions-regional-travel-patterns.pdf

with 1,771K and 298K trips respectively via these routes; or via Dublin and Rosslare in the Republic of Ireland.

C1.2.5 Network capacity and the future

Some of the key issues highlighted in the Call for Evidence submissions focus on the issues of resilience and current network capacity. For instance, the M4 corridor between South Wales and England regularly exceeds capacity on sections of the corridor and the approaches to it, resulting in low speeds along this section. There are high levels of commuter flows in this region in addition to the longer distance freight trips.

The border between North Wales and England similarly has a mix of strategic and commuting trips across it, 30% of all cross-border journeys between Wales and England are in this region.

The M6/A74 border is dominated by long distance journeys (>125miles), with shorter journeys generally on the A1(M). Although there are not significant capacity issues at the England – Scotland border, there are issues further afield which affect the longer distance freight journeys. 50% of HGVs entering Scotland via the M6/A74 start their journeys over 100 miles away, mostly in the Midlands.

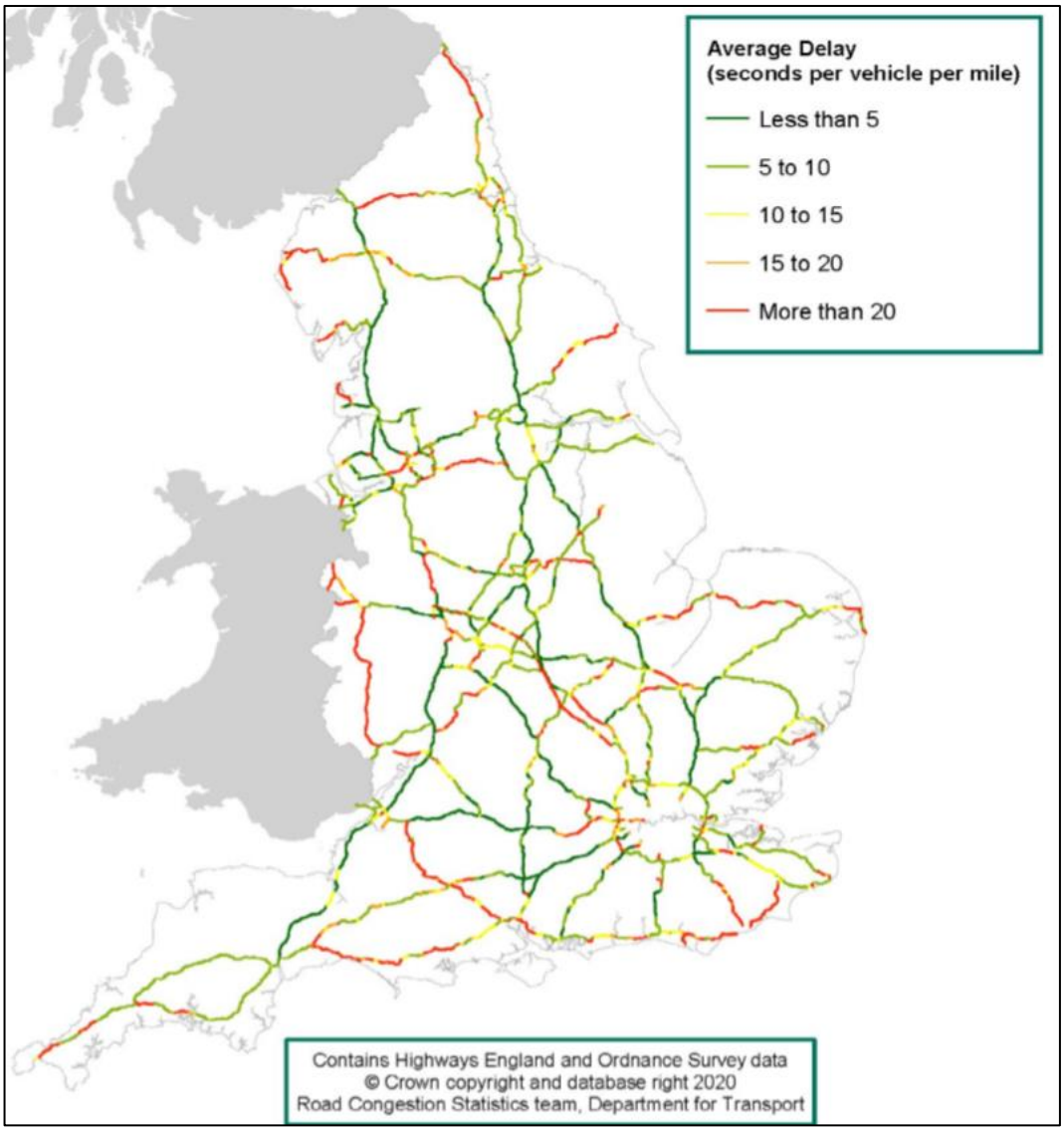
Resilience is another key theme highlighted in the Call for Evidence, in that the alternative routes for a number of the strategic corridors are unable to carry the same level of demand, tending to be smaller A and B roads. In addition to this, the A75 and A77 which form key routes between Northern Ireland and South West Scotland and the North of England are both single carriageway routes heavily used by freight. This route and other routes such as the A69 which are single carriageway have the potential to result in some disruption should there be any accidents on the networks.

Significant growth on the network is expected with the DfT's 2018 Road Traffic Forecast predicting increases of between 33-38% in overall traffic from 2015 to 2050, in the reference scenario and congestion increasing from 6.5% in 2015 to 11% in 2050. The Highways England Call for Evidence indicates increases in demand of 70% on the M4 corridor between 2015 and 2041 and 40% on the M6 over the same time frame. It is noted that these forecasts do not account for the impacts of Covid-19, although this is most likely to have greatest impact in the shorter term. Consideration will need to be given to future travel patterns in a post-Covid world with additional consideration for changes needed in response to the Climate Emergency.

The average delays on the SRN in England in 2019 are presented in Figure 106. These highlight higher levels of delay on the A1 than the M6/M74 at the England-Scotland border and on the A69 which is one of the key east-west routes for resilience between the M6 and A1. Delays further south on the M6, to the north of Birmingham may also impact freight from the Midlands through to Scotland and Northern Ireland. The A49 running parallel to the England-Wales border also has high levels of delays, along with the A483 and A458 into Wales.

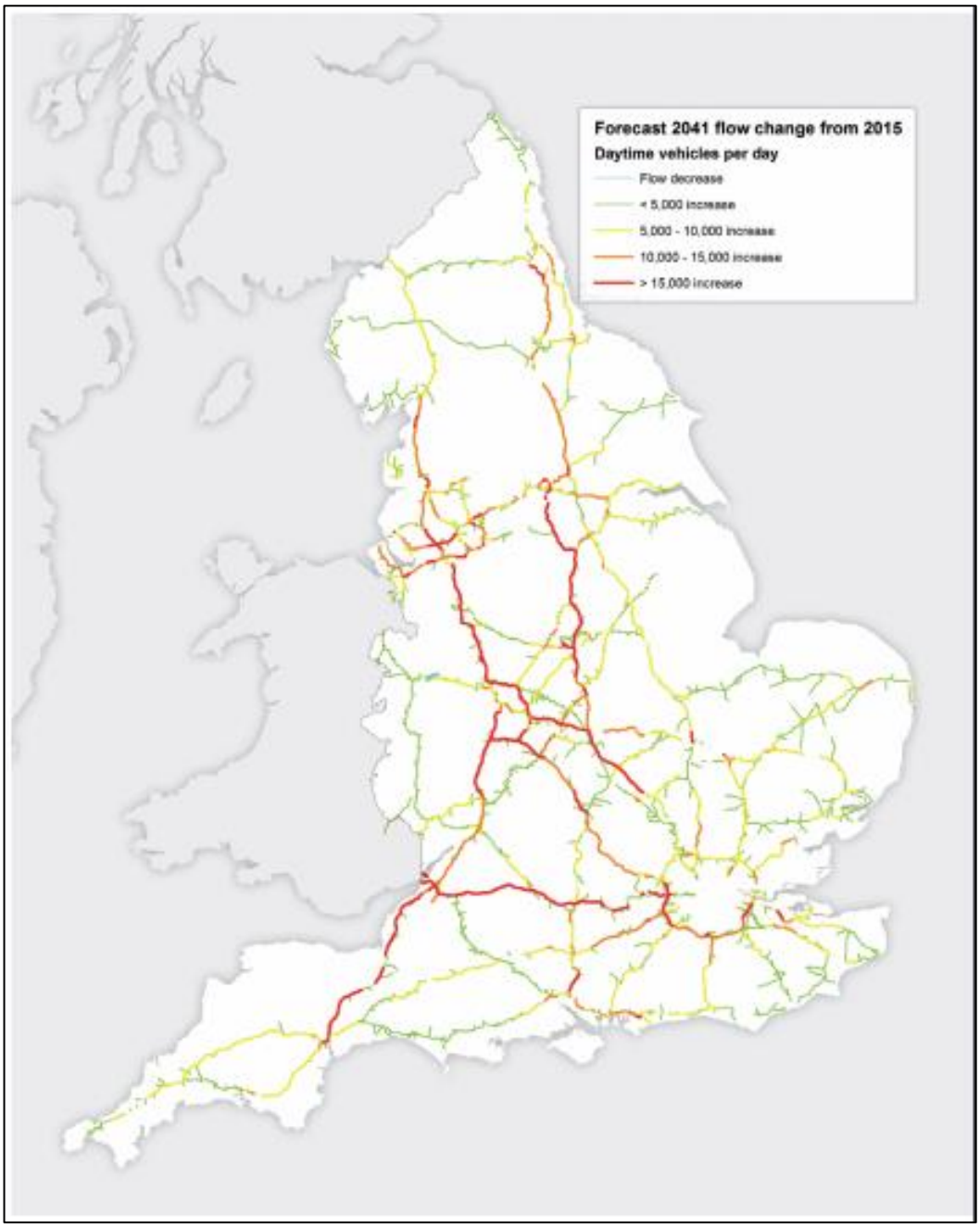
Figure 107 and Figure 108 show the 2041 forecast flow and delay change in England from 2015 respectively. These highlight significant increases in demand on the motorways, with significant increases in delay expected on the M4/M5 near Bristol; the M6 corridor between Birmingham and Lancaster; and the A1 and A19 around Newcastle-upon-Tyne.

Figure 106 – Average Delay on the Strategic Road Network in England, 2019



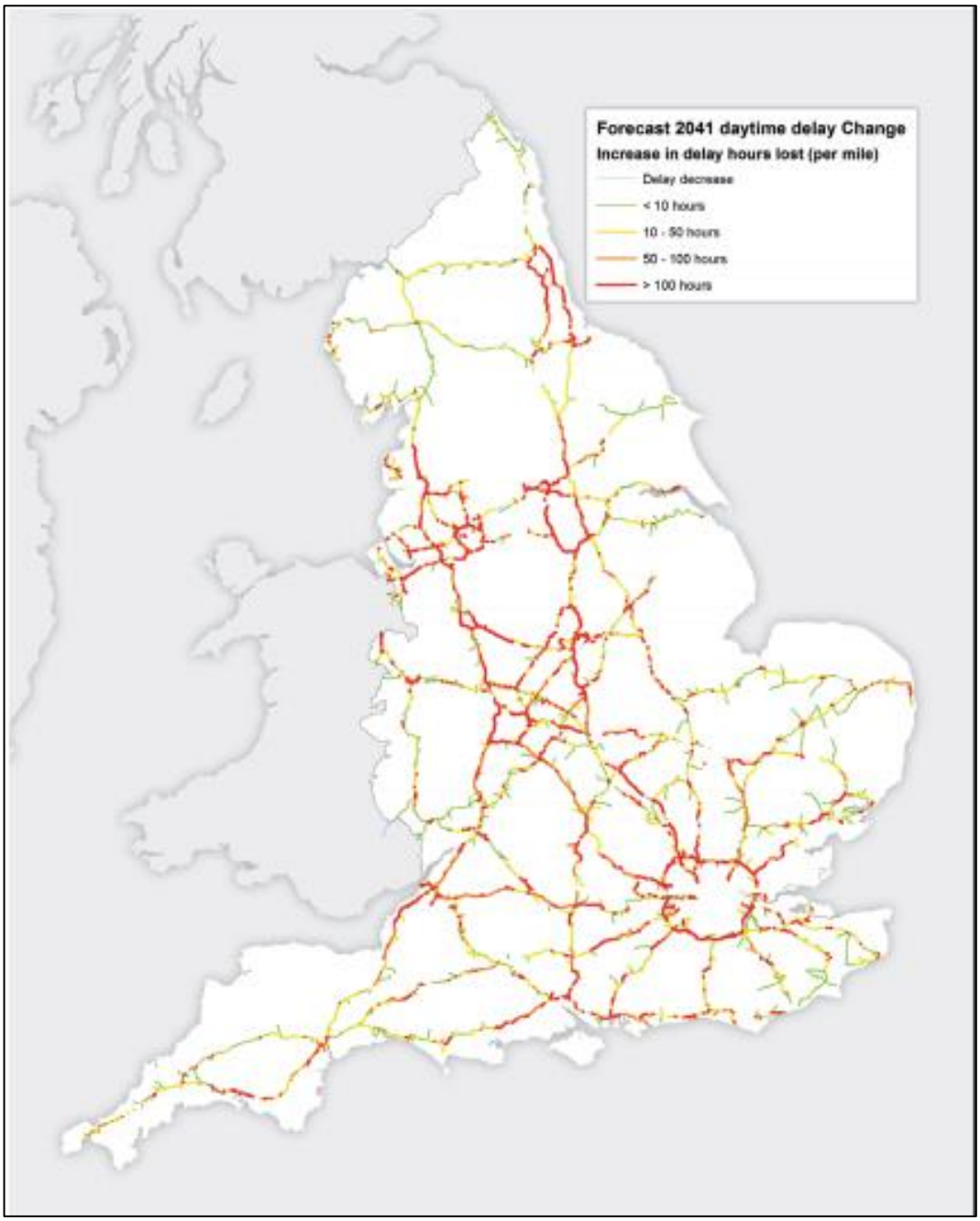
Source – Travel time measures for the Strategic Road Network and local 'A' roads, DfT, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870292/travel-time-measures-srn-local-a-roads-2019.pdf

Figure 107 – 2041 Forecast flow change from 2015 (vehicles per day)



Source – https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/666884/Highways_England_Strategic_Road_Network_Initial_Report_-_WEB.pdf

Figure 108 – 2041 Forecast delay change from 2015 (delay hours lost per mile)

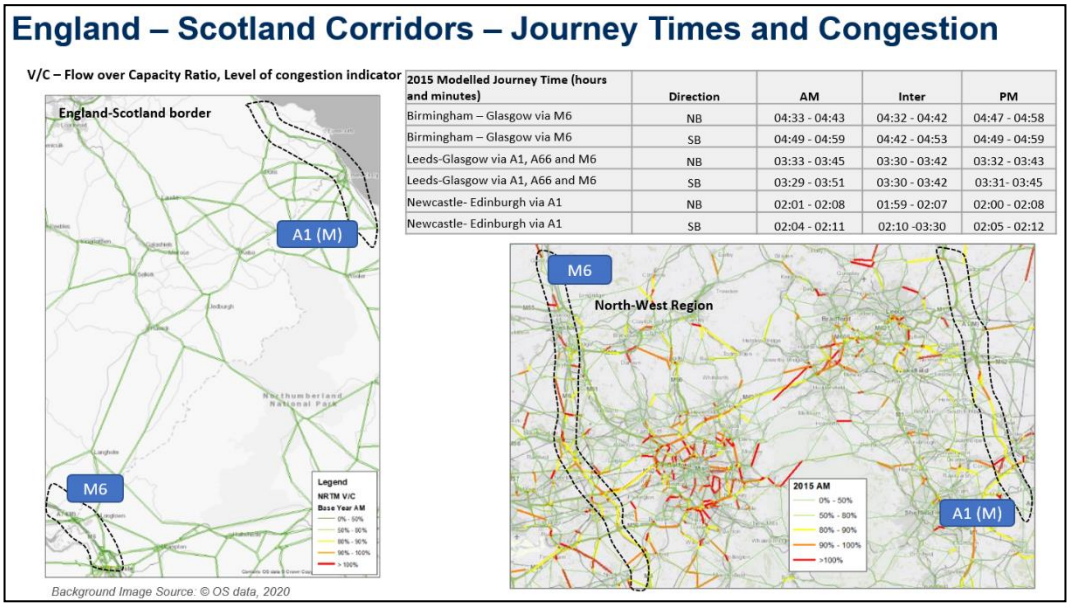


Source – https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/666884/Highways_England_Strategic_Road_Network_Initial_Report_-_WEB.pdf

The Highways England Call for Evidence response provides analysis of journey times and congestion on key corridors between England and Scotland, and England and Wales, these are presented in Figure 109 to Figure 111. The overall modelled 2015 journey time on the individual corridors does not vary significantly by time period, suggesting there are not significant congestion differences across the day for these journeys. The M6 and A1(M) do experience congestion in the North West region, particularly on approaches to the routes similarly for the M56.

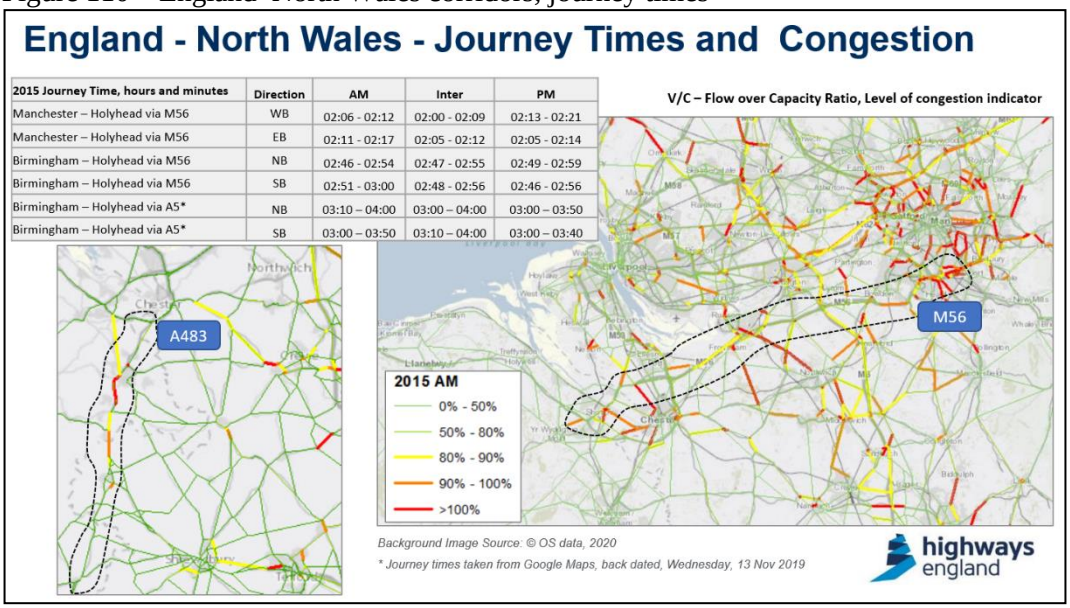
This congestion although not directly at the border, will affect longer distance journeys using this route, such as freight journeys. It should be noted that the RTMs contain limited simulation coding outside of England, and as such will not reflect volume/capacity issues outside of this area.

Figure 109 – England–Scotland corridors, journey times



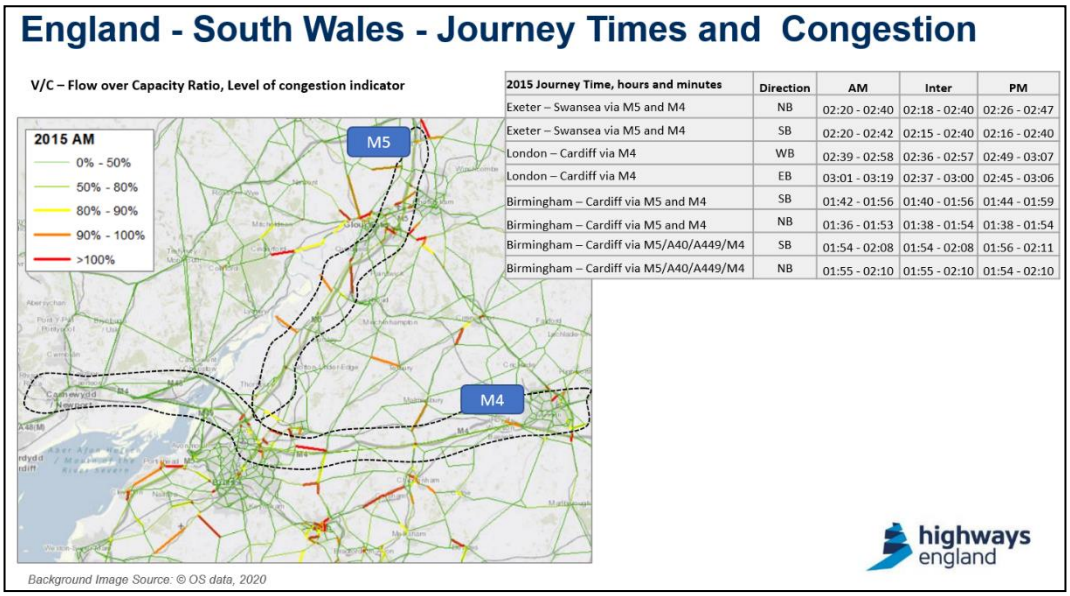
Source – Highways England's Call for Evidence Response

Figure 110 – England–North Wales corridors, journey times



Source – Highways England's Call for Evidence Response

Figure 111 – England–South Wales corridors, journey times



2015 Journey Time, hours and minutes	Direction	AM	Inter	PM
Exeter – Swansea via M5 and M4	NB	02:20 - 02:40	02:18 - 02:40	02:26 - 02:47
Exeter – Swansea via M5 and M4	SB	02:20 - 02:42	02:15 - 02:40	02:16 - 02:40
London – Cardiff via M4	WB	02:39 - 02:58	02:36 - 02:57	02:49 - 03:07
London – Cardiff via M4	EB	03:01 - 03:19	02:37 - 03:00	02:45 - 03:06
Birmingham – Cardiff via M5 and M4	SB	01:42 - 01:56	01:40 - 01:56	01:44 - 01:59
Birmingham – Cardiff via M5 and M4	NB	01:36 - 01:53	01:38 - 01:54	01:38 - 01:54
Birmingham – Cardiff via M5/A40/A449/M4	SB	01:54 - 02:08	01:54 - 02:08	01:56 - 02:11
Birmingham – Cardiff via M5/A40/A449/M4	NB	01:55 - 02:10	01:55 - 02:10	01:54 - 02:10

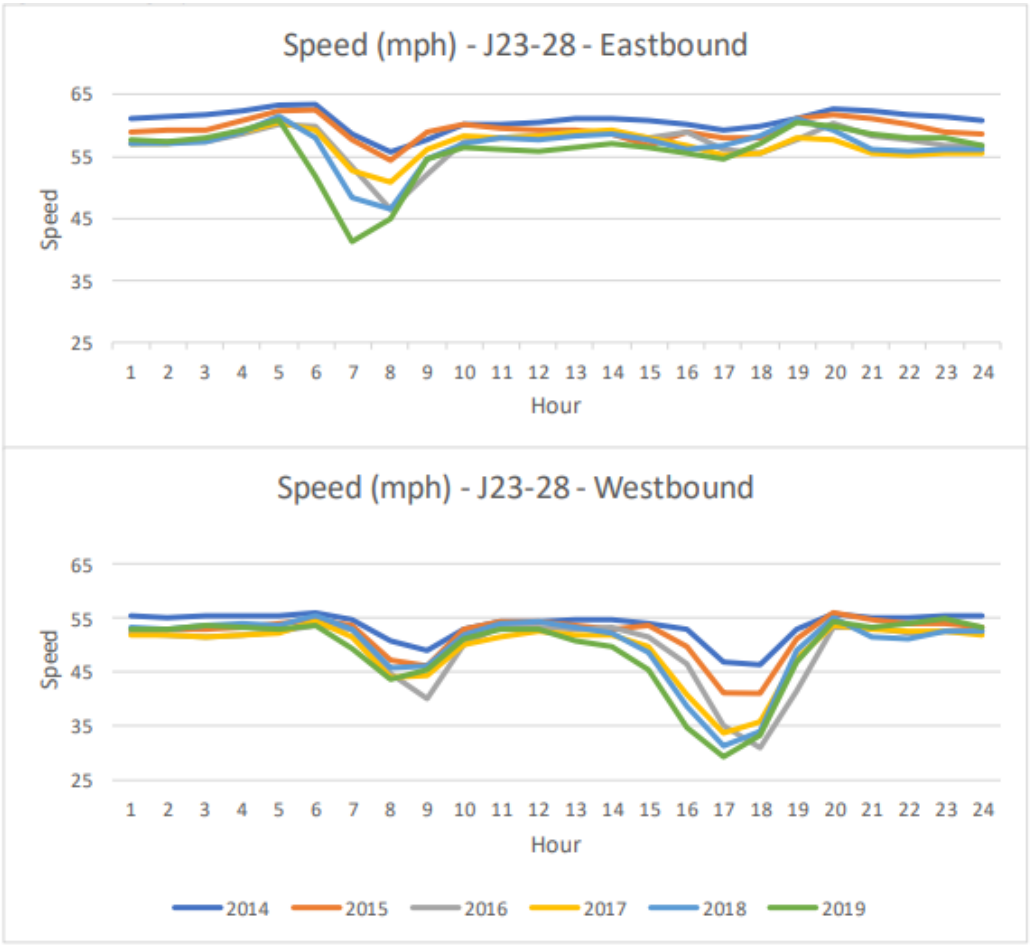
Source - Highways England's Call for Evidence Response

The South East Wales Transport Commission highlights congestion impacts on the M4, particularly westbound between the Prince of Wales crossing and Cardiff. Low speeds (below 40mph) are expected across all weekdays between 3-4pm, with prolonged periods on Fridays, in particular, with this extending between 2-5pm and with speeds dropping as low as 20mph between J23A and J24.207

Figure 112 presents the hourly average speed on the M4 between the Prince of Wales crossing and the west of Newport for 2014-2019. This highlights peak congestion in the AM eastbound and the PM westbound increasing over time. Speed is less variable on the M4 to the west of Newport. Figure 113 presents the average speed by day of the week on the M4 between the Prince of Wales Bridge and A4119 to the west of Cardiff, highlighting lower speeds in the afternoons on Fridays, particularly westbound, likely tourist traffic accessing South Wales via the M4.

[207] https://gov.wales/sites/default/files/publications/2020-07/emerging-conclusions-m4-traffic.pdf

Figure 112 – Average speed on the M4 2014-2019, M4/M48 junction to west of Prince of Wales Bridge (J23) to West of Newport (J28)

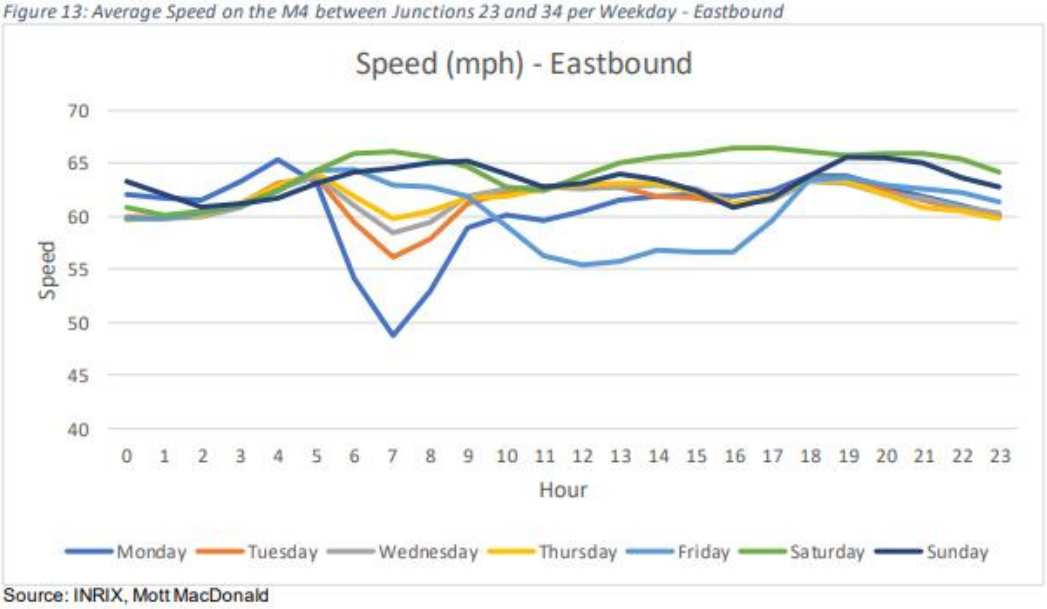


Source: INRIX, Mott MacDonald

Source - Transport for Wales, TN05-010-Traffic Flows and Congestion (Rev C).pdf

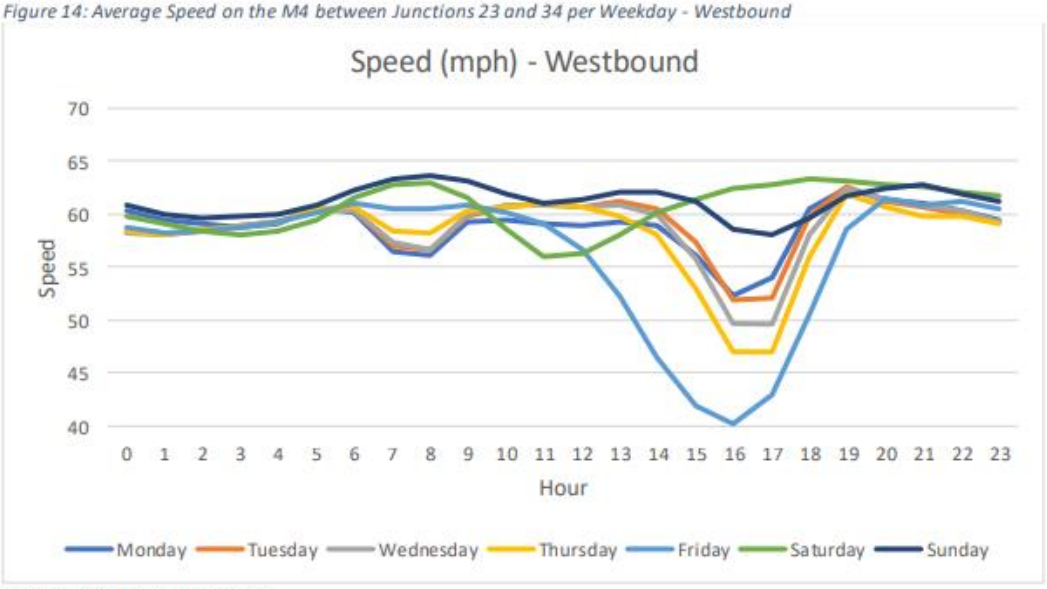
Figure 113 – Average speed on the M4 between Junctions 23 (M4/M48 junction to west of Prince of Wales Bridge) and J34 (A4119 to the west of Cardiff), by weekday

Figure 13: Average Speed on the M4 between Junctions 23 and 34 per Weekday - Eastbound



Source: INRIX, Mott MacDonald

Figure 14: Average Speed on the M4 between Junctions 23 and 34 per Weekday - Westbound

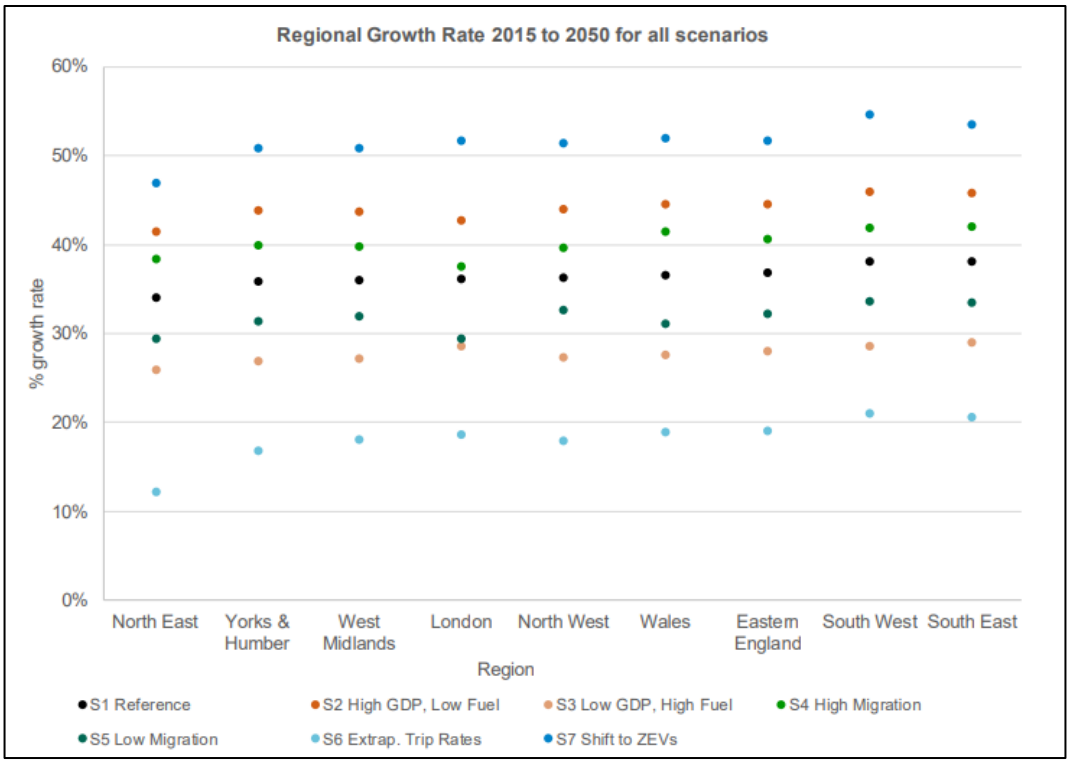


Source: INRIX, Mott MacDonald

Source - Transport for Wales, TN05-010-Traffic Flows and Congestion (Rev C).pdf

The DfT produces the Road Traffic Forecast for expected traffic demand and congestion based on the National Transport Model. The latest set of forecasts were produced in 2018, for various scenarios. Figure 114 presents the regional growth rates for England and Wales between 2015 and 2050, showing growth of between 33-38% in the reference scenario across all regions. The South West and South East regions are expected to have the highest growth in traffic demand, with lower levels in the North East across all scenarios.

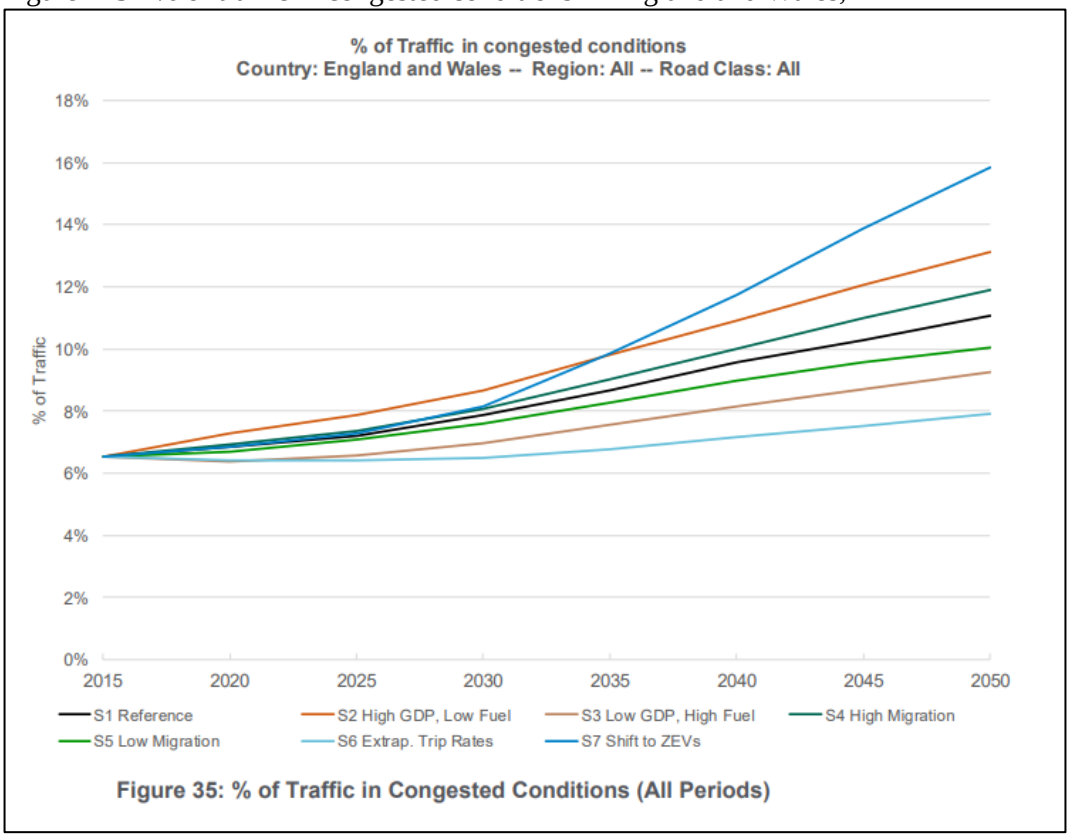
Figure 114 - Regional growth rate for England and Wales 2015-2050 for all scenarios, DfT



Source - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873929/road-traffic-forecasts-2018-document.pdf

Across all regions and all road types, congestion is expected to increase from 6.5% in 2015 to 11% in 2050 in the reference case, as shown in Figure 115.

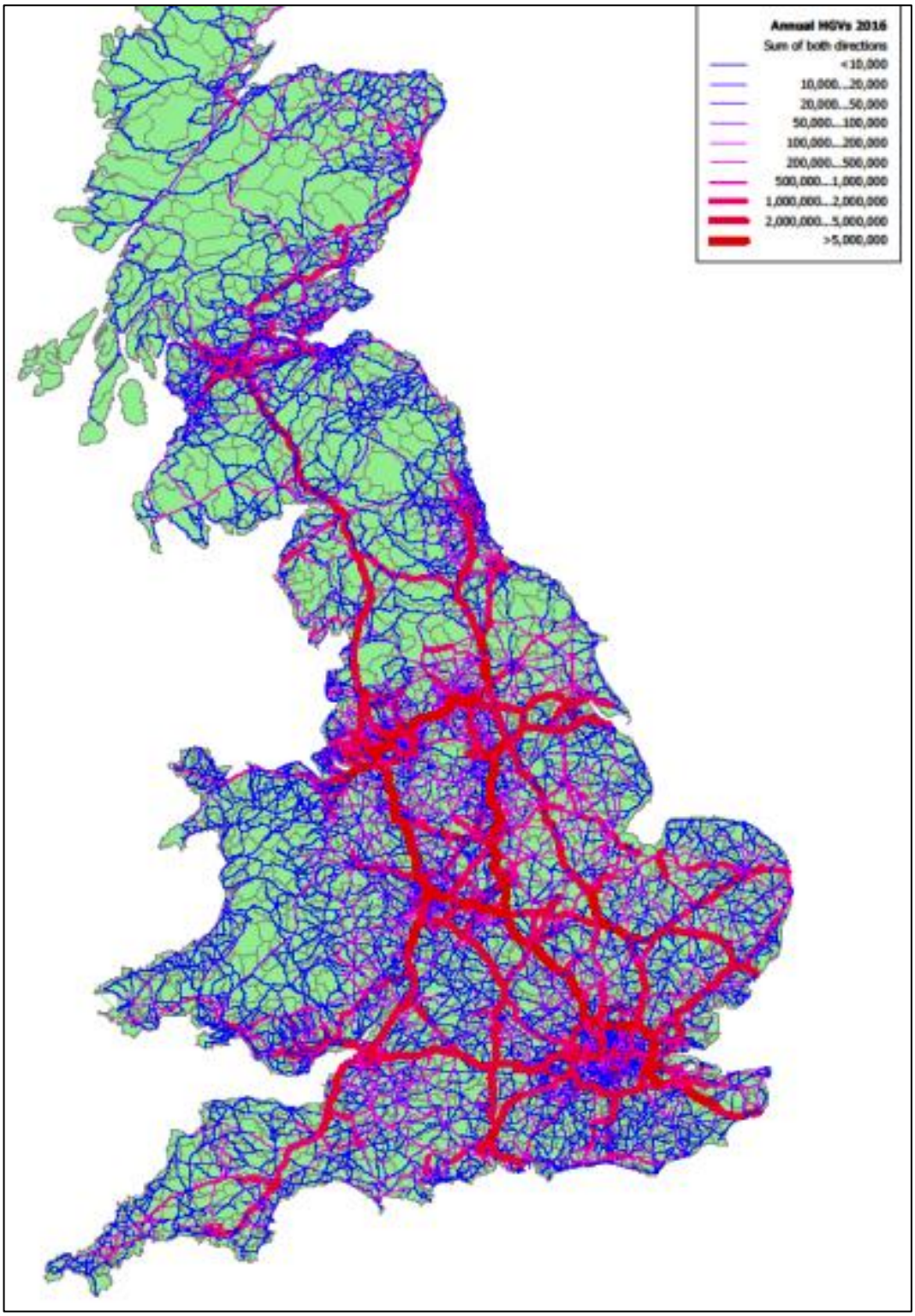
Figure 115 - % of traffic in congested conditions in England and Wales, DfT



Source - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873929/road-traffic-forecasts-2018-document.pdf

Figure 116 shows the annual HGV flows on the GB network in 2016, highlighting the importance of the strategic and trunk road networks in England, Wales and Scotland for the transfer of goods.

Figure 116 – Annual HGV flows on the GB road network, 2016



Source – https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/777781/fom_understanding_freight_transport_system.pdf

Network capacity

Scotland – England

Resilience of the A1 is discussed in a number of the Call for Evidence submission, particularly the sections through Northumberland and on the Scottish side of the border where the road is single carriageway. Although the larger portion of freight traffic crossing the border between England and Scotland is via the M6, around 15% of total annual average weekday traffic volumes on the A1 in 2019 were HGVs. Given the mix of traffic and the single carriageway nature of the A1 this can result in journey time variability and significant impacts during maintenance or in the event of an accident. The diversion routes in this area are generally limited to smaller A and B roads parallel to the corridor which do not offer sufficient capacity as an alternative strategic route. There are sections of the A1(M) which are due to be upgraded to dual carriageway as part of the second Road Investment Strategy. The Highways England Call for Evidence response highlights the section immediately south of the border is in the highest level of risk category for KSI (Killed and Seriously Injured) casualties.

The A66 and A69 are both highlighted as key roads for resilience for journeys between Scotland and England as they offer a connection between the M6 and A1(M) routes. The A66 however is prone to accidents and can experience severe weather conditions in winter – this provides constraints for east-west connectivity between the M6 and A1(M). There is a commitment in the DfT's Road Investment Strategy 2 to upgrade this to dual carriageway, along with sections of the A1. The A1 does not currently experience capacity constraints at the border itself, although there are safety issues with regards the mix of traffic. This potentially provides an opportunity for growth around the border. The A69 is dual carriageway between Newcastle-upon-Tyne and west of Hexham, with the remainder of the route to the west single carriageway

The Secretary for State for Scotland notes that the A75/A77 provides the key route connecting the North of England and South West Scotland and on to Northern Ireland via Cairnryan, both routes are single carriageway and heavily used by freight.

Wales – England

The road network on the English side of the England-Wales border is of a higher capacity, with motorway designations, than that on the Welsh side. The English part of the M4 and the M5 join to feed into the Welsh M4, which is a particularly congested corridor in the peak hours limiting the level of growth that can be accommodated in this corridor.

Analysis on behalf of the Welsh Government using INRIX GPS data indicates that there are several locations on the M4 and approaches to it where the demand exceeds the capacity of the road network on a regular basis. The issues are generally on the M4 around Newport, M4 near Port Talbot and on the periphery of

Cardiff.[208] Congestion in five of the most severely affected locations extends for at least 3.5 miles.

The South East Wales Transport commission has released a number of recommendations for the M4 corridor, complementary to the existing plans for a South Wales metro – this predominantly focusses on sustainable modes of transport rather than increasing the capacity on the M4. Highways England have allocated funding for a Severn Resilience package as part of the RIS3 pipeline on the eastern side of the Severn Crossings to tackle future congestion levels following the removal of the tolls in December 2018. Although this has not been committed it would offer opportunities for growth in the area.

In addition to congestion on the M4 around Cardiff and Newport, the M56/A494/A55 and A54/A5 corridors are both congested in peak hours on the approaches to urban areas such as Chester, Manchester and Shrewsbury. The M50/A40 has a lower capacity, providing a potential barrier to it serving more strategic routes.

Call for Evidence responses also identified the A49 as a key area in need of investment as journey times through Hereford are unreliable due to congestion caused on the river crossing, poor weather can also affect the strategic road network between England and Wales.

Great Britain – Northern Ireland

Capacity for road journeys between Northern Ireland and Great Britain are additionally limited by the ferry crossings. As part of the National Development plan, the government will update and enhance commitment to jointly funding cross-border investment.

The Holyhead-Dublin route depends on the M1 corridor in the Republic of Ireland and A1 in Northern Ireland to connect through to Belfast.

Significant growth is expected on the road network, although this currently does not account for the impacts of Covid-19, it is likely that there will be growth in demand and additional stress on the network. The exact shape which this takes will be determined by policies which shape the recovery following Covid-19. Whether we look at an increased level of Work-from-Home driving changes to the locations where people choose to live, resulting in longer journeys when they do work in an office; or whether there are increases in leisure trips; or a return to something similar to pre-Covid-19. Consideration to the resilience of the network will also be critical for dealing with the outcomes of extreme weather events and providing alternatives to ensure the continued delivery of goods throughout the union.

[208] https://gov.wales/sites/default/files/consultations/2020-11/supporting-information-transport-data-and-trends.pdf

C1.3 Sea

A summary is as follows.

- The surface links to Northern Ireland are dependent upon ferry links, which for much of England and Wales are also dependent upon a transit through the republic via Holyhead and Dublin.
- Almost all of the passenger ferry traffic between the GB and the island of Ireland is carried on two routes, Holyhead – Dublin and Loch Ryan – Belfast
- There are significant international and domestic freight flows at ports, with the busiest ports being in England and Wales. The largest domestic moves are across the Irish sea, between north west England and Scotland, and Northern Ireland.
- Ro ro and Lo lo are the fastest growing categories of good carried.
- There are 8 further freeports planned.

C1.3.1 Ownership and structure

As an island nation there is a significant number of ports spread across all regions of the UK, handling both international and domestic movement of freight and passengers by sea, as well as supporting the offshore energy industry. Sea crossings, sometimes together with air, offer a lifeline links to the UK's more dispersed islands, and between Great Britain and Northern Ireland.

Port ownership follows a number of different structures, and ports are further classified into whether they are major or minor. The 'Modern Ports' review of national ports policy in 2000 resulted in a process of deregulation whereby port ownership fits into one of three categories – private, municipal and trust.[209] All three ownership models are run as stand-alone, self-financing enterprises, independent of government support or subsidy. The ports sector is, as such, open to market forces and the characteristics of the ports vary according to the markets they serve.

Most commercial UK ports are owned by five companies: Associated British Ports (ABP), Forth Ports, Hutchison Port Holdings (HPH), Peel Group and PD Ports.

C1.3.2 Completeness of the network

UK ports are classified as 'major' or 'minor', based on the amount of freight they handle annually. Major ports, of which there are 51 major ones in the UK, are those with cargo volumes of at least 1 million tonnes annually (this threshold was adjusted in 2000 when it was in was reduced from 2 million tonnes annually). These are located in all regions of the UK but are particularly focussed on the

[209] DfT, Modern ports: a UK policy, November 2000

southern half of Great Britain. Figure 117 shows the distribution of major ports across the UK.

Figure 117 - Map of Major UK Ports, 2021

Source – DfT Port and domestic waterborne freight statistics https://www.gov.uk/government/statistical-data-sets/port-and-domestic-waterborne-freight-statistics-port

C1.3.3 Passenger demand

In 2019 there were approximately 22 million short sea passenger journeys. 84% of these journeys were international with crossing between Dover and Northern France accounting for 11 million journeys alone.[210] Dover is by far the busiest international passenger ferry port in the UK (see Figure 118 below). A further 2.5 million passenger journeys were made between Great Britain and the Republic of Ireland, mostly via Holyhead, and 1.9 million between Great Britain and the Netherlands. Of the 22 million journeys, there were 3.5 million domestic sea crossings in 2019 with 60% of those trips between Great Britain and Northern Ireland.

Over the past decade (2010-2019) domestic sea passengers between Great Britain and Northern Ireland have been declining, on average 1% per year. International passenger ferry trips have also been declining by an average of 2% per year.

Figure 118 - Top 5 international passenger ferry ports in the UK, 2019

Nation	Port	International passengers (millions)
England	Dover	10.9
Wales	Holyhead	1.9
England	Portsmouth	1.7
England	Hull	0.8
England	Harwich	0.7

Source – SPAS0101 DfT, Sea Passenger Statistics (2019)

The importance of the Irish Sea routes

The Irish Sea routes link the islands of Ireland and Great Britain, thus linking Northern Ireland to the remainder of the UK. The largest flow of passengers is on the L - Belfast link, which carried 1.3m passengers in 2019, or two-thirds of the passengers on direct services linking Britain and Northern Ireland. It can also be assumed that some of the passengers transit through the Republic of Ireland to complete a journey that begins or ends in Ulster, and for many passengers travelling between England, Wales and Northern Ireland, the route via the republic is the most practical. The sea links carry a small proportion of the passenger market between the islands, when compared with the air link.

Both of the busiest Irish Sea routes have been growing in recent years, as some services have consolidated on Cairnryan, Belfast and Holyhead ports. The Liverpool – Belfast route has also been growing strongly. Figure 119 below shows the major routes crossing the Irish Sea and 2019 annual ferry passenger numbers. Passenger numbers capture movements in both directions on each route. These routes are displayed on a map in Figure 120.

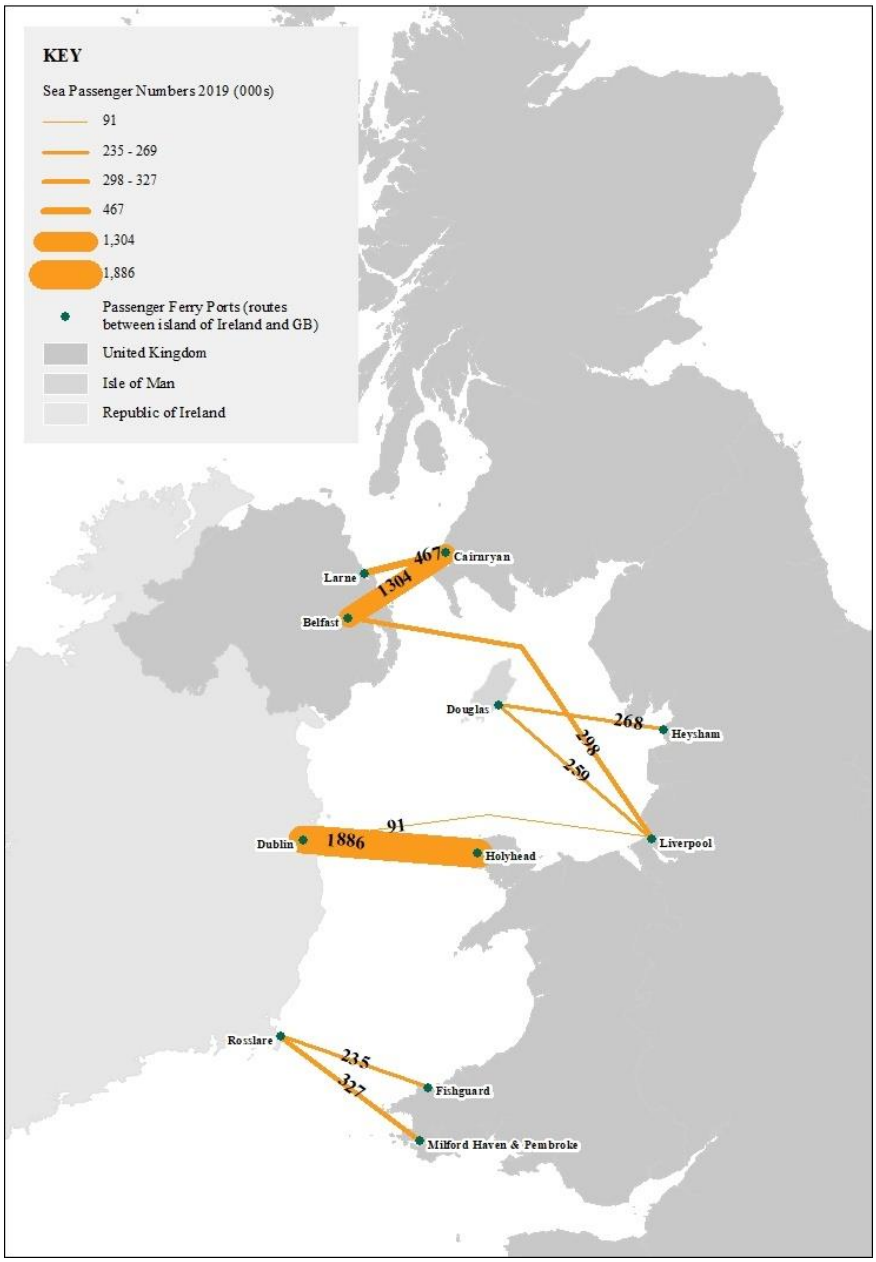
[210] https://www.gov.uk/government/statistical-data-sets/sea-passenger-statistics-spas

Figure 119 - Annual ferry passenger numbers across Irish Sea, 2019

Connection	Route	Passenger Numbers (000s)	CAGR[3] (10 years)	Journey Time (hours)	No. of Sailings (Both directions)
Scotland - NI	Cairnryan - Belfast[1]	1,304	1.7%	02:15	12/day
Scotland - NI	Cairnryan - Larne	467	-2.5%	02:00	7/day
England - NI	Liverpool - Belfast	298	4.8%	08:00	2/day
England - IoM	Heysham - Douglas	268	-0.6%	03:30	2/day
England - IoM	Liverpool - Douglas	259	-0.6%	02:45	2/day[4]
Wales - RoI	Milford Haven[2] - Rosslare	327	0.4%	03:50	2/day
Wales - RoI	Fishguard - Rosslare	235	-7.3%	03:30	2/day
Wales - RoI	Holyhead - Dublin	1,886	1.7%	03:15	4/day
England - RoI	Liverpool - Dublin	91	-6.1%	08:00	2/day

1. Prior to 2012 the Cairnryan-Belfast route existed as the Stranraer-Belfast route
2. Also includes Pembroke
3. Calculated for 10 years, 2009-2019
4. Seasonal service only (March-October)
Source – Routes and passenger numbers have been extracted from DfT Statistics - Table SPAS0102 and Table SPAS0201. These tables have also been used to calculate the CAGR from 2009-2019 (10 years)
https://www.gov.uk/government/statistical-data-sets/sea-passenger-statistics-spas
Journey times and number of sailings have been sourced from operator websites (November 2020).

Figure 120 – Irish Sea passenger routes and numbers, 2019



Source – Data tables: spas0102 and spas0201, https://www.gov.uk/government/statistical-data-sets/sea-passenger-statistics-spas

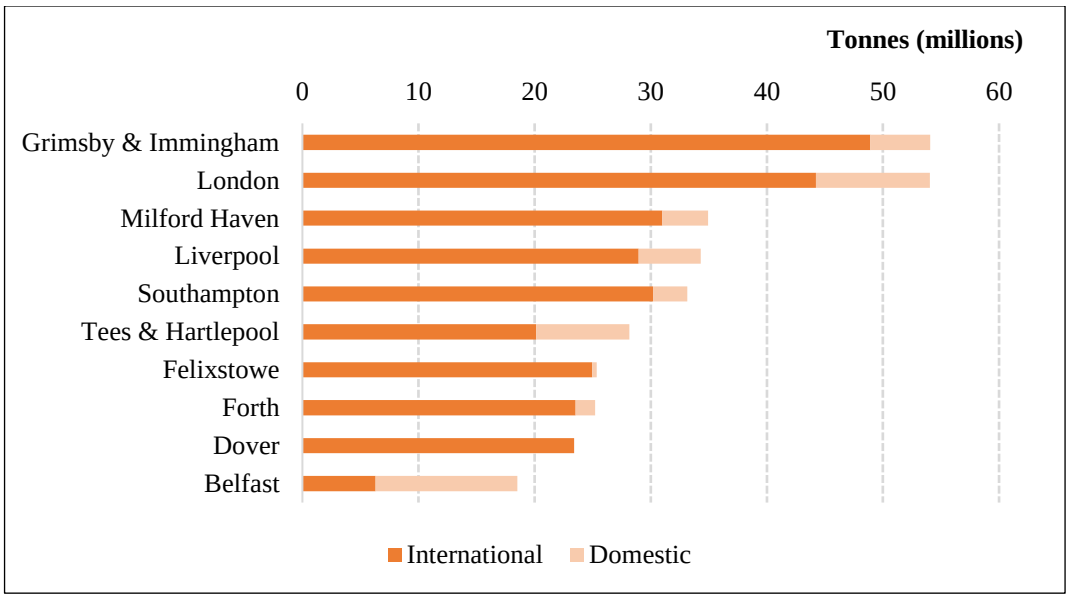
C1.3.4 Freight demand

In 2020, 458 million tonnes of freight moved through major UK ports.[211] Freight volumes in the maritime sector are predominantly international (81%) and are also skewed towards limited number of key ports. The ten highest volume ports, which are substantially located in England, are responsible for 72% of all freight volumes.

[211] DfT Statistics Table PORT0304 https://www.gov.uk/government/statistical-data-sets/port-and-domestic-waterborne-freight-statistics-port#port-level-statistics

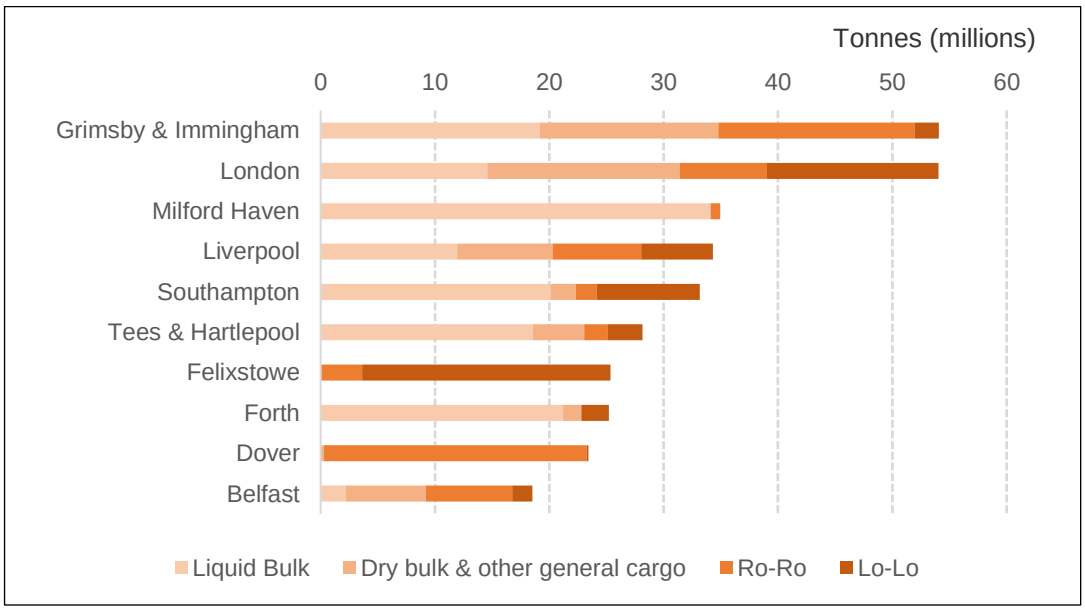
The figures below shows the Top 10 UK ports by freight volume—Figure 121 shows how his freight is divided between International and Domestic routes while Figure 122 shows how this freight breaks down by type. Driven by the new Gateway port, London has grown significantly in importance in the last decade. There are 4 general types of freight classification:

Figure 121 – Top 10 UK ports by freight and route category, 2020[212]



Source - DfT Statistics Table PORT0304 (2020)

Figure 122 – Top 10 UK ports by freight volume and type, 2020[213]



Source - DfT Statistics Table PORT0304 (2020)
Liquid Bulk – liquified gas, crude oil, oil products, other

[212] DfT Statistics Table PORT0304 https://www.gov.uk/government/statistical-data-sets/port-and-domestic-waterborne-freight-statistics-port#port-level-statistics
[213] DfT Statistics Table PORT0304 https://www.gov.uk/government/statistical-data-sets/port-and-domestic-waterborne-freight-statistics-port#port-level-statistics

Dry bulk and other general cargo – ores, coal, agriculture products, forestry products, iron, steel and other
Ro-Ro (Roll-on/Roll-off) – road goods and vehicles, rail wagons, live animals, other
Lo-Lo (Container traffic)
Domestic freight routes

The domestic freight market plays a strategic role in the connectivity of the UK and carries almost one-fifth of the total seaborne freight volume. Figure 123 below shows the top ranked ports by the volume of freight handled in each of the nations. Belfast is the largest port by volume for domestic freight in all the UK. London also has a significant, and growing portion of the domestic freight market.

Figure 123 - Largest UK Domestic Freight Ports by Volume, 2020

Overall UK Rank for Domestic Volumes	Country	Port	Domestic freight volume (Tonnes, millions)
1	Northern Ireland	Belfast	12
2	England	Port of London	10
6	Wales	Milford Haven	4
9	Scotland	Aberdeen	3

Source - DfT Statistics Table PORT0304 (2020)

Domestic freight routes can broadly be categorised into 2 key groups:

1. 'Single Region' movement: the country of the port is the same for both the load and the unload (i.e. cargo is moved between two different ports in the same country); and

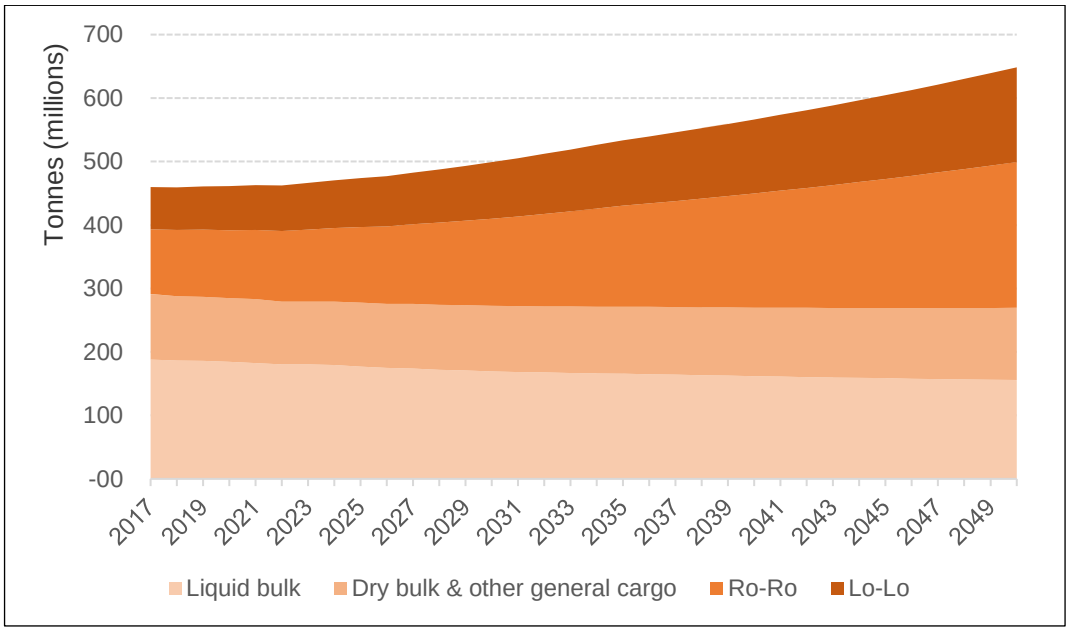
2. 'Cross Region' movement: between ports in different countries within the UK (England, Scotland, Wales, Northern Ireland).

C1.3.5 Network capacity and the future

DfT forecasts last updated in 2019 project increasing growth in freight traffic at UK ports in the years ahead. Freight tonnage is expected to grow by 39% between 2016 and 2050 (see Figure 124).[214] While DfT does not provide detailed freight forecasts for each of the major maritime ports Port of London Authority, as the largest maritime port in the UK, released an independent forecast projecting a 77% growth in freight volumes by 2035.[215]

[214] UK Port Freight Traffic 2019 Forecasts, DfT, 2019
[215] Port of London Trade Forecasts to the Year 2035, Port of London Authority, 2015 https://www.pla.co.uk/assets/forecasts-consultationdocumentv11december-1.pdf

Figure 124 - Total port freight tonnage forecast by category, 2017-2050



Source - UK port freight traffic forecasts 2019 data, DfT, https://www.gov.uk/government/publications/uk-port-freight-traffic-2019-forecasts
In 2019, DfT published Maritime 2050: Navigating the future which lays out an ambitious vision for the future of the maritime industry216 and suggests that "the UK will continue to play a leading role in this market… at the forefront of innovation and productivity, academic research and thought leadership"

The report identifies a number of shifting future trends that will impact the maritime sector as well as a few key risks. In particular the report identifies the need to remain commercially competitive in a global maritime trade market, through competitive tax legislation, innovation, environmental protection and robust supporting infrastructure (including transport connectivity). There are few projections for port activity in the years ahead, and even less work has been done on the impact of Covid and Brexit on previous projections. National sea passenger estimates suggest that the number of journeys will remain relatively consistent over the coming decade remaining stable or achieving up to 1% growth by 2023.[217]

Freeports

Helping support the Maritime 2050 vision the government has recently announced its ambitions to establish 8 freeports across England (see Figure 125). Common features of freeports include various concessions on customs, other tax and planning advantages and reduced bureaucracy—together these features help support the growth of maritime trade, but also local, regional, and national economies.[218] While being within a country's geographical borders, freeports are effectively outside a country's customs borders. Goods imported into a freeport

[216] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/872194/Maritime_2050_Report.pdf
[217] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/872194/Maritime_2050_Report.pdf
[218] https://commonslibrary.parliament.uk/research-briefings/cbp-8823/

are generally exempt from customs duties until they leave the freeport and enter the domestic market. No duty is payable if they are re-exported.

Figure 125 - Announced freeport locations in England

Freeports
Felixstowe & Harwich
Humber
Liverpool City Region
Plymouth and South Devon
Solent
Teesside
Thames
East Midland Airport

Source – UK Government policy on freeports, House of Commons Library (2021) https://commonslibrary.parliament.uk/research-briefings/cbp-8823/

C1.4 Air

A summary is as follows.

- The busiest UK domestic air routes are between London, Glasgow, Edinburgh and Belfast. Because of the distance involved, cross border flows make up the most popular air routes, making it unique among the modes.
- Air travel fulfils a lifeline role in many remote locations. Public service obligation flights include those to many Scottish islands.
- Air travel demand is projected to grow significantly in future.
- Air freight is a major, but often overlooked component, with Heathrow carrying almost as much tonnage as some of the major ports and is the largest UK port by value.

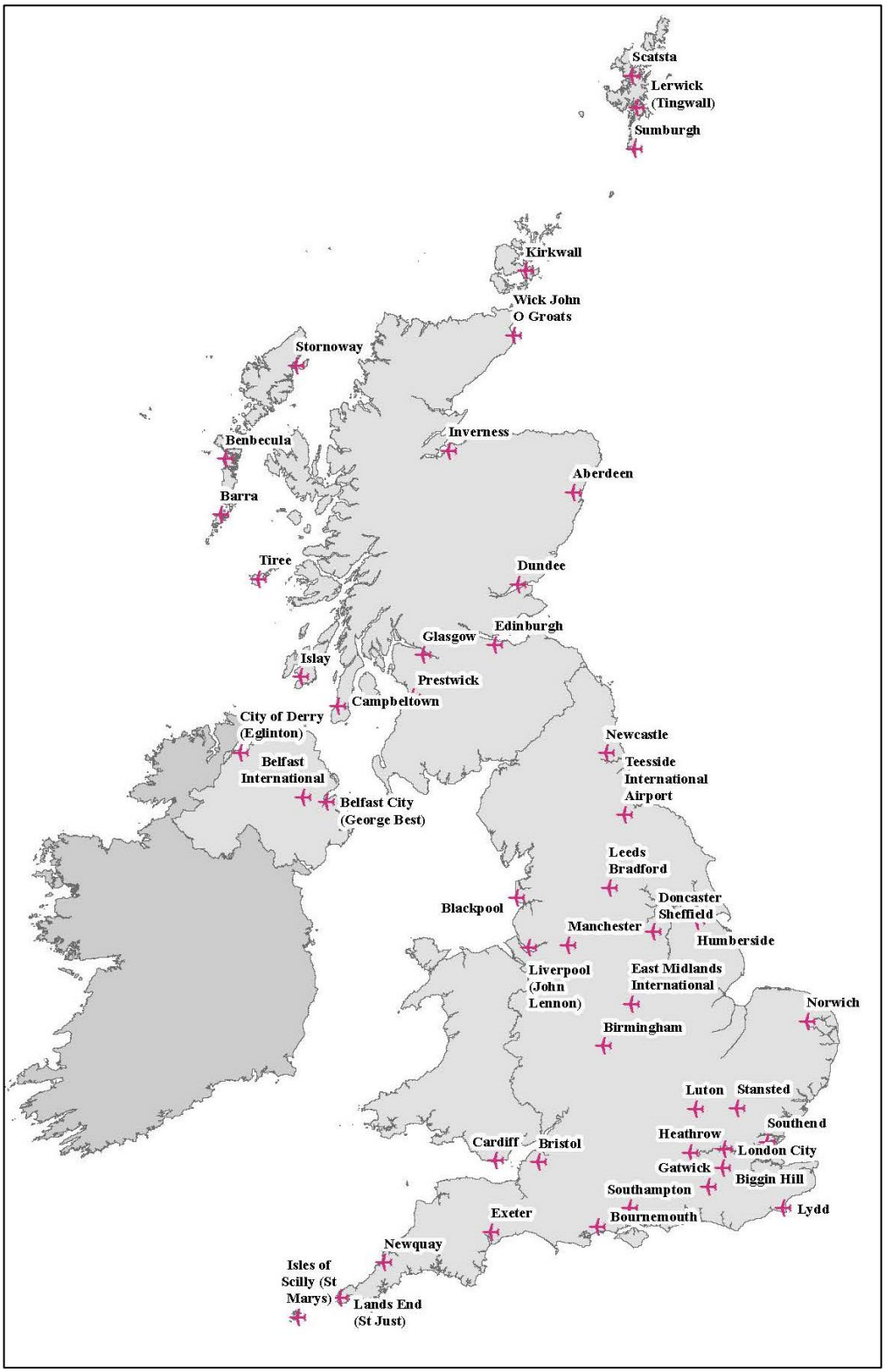
C1.4.1 Ownership and structure

There is an extensive spread of airports across the UK. Privatisation of the sector from the 1970s onwards means that there is no government-sponsored domestic aviation route network in the UK, and so with the exception of public service obligation routes capacity and frequency on routes are determined primarily on their meeting of market demand.

Domestically, policy on air travel and airports is largely reserved to the UK Government, and some aspects are devolved to Scotland, Wales and Northern Ireland, particularly as regards to noise pollution and control.[219] The Civil Aviation Authority (CAA) is the economic and safety regulator and collects data on the 47 publicly regulated airports across all regions of the UK.

[219] https://commonslibrary.parliament.uk/research-briefings/cbp-8739/

Figure 126 - Map of UK Public Airports, 2019[220]



Source – UK Airports, Civil Aviation Authority, 2019

[220] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2019/ (Table 1)

C1.4.2 Completeness of the network

The domestic aviation network in the UK can be divided into three route categories[221].

1. **Trunk Routes:** connect between the principal London airports and major regional centres (Manchester, Edinburgh, Glasgow, Aberdeen, and Belfast). These routes are typically serviced by multiple flights per day.
2. **Provincial Routes:** are flights connecting regional cities in the UK. They are operated less frequently then Trunk Routes and typically serviced by smaller aircraft.
3. **Public Service Obligation (PSO) Routes:** These are 22 publicly subsidised 'lifeline' flights between geographically remote and/or inaccessible communities in Wales, Northern Ireland and Scotland which would not be commercially viable without public subsidy (See Figure 127). This routes typically operate once a day or less frequently using small aircraft.

Figure 127 – Public Service Obligation Routes in the UK

#	Airport 1	Airport 2
1	Cardiff	RAF Valley, Anglesey
2	Glasgow (International)	Barra
3	Glasgow (International)	Campbeltown
4	Glasgow (International)	Tiree
5	Kirkwall	North Ronaldsay
6	Kirkwall	Papa Westray
7	Kirkwall	Eday
8	Kirkwall	Sanday
9	Kirkwall	Stronsay
10	Kirkwall	Westray
11	Oban	Coll
12	Oban	Colonsay
13	Oban	Tiree
14	Coll	Tiree
15	Stornoway	Benbecula
16	Tingwall	Fair Isle
17	Tingwall	Foula
18	Tingwall	Out Skerries

221 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/777681/fom_domestic_aviation.pdf

19	Tingwall	Papa Stour
20	Newquay	London Heathrow
21	Dundee	London Stansted
22	City of Derry	London Stansted

Source – PSO Inventory table list of routes concerned, European Commission (https://ec.europa.eu/transport/modes/air/internal-market/pso_en)

For regional airports, having a link to a major hub, and hence the possibility for onward domestic and global travel, is important. Almost every UK regional airport has flights to one of the major UK hub airports (Birmingham, Manchester, Edinburgh, Glasgow, Aberdeen, Belfast and the London airports), although in 2019 there were no direct flights between Welsh airports and the major English hubs, with interchange needing to take place in Scotland, Northern Ireland, or at an international airport.

C1.4.3 Passenger demand

Excluding the current major demand impacts of the Covid-19 pandemic, UK air passenger numbers have roughly tripled over the last 40 years: 104 million air passengers passed through UK airports in 1990; this had increased to 297 million in 2019.[222]

The majority of flights are taken by a small portion of the population. A 2014 DfT report indicated that 70% of all flights were being taken by only 15% of the population and 52% of the population had not flown at all over the past year (2013).[223]

Most journeys are made for leisure. According to CAA data, in 2019, 81% of air passengers surveyed were travelling for leisure passengers, of leisure travel 64% was domestic based leisure travel.[224]

Domestic travel only accounts for 10% of all air passengers in the UK with the international air market playing a dominating role. However, due to differences in passengers per flight domestic travel accounts for 28% of all Air Traffic Movements (flights) in the UK.[225]

[222] https://commonslibrary.parliament.uk/research-briefings/cbp-8826/
[223] https://www.gov.uk/government/statistics/public-experiences-of-and-attitudes-towards-air-travel-2014
[224] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Consumer-research/Departing-passenger-survey/2019-Passenger-survey-report/

[225] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2019-01/ (Table 5)

Almost all of the UK is connected to the national aviation network. Analysis showed that 97% of the population of the UK is within two hours of an airport offering a direct connection to one or more major destinations on a daily basis.[226]

Domestic passenger numbers

The most popular domestic aviation routes are those that link centres of major populations that would be over several hours in length if undertaken by surface modes. As such, flows between London, and Scottish and Northern Ireland airports dominate the most popular domestic routes (see Figure 128 below). The Manchester – London link is an important route for interlines.

Figure 128 - Top 10 most popular domestic aviation routes 2019

#	Airport 1	Airport 2	Annual passengers (m)
1	London Heathrow	Edinburgh	1.2
2	London Heathrow	Glasgow	0.9
3	London Gatwick	Edinburgh	0.7
4	London Heathrow	Aberdeen	0.7
5	London Heathrow	Belfast (City)	0.7
6	London Gatwick	Glasgow	0.6
7	London Stansted	Edinburgh	0.6
8	London Gatwick	Belfast (International)	0.6
9	London Stansted	Belfast (International)	0.6
10	London Heathrow	Manchester	0.6

Source – CAA Data Table 12.2

Demand is focussed on the major cities, with the leading 5 airports (Heathrow, Gatwick, Manchester, Stansted, Luton) responsible for 68% of passenger trips and the top 20 airports being responsible for 98% of all passenger trips.[227] Lower volume regional routes often provide a 'lifeline' service to more remote locations, as well as linking smaller airports into the global aviation network via one of the major UK hubs.

Figure 129 below shows the annual (bi-directional) passenger number for domestic air travel between the UK nations. Flights across the Scotland-England border dominate the demand for domestic air passenger travel accounting for 50% of all travel, with 7 of the 10 most popular cross-border domestic routes being England ↔ Scotland connections in 2019 (see Figure 130).

226 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/765371/york-regional-connectivity-report.pdf

227 https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2019-01/ (Table 1)

Figure 129 - Annual air passenger numbers between UK countries, 2019 (thousands)

	England	Scotland	Wales	Northern Ireland	Scottish Islands
England	2,278	9,695	13	5,287	4
Scotland		22	137	1,081	597
Wales			0	62	0
Northern Ireland				0	0
Scottish Islands					43

Source – Table 12_2, Civil Aviation Authority Airport Data 2019

The air and ferry routes between Northern Ireland and Great Britain are particularly critical for capacity and resilience, given that the Irish Sea prevents rail or road routes. 75% of all direct passenger trips between Northern Ireland and Great Britain are made by air.

Figure 130 - Most popular cross-border domestic routes in the UK, 2019 (thousands)

Rank	Airport 1	Airport 2	2019 Total Passengers (000s)
1	Heathrow	Edinburgh	1,196
2	Heathrow	Glasgow	865
3	Gatwick	Edinburgh	732
4	Heathrow	Aberdeen	692
5	Heathrow	Belfast City (George Best)	669
6	Gatwick	Glasgow	642
7	Stansted	Edinburgh	619
8	Gatwick	Belfast International	582
9	Stansted	Belfast International	573
10	London City	Edinburgh	513
11	Liverpool (John Lennon)	Belfast International	492
12	Manchester	Belfast International	470
13	Bristol	Edinburgh	397
14	Luton	Belfast International	341
15	Edinburgh	Belfast International	330
16	Bristol	Glasgow	322
17	Luton	Edinburgh	312
18	Glasgow	Belfast International	294
19	Bristol	Belfast International	279
20	Stansted	Glasgow	279

Source – Table 12_2, Civil Aviation Authority Airport Data 2019

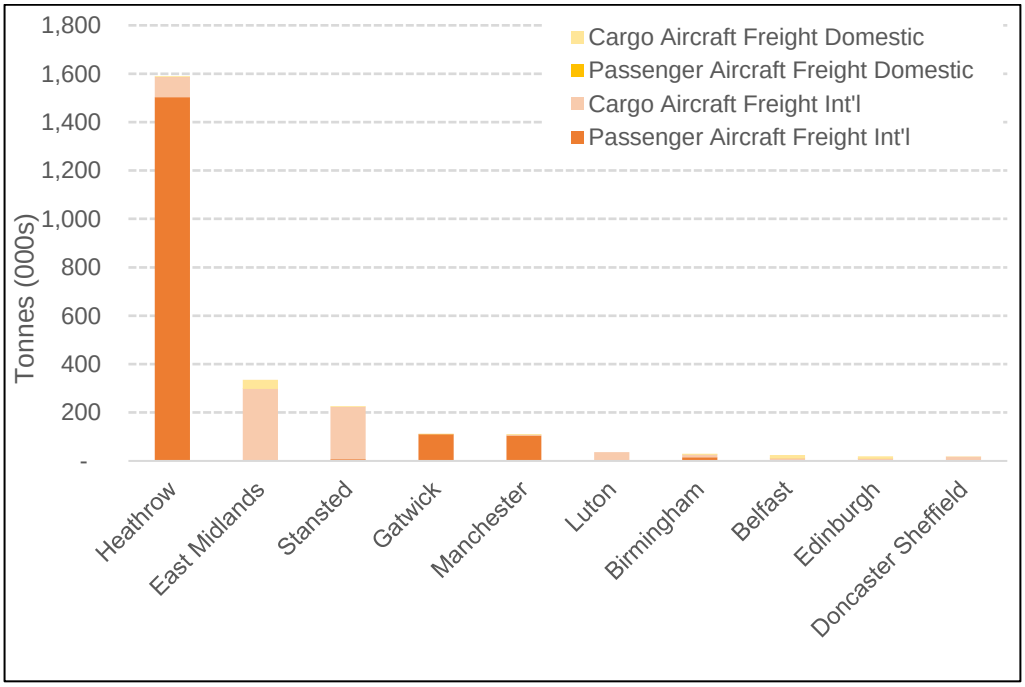
C1.4.4 Freight demand

UK airports handled 2.5 million tonnes of freight in 2019[228], a figure which has increases 9% over the past decade (2010-2019).

Similar to passenger demand freight demand is heavily skewed towards a few key airports in the UK. Heathrow alone, accounts for 63% of all freight tonnes moved through UK airports and together the top 5 airports for freight movement (Heathrow, East Midlands, Stanstead, Gatwick and Manchester) account for 93% of all aviation freight movements in the UK.

Figure 131 below, show the vast majority of freight movements managed by UK airports involve international freight, and the aviation network is not a primary mode for the domestic movement of goods. There is also a distinction between passenger dominated airports like Heathrow, Gatwick and Manchester where most freight movements occur in the 'belly' of passenger aircraft whereas airports like the East Midlands, Stanstead and Luton specialise in freight movements via cargo dedicated aircraft. Air cargo is more valuable, per tonne, than other types of freight, and so Heathrow is the largest air or sea port by value in the United Kingdom.

Figure 131 - Freight demand in tonnes of top 10 UK airports, 2019[229]



Source – Table 14 International and Domestic Freight, Civil Aviation Authority, 2019

Despite the skew of freight towards a limited number of airports based in England, based on researched by Airlines UK, there are significant impacts of air

[228] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2019/ (Table 13)
[229] https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2019/ (Table 14)

freight on GVA in all UK regions, including based on this data an estimated 8.6% of the total GVA of the Welsh economy is dependent on air freight—despite Wales having no major air freight traffic at its airports.230

C1.4.5 Network capacity and the future

The UK government released a green paper *Aviation 2050: The future of UK Aviation* in 2018 outlining an initial draft vision for the future of UK aviation. The final *Aviation 2050* white was anticipated in 2020 but has been delayed due to the ongoing Covid-19 pandemic.[231]

As is outlined in the green paper there are two major categories of influence that are likely to impact future aviation passenger demand: **Network Capacity** and **Socio-Economic Conditions.**

Network Capacity

Apart from the current, temporary, period of dramatic decline in UK aviation (80-90% below 2019 levels)[232], it is anticipated that demand for aviation will continue to rise in the period up to 2050.[233] Based on Pre-Covid central forecasts, without constraints to airport growth, demand is forecast to rise to 355 million by 2030 and 495 million passengers in. When capacity constraints are taken into consideration, and no new runways are added, national demand is forecast to rise to 315 million by 2030 and 410 million passengers in 2050. This means aviation demand is anticipated to grow between 35 and 65 percent above todays levels by 2050.[234] While the forecasts are less specific it is anticipated that Air Freight will also continue to grow steadily over the period through 2050.

230 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769696/aviation-2050-print.pdf

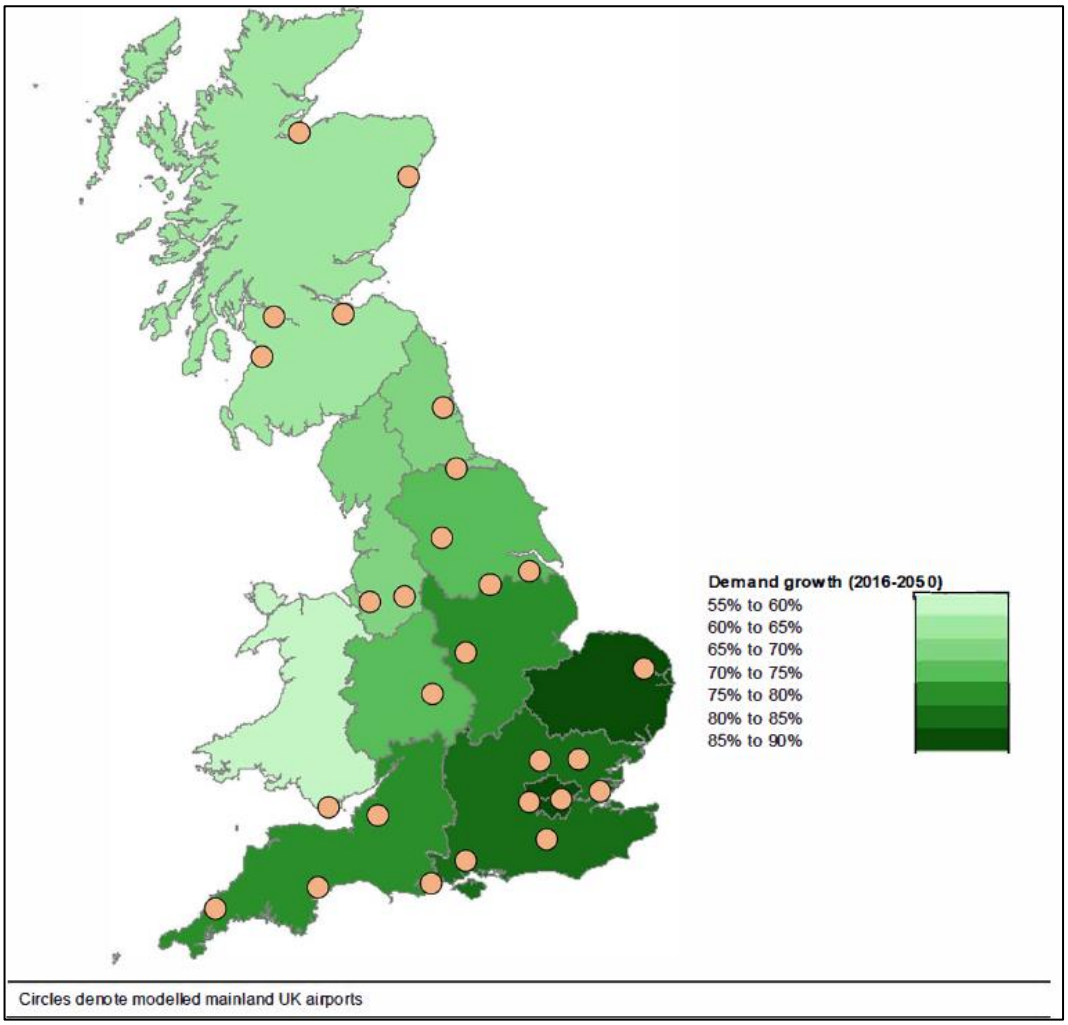
231 https://commonslibrary.parliament.uk/research-briefings/cbp-8826/

232 https://commonslibrary.parliament.uk/research-briefings/cbp-8739/

233 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/769696/aviation-2050-print.pdf

234 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878705/uk-aviation-forecasts-2017.pdf

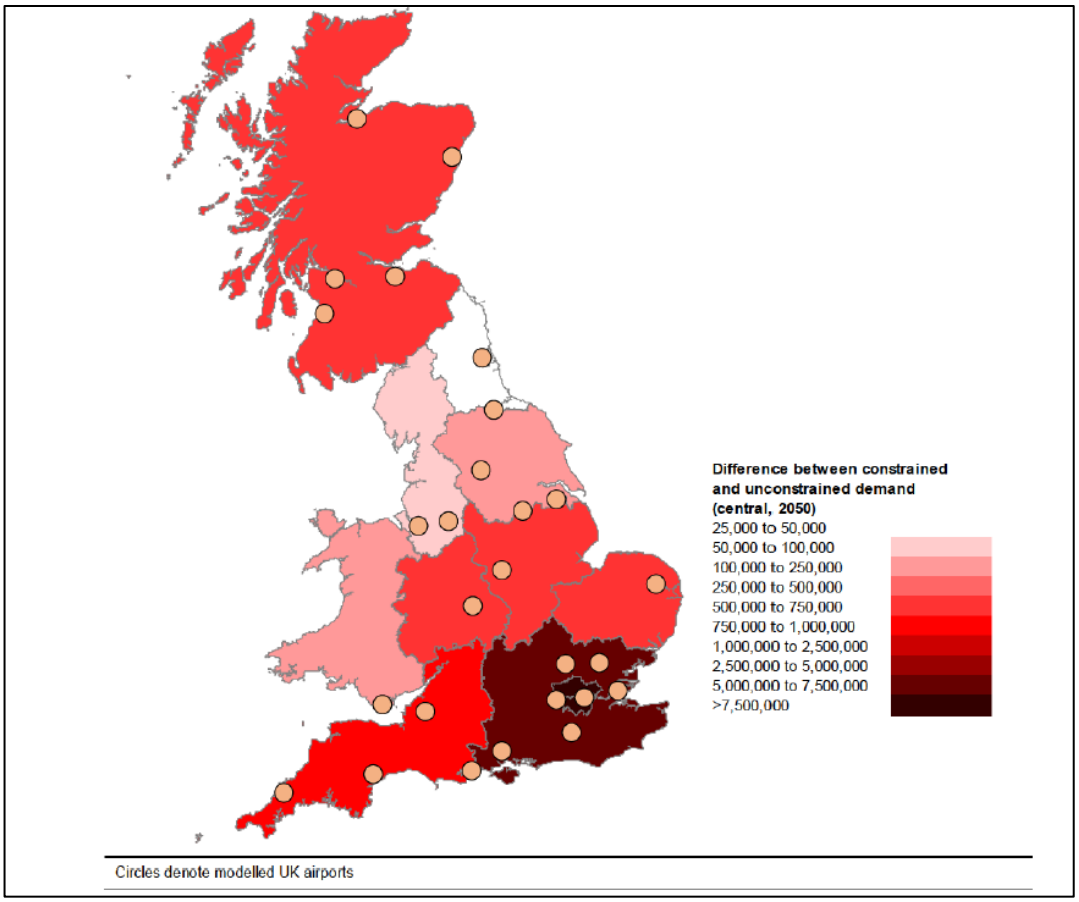
Figure 132 - Forecast unconstrained demand growth in UK air passengers, 2016-2050[235]



Source – DfT (2017) UK Aviation Forecasts (page 93)

[235] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878705/uk-aviation-forecasts-2017.pdf

Figure 133 – Difference in aviation passenger demand between constrained and unconstrained scenarios in 2050[236]



Source – DfT (2017) UK Aviation Forecasts (page 99)

As is alluded to in the figures above, the anticipated growth in demand is expected to put extensive pressure on existing aviation infrastructure, in the South East of England in particular. The UK government has accepted the findings of the Independent Airports Commission the there is a need to increase capacity through a new runway in the South East.[237] A new runway would not only significantly increase air passenger capacity across the UK but also air freight capacity as well.

The distribution of demand between international and domestic air passengers passing through UK airports is anticipated to stay relatively consistent through 2050, with 10-15% of UK air passengers making domestic journeys. Leisure travel is also forecast to continue to be the primary journey purpose for approximately 70% of all air passenger trips in the UK through 2050.

236 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878705/uk-aviation-forecasts-2017.pdf

237 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/878705/uk-aviation-forecasts-2017.pdf

Socio-Economic Conditions

While the UK government draft report *Aviation 2050* acknowledged the important need to alleviate network capacity constraints in South East England, it also emphasised the important responsibility it places on the UK aviation sector to grow in a sustainable manner, taking a more ambitious stand on environmental protection in particular.

Furthermore, air traffic is driven by the overall economic strength of the UK as well as the global economy. With historical air passenger demand following trends in global economic performance. With the opportunities presented to increase future trade and global connectivity in a new era for Global Britain during the post-pandemic recovery. Broader economic performance is likely to have a big impact on the future of aviation demand.

At a regional and local level airports and aviation connectivity can play a vital role, providing connectivity to a national and international market as well as direct, indirect, and induced employment opportunities. The UK government acknowledges in *Aviation 2050* that supporting local and regional airports can support a more geographically balanced economy that enables levelling up in all regions of the UK. There is a desire to further enhance the connectivity of the regional aviation network by increasing the role regional airports play as Public Transport hubs providing better interconnectivity between modes to enable connectivity and economic opportunity.

To support crucial connectivity in more remote areas of the UK the government outlines in *Aviation 2050* a commitment to expand the scope of PSOs to support more routes which connect into regional airports like Manchester and Edinburgh.

Appendix D

RAG Rankings Rationale

D1 Extended road 'long-list'

Road	Issues identified / areas for improvement	Relevant Planned Schemes	Include / reason for exclusion
M1, Northern Ireland	- Poor connectivity on the M1/A1 in Northern Ireland on the Belfast-Dublin route. Slip roads to exit the M1, followed by a slow section before the reaching the dual carriageway part of the A1 - This route provides for 20% of all freight demand between Great Britain and Northern Ireland	- Possible scheme but not committed - M1/A1 flyover	**Include**
A1, Northern Ireland	-Poor connectivity on the M1/A1 in Northern Ireland on the Belfast-Dublin route. Slip roads to exit the M1, followed by a slow section before the reaching the dual carriageway part of the A1 - This route provides for 20% of all freight demand between Great Britain and Northern Ireland - Safety concerns, journey time reliability issues in Belfast-Dublin corridor	- DfI NI Priority scheme A1 road, Newry Southern Relief Road - A1 Junctions Phase 2 construction to begin 2023 - A1-A2 Newry Southern Relief Road / Bypass Construction 2025-27	Committed scheme
A6, Northern Ireland	- A6 single carriageway, some congestion (google maps) on sections through urban areas	- Priority scheme in NDNA 2020 - A6 dualling under construction (M22 to Castledawson & Dungiven to Derry/Londonderry	Committed scheme
A9, Scotland	- Large sections of single carriageway north of Perth - driver frustration (including rapid changes from DC to SC - safety issues)	- A9 dualling Perth to Inverness - completion in 2025	Committed scheme
M6, England	- Congestion - HE CfE response, generally in NW region could affect longer distance freight movements. Forecast to worsen (NTM outputs) - Congestion north of	- Committed for RP2: M54/M6 Link Road	Committed scheme

	Birmingham. J10-16 - Prone to congestion and accidents between Birmingham and Greater Manchester		
A1, Scotland / England	- Single carriageway sections between Ellingham and Edinburgh, issues during maintenance or accidents leading to journey time variability - Non-continuous motorway designation causing safety issues on this route	- Committed for RP2- A1 Morpeth to Ellingham dualling; A1 Birtley to Coal House route widening to dual-three lanes (both south of issues identified) - Strategic study (not committed): Dualling the A1 to Scotland	**Include**
A66, England	- Single carriageway sections, insufficient capacity to form an alternative route between A1 / A1(M) and M6. - A66 is also prone to accidents, and can experience severe weather conditions in winter - High levels of HGV demand	- Committed for RP2 - A66 Northern Trans Pennine dualling	Committed scheme
A69, England	- Single carriageway sections with high volumes of HGV demand (18% of overall traffic on weekdays), insufficient capacity to form an alternative route between A1/A1(M) and M6 for network resilience. insufficient capacity to form alternative route between A1 / A1(M) and M6.	- Committed for RP2 - A66 Northern Trans Pennine dualling	**Include**
A75, Scotland	- Single carriageway routes with high HGV flows - resilience issues - HGVs limited to 40mph on single carriageway roads, particularly an issue for disembarkation when HGVs are released in waves - Carries two-thirds of Cairnryan freight traffic		**Include**
A77, Scotland	- Single carriageway routes with high HGV flows - resilience issues	- Maybole Bypass construction began 2019	**Include**

	- HGVs limited to 40mph on single carriageway roads, particularly an issue for disembarkation when HGVs are released in waves - Carries one-third of Cairnryan freight traffic		
M62, England	- Only motorway standard east-west route in north of England - Carries half of all Trans-Pennine traffic including the majority of road freight - set to increase by 23% by 2050 - Capacity issues	- Strategic study (not committed) - Trans-Pennine tunnel study between Manchester and Sheffield, Central Pennines study	**Include**
M56, England	- Congestion on sections towards Manchester	- Committed for RP2 - M56 J6-8 Smart Motorway	Committed scheme
A55, Wales	- Key for freight connectivity, high HGV flows for port access through to Northern Ireland via the Republic of Ireland - Seasonal congestion effects - Britannia Bridge is the only section that is not dual carriageway - Congestion on approaches to urban areas	- Welsh Gov Planned: A55 3rd Menai Crossing - A55 Flintshire Corridor Scheme (WelTAG Stage 3) - European funding for J14-16, expected to open 2023 (https://a55engagement.gov.wales/overview.html) *Note freeze on all new road building schemes in Wales announced 22nd June 2021*	Committed scheme
A49, England	- High levels of delays, single carriageway. High demand for HGVs		Regional network connection
A5, England	- High HGV demand, delays		Regional network connection
A483/A493, Wales	- High levels of congestion in 2015 on A483 with sections between Oswestry and Wrexham showing >100% V/C - A458 delays	- Pipeline for RIS3 - A483 Pant Bypass - Welsh Gov Planned: A483 and A489 Newtown bypass *Note freeze on all new road building schemes in*	Regional network connection

		Wales announced 22nd June 2021	
A470, Wales	- Congestion between Cardiff and Pontypridd - connects North, Mid and South Wales	*Note freeze on all new road building schemes in Wales announced 22nd June 2021*	Neither on UKNET or regional network connection
M4, Wales / England	-Significant increase in flows on the M4 expected between 2015 and 2041. The Severn Crossing tolls were removed in December 2018 resulting in an increase in cross-border flows between England and Wales. -Severe congestion is already apparent on this corridor, with congestion in the most severely affected locations extending for at least 3.5 miles	- RIS3 Pipeline - Severn Resilience Package - Strategic study (not committed) - SE Wales Transport Commission to develop alternative for M4 traffic	**Include**
A30, England	- seasonal congestion, particularly on single carriageway sections (including Friday evenings, school holidays, public holidays) - bottlenecks and safety issues in Cornwall	- Chiverton to Carland Cross due to open - Committed A303 / A358 improvements likely to reduce strain on Ilminster to Honiton section of the A30	Committed scheme
A303, England	- seasonal congestion, particularly on single carriageway sections (including Friday evenings, school holidays, public holidays) - some safety issues with at grade junctions on this corridor	- A303 Expressway: Committed schemes=A358 Taunton to Southfields; A303 Sparkford to Ilchester; A303 Amesbury to Berwick Down (Stonehenge) - A303 Expressway: RIS3 Pipeline schemes for the A303 Phase 2	UK Government commitment to create Expressway. Committed schemes to achieve part of this
A2, England	- Sections of the corridor with at-grade junctions cause delays / safety issues - Key route for resilience for Dover Port Access and onward international connections	- Pipeline for RIS3: A2 Dover Access	**Include**

M25, England	- M25 SWQ - 12-hour peak 6-6 with severe congestion throughout - Section of road with the highest delays on the SRN in England - provides connectivity for freight connectivity to Heathrow and Southampton ports	- Methods to reduce pressures, provide parallel capacity. (Alternatives to travel, more sustainable modes, potential capacity elsewhere) Multiple solutions likely to be required https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/600047/m25-south-west-quadrant-strategic-study-stage-3.pdf - Smart Motorway J10-16, subject to SMP review	**Include**
M25, England	- Capacity issues at Dartford Crossing, one of the least reliable sections of the UK strategic road network -provides freight connectivity for ports in the South East	- Committed for RP2: Lower Thames Crossing	Committed scheme

D2 RAG Rankings Rationale

Note that this excludes the Environmental RAG Assessment, which is detailed separately in Appendix E.

A. West Coast Mainline North of Crewe

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	The West Coast corridor is of primary importance for travel between England and Scotland, both for freight and passengers. It is also a key artery for travel across the UK and so has secondary benefits for Wales and Northern Ireland.
	Transport improvement	Would improve journey times between key Scottish and English city pairings, better connecting Edinburgh, Glasgow, London, Birmingham, Manchester, Liverpool and many others. Network Rail are studying the possibility for an eventual 3-hour London-Glasgow journey time. Capacity improvements would enable more freight to run through the corridor, greater passenger frequencies and a greater range of services and stopping patterns. This would be a major improvement to connectivity.
Economic growth and recovery	**Increase productivity**	Essential freight corridor, playing a critical role in trade between England and Scotland, as well as linking Scottish freight to international markets. Major freight growth expected over the next 25 years. Significant volume of business travel between England and Scotland along the corridor, and potential for many of those who currently use aviation to switch to rail, with improved journey times.
	Secure inward investment	Access to international flights at Manchester Airport will be significantly improved to/from Scotland and the very north of England. The West Coast Mainline is an important rail artery for international freight movements (through onward connections eg. to Felixstowe). On the London-Scotland routes, mode shift from aviation is more likely to come from point-to-point demand, rather than interlining demand (see aviation commentary). Therefore, it is unlikely that this intervention will have a major impact on rail travel from Scotland to Heathrow - domestic aviation will still be preferable for most on this route.
Economic and social inequalities	**Deliver inclusive growth**	There are concentrations of above average deprivation around Manchester, Carlisle and Glasgow. This intervention would help to 'level-up' connections in the North of England and into Scotland.
Quality of life	**Enhance accessibility**	The focus here is on long-distance intercity connectivity; the employment and leisure catchment areas of urban centres along the route may increase somewhat depending on the eventual service offering and stopping patterns.

	Connections to isolated areas	Glasgow and Edinburgh cannot be considered separated or isolated areas, but they are a long distance from most major cities in England. This intervention will enable families and friends spread across England and Scotland to visit one another more conveniently. The eventual stopping and service pattern will determine how significant the benefits are to more separated communities along the line, such as Carlisle.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

B. Glasgow - Leeds/Sheffield

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	New cross-border route between Glasgow and Leeds/Sheffield
	Transport improvement	There is potential for the journey time to be slightly faster as compared with the route via the East Coast Main Line. There would also be released track capacity on the East Coast Mainline if some or all Leeds-Scotland services used the Settle and Carlisle Line.
Economic growth and recovery	**Increase productivity**	Agglomeration not relevant since this is focused on long-distance England-Scotland travel. Improved resilience and potentially slightly improved journey time for business trips. Benefits to freight are on the East Coast Mainline, where more services can run if passenger demand is diverted elsewhere.
	Secure inward investment	There are convenient international airports available for both Leeds and Glasgow, so there is no need to travel between the two for international travel.
Economic and social inequalities	**Deliver inclusive growth**	Improved connectivity for areas of concentrated above average deprivation around Leeds, Sheffield and Carlisle. Glasgow is also a beneficiary and has concentrated areas of above average deprivation.
Quality of life	**Enhance accessibility**	Focus is on long-distance England-Scotland services, so increase in catchment areas would be limited. Running new long-distance services over the Settle and Carlisle Line is likely to reduce the number of stopping services that can be run. This could reduce access to opportunities for those located on the Settle-Carlisle line.
	Connections to isolated areas	As above, the separated areas along the Settle and Carlisle Line may become less connected (to communities in Northern cities and beyond) if stopping services have to be removed to make way for Leeds-Glasgow services.

Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

C. Carlisle - Edinburgh

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Would add a new cross-border rail link between England and Scotland, although Carlisle is already connected to Glasgow (and Edinburgh) via the West Coast Mainline.
	Transport improvement	Benefit is primarily resilience. The journey time would not be as fast as on the West Coast Main Line but would provide an important diversionary route if there were a problem.
Economic growth and recovery	**Increase productivity**	While business trips will not become any faster, reliability of transport connectivity is important to business. Diversion of some passengers to the Borders Railway could allow more freight services to operate on the West Coast Mainline.
	Secure inward investment	Improved resilience of trips to/from Edinburgh's international sea and air ports, but no significant connectivity improvement.
Economic and social inequalities	**Deliver inclusive growth**	The route of the (extended) Borders Railway better links Carlisle, which is a concentrated area of above average deprivation. The remainder of the line does not have concentrated areas of above average deprivation.
Quality of life	**Enhance accessibility**	Potential for a very slight increase in catchment of Carlisle into Scotland, but this is a negligible benefit with low population densities on the route and Carlisle not being a major employment centre.
	Connections to isolated areas	Isolated towns near the Scottish border and on the way to Edinburgh will benefit from improved connectivity to Carlisle and onward connectivity through the West Coast Mainline. Will better connect these communities both within Scotland and cross border.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

D. A1 Improvements

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Improved connectivity and reliability along the East Coast corridor. Route predominantly used for commuting for journeys under 50km between Berwick-upon-Tweed and smaller settlements along the corridor to the north of the border.
	Transport improvement	Additional resilience in parallel route to M6/A74(M)/M74 between England and Scotland Safety improvements Small time savings due to increased reliability and ability to overtake HGVs and agricultural vehicles (relatively high proportions of HGVs on route)
Economic growth and recovery	**Increase productivity**	Likely to improve journey times and reliability on this corridor. Some evidence that this may improve access to Tyne and Wear Urban Area at the southern end resulting in some agglomeration impacts
	Secure inward investment	May bring a slight improvement in connectivity to Edinburgh airport and seaport
Economic and social inequalities	**Deliver inclusive growth**	A1 runs through areas where there are higher than average levels of deprivation - particularly the north-east of England where there are concentrated areas of above average deprivation
Quality of life	**Enhance accessibility**	Likely to facilitate delivery of planned housing and employment growth across Northumberland Section 4.3 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/408648/a1-north-newcastle-stage-3-report.pdf
	Connections to isolated areas	Improvement in transport provision within Scottish Borders regions in addition to long distance journeys
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Neutral impact. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

E. East Coast Mainline North of Northallerton

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	The East Coast corridor is of primary importance for travel between England and Scotland, for freight and passengers.
	Transport improvement	Alleviating infrastructure capacity bottlenecks would enable more frequent and reliable services, which would offer time savings on a number of OD routes. The line passes through a

		number of key UK cities and large populations. This is a key artery for onward journeys, so capacity improvements and consequent time savings will have knock-on impacts for other locations on the strategic network.
Economic growth and recovery	**Increase productivity**	Significant volume of business travel and freight transport between England and Scotland along the corridor; potential for some business passengers who currently use aviation to switch to rail, however the scope for reductions in journey time is not so large compared to the West Coast Mainline (with HS2). No major agglomeration benefits since this is focused on long-distance England-Scotland travel.
	Secure inward investment	Improves freight connectivity to international ports (Humber, Felixstowe) to/from Scotland. Freight volumes on the corridor are predicted to rise significantly over the next 30 years, so this will become increasingly important.
Economic and social inequalities	**Deliver inclusive growth**	Brings benefits to the North-East of England, where there are concentrated areas of above average deprivation. This would be an effective way of capitalising on the benefits of HS2 and NPR to level-up connections in the North of England and Scotland.
Quality of life	**Enhance accessibility**	Focus is on long-distance connectivity, so catchment areas unlikely to increase significantly. Potential for slight increase in catchments of Newcastle and Edinburgh if there is infrastructure capacity allows for more frequent services.
	Connections to isolated areas	While isolated areas are not the primary beneficiaries, more services and paths on the East Coast Mainline will enable for families and friends spread across England and Scotland to visit one another more conveniently.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

F. A69 Capacity

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Improved east-west connectivity in England between the A1(M) and M6, in addition to secondary benefits for connectivity between England and Scotland, particularly for freight access. Improved reliability for this corridor and both the A1(M) and M6 providing resilience for long distance movements between England and Scotland
	Transport improvement	Enables network resilience in the event of incidents on the A1 or M6 Small time savings due to increased reliability

Economic growth and recovery	**Increase productivity**	Likely to improve journey times and reliability on this section, particularly for HGV demand. Increased reliability and ability to overtake HGVs on single carriageway sections
	Secure inward investment	May provide some improved resilience for access to Cairnryan, but otherwise does not directly connect international gateways
Economic and social inequalities	**Deliver inclusive growth**	There are some areas with above average deprivation along the route which may benefit from this intervention
Quality of life	**Enhance accessibility**	The A69 runs between Newcastle and Carlisle, and as such will improve access to these urban centres for communities along the route
	Connections to isolated areas	These areas are not considered separated and isolated in this context
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Neutral impact. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

G. A75 Capacity

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Important cross border connection between Southern Scotland / England and Northern Ireland via Cairnryan. Particularly for freight access. Two-thirds of freight traffic for Cairnryan is via the A75 (one-third via A77).
	Transport improvement	Time savings due to increased reliability and ability to overtake HGVs (relatively high proportions of HGVs on route, with HGVs limited to 40mph on single carriageways) Enables network resilience in the event of incidents on the A75
Economic growth and recovery	**Increase productivity**	Improved travel times on this section due to ability to overtake slow moving traffic. Significant volume of freight trips will benefit from intervention. Improved access to Dumfries, a key employment centre may provide some agglomeration benefits
	Secure inward investment	Improved access to Cairnryan for both freight and passengers to/from Northern Ireland
Economic and social inequalities	**Deliver inclusive growth**	There are concentrations of above average deprivation levels along the route which will benefit from improvements on the A75 with faster journey times and the potential for better connectivity to Dumfries, in addition to the freight benefits
Quality of life	**Enhance accessibility**	Some improved access to Dumfries for employment opportunities

	Connections to isolated areas	Improvement in transport provision within Scottish Borders regions in addition to long distance journeys
Technological innovation	Embraces emerging technologies	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Neutral impact. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	Value for money	Estimate based on available costs and judgements about changes in demand patterns and travel times.

H. A77 Capacity

Objective	Criteria	Rationale
Transport provision across the Union	Connecting the Union	Important cross border connection between Scotland (especially Glasgow) and Northern Ireland via Cairnryan. Particularly for freight access. One-third of freight traffic for Cairnryan is via the A77 (two-thirds via A75)
	Transport improvement	Time savings due to increased reliability and ability to overtake HGVs (relatively high proportions of HGVs on route, with HGVs limited to 40mph on single carriageways) Enables network resilience in the event of incidents on the A77
Economic growth and recovery	Increase productivity	Improved travel times on this section due to ability to overtake slow moving traffic. Significant volume of freight trips will benefit from intervention. Limited agglomeration benefits likely
	Secure inward investment	Improved access to Cairnryan for both freight and passengers to/from Northern Ireland
Economic and social inequalities	Deliver inclusive growth	Above average deprivation levels close to Cairnryan, but primary beneficiaries are for freight
Quality of life	Enhance accessibility	Unlikely to provide much increase in catchments for urban areas, although there may be some local benefits
	Connections to isolated areas	Improvement in transport provision within Scottish Borders regions in addition to long distance journeys
Technological innovation	Embraces emerging technologies	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Neutral impact. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	Value for money	Estimate based on available costs and judgements about changes in demand patterns and travel times.

I. Stranraer - Dumfries

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	With a Fixed Link, re-opening this line would connect Northern Ireland to the West Coast Mainline by rail. England, Scotland, and Northern Ireland would all benefit significantly, with lesser benefits for Wales
	Transport improvement	Trips that were previously not feasible by rail would become possible and attractive, including both passenger and freight trips between Northern Ireland and GB. Connecting Northern Ireland to the West Coast Mainline is particularly valuable given the major cities served by this line, most notably London. The Fixed Link Technical Advisors have been investigating the potential for a 4-hour rail journey time between Belfast and London with a Fixed Link.
Economic growth and recovery	**Increase productivity**	If the line were fully equipped for freight, much of the freight that currently travels by air or sea could be transported by rail using this line. Some business trips between NI and major English and Welsh cities may switch from air to use this line, depending on the journey time differential.
	Secure inward investment	Improvement in through connectivity to the Republic of Ireland from Scotland.
Economic and social inequalities	**Deliver inclusive growth**	There is a high concentration of above average deprivation around Belfast, but not along the line in Scotland.
Quality of life	**Enhance accessibility**	The employment catchment of Belfast is unlikely to grow significantly since the population density along the line at the west coast of Scotland is low. Increase in leisure and tourist travel to NI from Scotland and the rest of GB.
	Connections to isolated areas	This line connects separated areas in the south-west of Scotland. It would also build on the Fixed Link to reduce the geographic separation between Northern Ireland and the rest of the UK.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted. With a new line, there is the possibility to embrace technology in construction which does not exist for other interventions where the infrastructure is already built.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

J. Trans-Pennine Corridor

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Benefits concentrated primarily within England, as this intervention is not cross-border. However east-west journeys to/from North Wales may also benefit from the improved connectivity, along with road freight access in this corridor
	Transport improvement	Journey time savings of up to 30 minutes between Manchester and Sheffield / improved reliability Provides alternative route to the M62 for resilience in east-west connectivity in the north of England
Economic growth and recovery	**Increase productivity**	Some agglomeration benefits expected. Improved journey times and capacities between northern English cities (up to 30 minutes between Manchester and Sheffield). Improved east-west connectivity for long distance freight trips reducing the pressure on the M62 as the key east west motorway in this part of the UK
	Secure inward investment	Improved freight connectivity to international gateways - including potential for improved access to Manchester Airport
Economic and social inequalities	**Deliver inclusive growth**	Route connects areas with concentrations of above average deprivation and lower incomes, relative to England as a whole, however this route is likely to benefit longer distance movements in particular between M1 and Manchester/M6. Improved connections will help stimulate inward investment in these areas driving growth in employment opportunities
Quality of life	**Enhance accessibility**	Catchment areas for urban areas may grow dependent on option and alignment, so businesses can access a wider pool of talent and commuting flows will rise, along with improved access to leisure opportunities
	Connections to isolated areas	Communities in this region are geographically close to one another, so cannot be considered isolated.
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Neutral impact. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

K. Rail Connections Between Northern English cities

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Benefits will be concentrated primarily within England, as this intervention is not cross-border. However, east-west journeys to/from North Wales will also gain from the

		improved connectivity, as will flows between the North of England and Scotland via Newcastle.
	Transport improvement	The improvements to frequencies, journey times and connectivity cited by NPR go well beyond 10% improvement. For example, NPR suggest that a 40-minute Manchester-Sheffield journey time is achievable, down from 49 minutes as the best current journey time. NPR suggest that similar improvements are possible between several OD pairs. This, or similar interventions, will benefit several large cities and release freight capacity. This would clearly be a major improvement to transport connectivity.
Economic growth and recovery	**Increase productivity**	Significant agglomeration benefits. Better journey times, frequencies and capacity will enable Northern cities to better exchange business, resources and talent, working as a cohesive whole rather than separate entities.
	Secure inward investment	Improved connectivity to proposed freeports in Liverpool, Humber and Teesside, which handle international freight. There will also be better connectivity to international flights at Manchester Airport, though this is contingent on full delivery of HS2 and better connectivity between Manchester Airport and the city centre.
Economic and social inequalities	**Deliver inclusive growth**	Communities living within a 5km area around the stations served by the proposed Northern Powerhouse Rail improvements tend to have higher proportions of people on lower incomes, and contain a higher proportion of deprived areas, relative to the rest of the North, and England as a whole. Better connections will help to stimulate inward investment around those stations and their hinterlands, driving jobs and skills growth.
Quality of life	**Enhance accessibility**	Catchment areas for Northern cities will grow, so that businesses have access to a wider pool of talent, and commuting flows between cities will rise. Leisure opportunities will also grow, both for those in cities wishing to 'escape the city' to more scenic regions of the North, and for those outside city-centres wishing to access concentrations of hospitality and culture.
	Connections to isolated areas	Communities in the North are geographically close to one another, so cannot be considered isolated. However, the poor rail infrastructure prevents the social cohesion and community that could exist across the North
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted. New lines are proposed, so there is the possibility to embrace technology in construction which does not exist for other interventions where the infrastructure is already built.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.

Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

L. North Wales Coast Line

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	The improvement serves a key cross-border corridor between Wales and England (serving flows between Manchester, Liverpool and Holyhead). The corridor is also important for passengers (and a small volume of freight) travelling to the Island of Ireland through Holyhead; some of this flow will continue through the Republic of Ireland to Northern Ireland.
	Transport improvement	Would bring significant connectivity improvements for communities on the North Wales coast - greater infrastructure capacity would enable more fast services to run from Holyhead, and line speed improvements would further improve journey times. This would capitalise and build on the benefits of HS2 for North Wales. However, the flow volumes are not large enough to warrant a Green ranking, and there is minimal rail freight on the route.
Economic growth and recovery	**Increase productivity**	Business trip volumes are low, with some using the line as a through-route to Dublin. Freight volumes are very low also, though there is appetite for the corridor to be better utilised for freight in future. Agglomeration benefits may exist, particularly in the single economic geography around the England-Wales border, however the population and employment densities are not worthy of a green ranking.
	Secure inward investment	Improved line speeds will enable faster journeys to access international flights at Manchester airport for communities all along the North Wales coast. Improved capacity at Chester Station could also enable more frequent airport services. Holyhead-Dublin is an important passenger and freight route; better rail connectivity to Holyhead will improve access to this international gateway.
Economic and social inequalities	**Deliver inclusive growth**	High concentrations of above average deprivation along the North Wales coast. Connecting these communities better to the North of England and to HS2 could bring major benefits for these areas.
Quality of life	**Enhance accessibility**	The catchment areas of Wrexham, Chester and (to a lesser extent) Liverpool will grow, as will the catchment for the smaller towns along the North Wales coast. Improved infrastructure capacity, particularly at Chester Station, will allow greater frequencies.
	Connections to isolated areas	Improved infrastructure capacity, particularly at Chester Station, will allow for more stopping services and will better enable those in more isolated towns and communities along the line to see friends and relatives elsewhere in North Wales. This intervention will also enable families and friends spread across England and Wales to visit one another more conveniently.

Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

M. Cardiff - Midlands / Yorkshire & NE

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	This is a significant cross-border freight and passenger route. Cardiff is the 'worst rail connected major city in the UK in respect of direct services to other major UK cities' according to Transport for Wales. The intervention would connect Cardiff and the rest of South Wales better into the benefits of HS2 and improve access to the Welsh capital from the midlands, north-east of England and Scotland.
	Transport improvement	The intervention would however connect Cardiff and the rest of South Wales better into the benefits of HS2 and improve access to the Welsh capital from the midlands and north-east of England. Given the range of ambition of the potential solutions, it is difficult to conclude as to the extent of benefit. Give that demand is not large (a contributor to the existing low investment in the service along the corridor), an Amber score was awarded.
Economic growth and recovery	**Increase productivity**	This improvement could increase the business prominence of Cardiff and grow business travel between Cardiff and major English cities in the Midlands and North-East. The distances involved are too far for meaningful agglomeration benefits. Freight volumes are significant but not large, with a comparable number of daily services to the flow into Wales via the Great Western Mainline.
	Secure inward investment	Some benefit from better connecting Cardiff to international flights at Birmingham Airport, but most would still choose to travel to Cardiff, Bristol or London airports.
Economic and social inequalities	**Deliver inclusive growth**	Birmingham and Cardiff both have concentrations of above average deprivation in their vicinity.
Quality of life	**Enhance accessibility**	Depending on the number and pattern of stopping services, there could be slight improvements to catchment of Cardiff by connecting better to Gloucester and Cheltenham.
	Connections to isolated areas	Better connections from Cardiff to the Midlands and HS2 is very important for connecting South Wales to family and friends in the North of England and Scotland. However, the areas along the route are not isolated.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.

	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

N. Severn Resilience

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Improved connectivity across the Severn as a result of relieving congestion on the eastern side of the crossings following removal of the tolls Important cross-border connection between England and Wales, connecting the densest populations in Wales.
	Transport improvement	The primary benefit is to relieve congestion on the M4 and improving journey times.
Economic growth and recovery	**Increase productivity**	Reduction in traffic to the east of the M4 expected to improve journey times in the area. There are significant commuting and business trips into Bristol which would benefit from the intervention Improved access to labour market leading to likely agglomeration benefits
	Secure inward investment	Improvements to connectivity to Cardiff and Bristol airports for communities along the route. Bristol Airport is better connected internationally than Cardiff Airport, so there is significant flow from Cardiff to Bristol for international flights
Economic and social inequalities	**Deliver inclusive growth**	Some areas with above average deprivation may benefit from the improvement, through better access to Bristol east of the M4
Quality of life	**Enhance accessibility**	Some improvement to local accessibility of the employment and leisure opportunities and boost cohesion in the region.
	Connections to isolated areas	Cardiff and Bristol are not isolated regions
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Neutral impact. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

O. Bristol – Cardiff (Rail-Led Solution)

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Very important cross-border connection between England and Wales, particularly because it connects into the Welsh capital and most dense populations in Wales.
	Transport improvement	Primarily, the benefit is to relieve congestion on the M4, solving a problem on the road network. However, additional rail benefits would come through increased frequencies and the servicing of new stations under the 'network of alternatives' suggested by the South East Wales Transport Commission.
Economic growth and recovery	**Increase productivity**	Significant commuting and business journeys within the single economic region. This cross-border route is more important for freight than the single economic region at the north of the England-Wales border.
	Secure inward investment	Improvements in capacity, resulting better frequencies and the servicing of new stations would improve connectivity to Cardiff and Bristol airports for communities along the route. Bristol Airport is better connected internationally than Cardiff airport, so there is a significant flow from Cardiff to Bristol for international flights.
Economic and social inequalities	**Deliver inclusive growth**	There are some concentrated areas of above average deprivation along the route.
Quality of life	**Enhance accessibility**	If the new station infrastructure and recommendations of the South East Wales Transport Commission are implemented, there will be significant improvement to local trips along the corridor. This will improve the accessibility of the employment and leisure opportunities and boost cohesion in the region
	Connections to isolated areas	Cardiff and Bristol are not isolated regions - there is strong onward connectivity to London through the Great Western Mainline and M4.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

P. South Wales Mainline West of Cardiff

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	The improvement area (west of Cardiff) is solely within Wales, but the South Wales Mainline serves a key cross-border corridor between Wales and England (serving flows between London, Bristol, Cardiff, Swansea and Milford Haven). Note that the shorter distance cross-border flows on

		the line between Bristol and Cardiff, are considered in a separate improvement.
	Transport improvement	Improvements to line speed and alleviation of capacity bottlenecks would improve journey times to/from the south-west of Wales, particularly trips to/from Swansea and the port of Milford Haven. Preventing the need for a change at Cardiff would improve both convenience and journey time. However, these flows are relatively small since population volumes along the route are comparably low, and Milford Haven is focused on liquid bulk freight, reducing the importance of rail links.
Economic growth and recovery	**Increase productivity**	Small volume of business trips along the route between Swansea and Cardiff/Newport/Bristol. Significant volume of rail freight to Swansea, but not further along the line.
	Secure inward investment	Improvement in passenger connectivity to Milford Haven and Fishguard, which have low volume sea routes to the Republic of Ireland. Milford Haven is the third largest UK port by total (domestic and international) freight tonnage, but as noted above this is overwhelmingly liquid bulk freight which is not dependent on rail links. Somewhat improved connectivity for the south-west of Wales to international flights at Bristol and London Airports, particularly if combined with Western Rail Link to Heathrow.
Economic and social inequalities	**Deliver inclusive growth**	There are some concentrated areas of above average deprivation along the south coast of Wales, particularly around Swansea.
Quality of life	**Enhance accessibility**	The catchment areas of Cardiff and Swansea will increase, with the potential for more employees to travel between the two. Alleviating infrastructure capacity bottlenecks would enable more services (including stopping services) and would enable those populations away from these urban centres to access opportunities in the cities, however the volumes are low owing to low population densities along the line.
	Connections to isolated areas	Alleviating infrastructure capacity bottlenecks would enable more stopping services and allow those in more isolated towns and communities along the line to see friends and relatives elsewhere in South Wales. This intervention will also enable families and friends spread across England and Wales to visit one another more conveniently.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

Q. Western Access to Heathrow

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Important improvement for connecting south Wales to Heathrow Airport.
	Transport improvement	Major journey time improvement for those in Wales accessing Heathrow, who previously would have had to travel in and out of London.
Economic growth and recovery	**Increase productivity**	Access to international hub airports is important for business trips. The volume of business trips to/from Heathrow is large and an increased volume of these will come from Cardiff and south Wales with this intervention.
	Secure inward investment	Heathrow Airport is probably the most important international gateway in the country, so improving access to the west will make international journeys more convenient for many.
Economic and social inequalities	**Deliver inclusive growth**	The route of the Great Western Mainline (which will be better connected to Heathrow) mainly passes through regions of low deprivation.
Quality of life	**Enhance accessibility**	Heathrow Airport itself is an important employment centre, so increased access for the west will improve its catchment. The volumes are not high enough to warrant a Green ranking.
	Connections to isolated areas	Heathrow, and the locations along the Great Western Mainline, are not separated or isolated regions.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

R. Birmingham - Nottingham/Sheffield/Leeds

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Benefits of connecting this corridor will be focussed in England. Some journeys across borders will benefit, such as those from Cardiff to Nottingham, but the benefits will overwhelmingly be England only.
	Transport improvement	Constructing HS2 Phase 2b will bring excellent journey time benefits along the corridor. Midlands Rail Hub improvements will take advantage of released capacity on the conventional network with better and additional freight and passenger services. This will bring major connectivity improvements for large population densities.
	Increase productivity	Major time savings for business trips between Birmingham and Nottingham/Sheffield/Leeds with HS2. Building HS2

Economic growth and recovery		Phase 2b would free up capacity on the existing rail network for more freight trains.
	Secure inward investment	Improved connectivity to Birmingham and East Midlands airports. Potential for this corridor to grow as an international freight corridor if HS2 releases capacity on the existing network.
Economic and social inequalities	**Deliver inclusive growth**	Significant deprivation concentrated particularly in and around the cities on this corridor, the intervention would assist in levelling-up connections in the midlands and north of England.
Quality of life	**Enhance accessibility**	The combination of high-speed intercity services and improved local connections would considerably increase the catchment of employment and recreation opportunities by public transport
	Connections to isolated areas	While the quality of connections needs improvement to better connect these communities and economies, these are not isolated or separated areas.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

S. Birmingham - Felixstowe

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Primarily benefits the corridor in England; some freight may continue on the East and West Coast Main Lines to Scotland, or into Wales.
	Transport improvement	This corridor was cited by Network Rail's 2017 Freight Network Study as the highest priority corridor for improvement. Completion of the Felixstowe to Nuneaton (F2N) package of enhancements would significantly increase capacity on the route.
Economic growth and recovery	**Increase productivity**	One of the busiest rail freight corridors in the UK. Increased freight capacity on the route would increase supply chain capacity and bring significant productivity benefits.
	Secure inward investment	Better connections to international freight to/from Felixstowe port, which is a high-volume rail freight route.
Economic and social inequalities	**Deliver inclusive growth**	Deprivation concentrated in and around Felixstowe and Birmingham, though the extent to which increased freight capacity will alleviate this deprivation is likely to be limited.
Quality of life	**Enhance accessibility**	Not focused on passenger improvements, though these could be a secondary benefit. No significant improvement in employment catchments unless the improvements bring journey time improvements for passengers on the route.

	Connections to isolated areas	Although Felixstowe is somewhat separated from major cities, this intervention is not focused on passenger improvements, so it is unlikely to bring significant benefit to community and cohesion.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

T. Oxford - Cambridge

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	The benefits of connecting this corridor will be in England only.
	Transport improvement	There is currently not a rail connection between Oxford and Cambridge, with passengers having to travel in and out of London. This intervention is therefore clearly a major improvement in connectivity, with large improvements in convenience and journey time. Oxford, MK and Cambridge are important strategic growth areas which will continue to grow in population in the coming years.
Economic growth and recovery	**Increase productivity**	Potential for significant agglomeration benefits. Direct connection will enable Oxford, Milton Keynes and Cambridge to better exchange business, resources and talent, working more cohesively as a corridor rather than as completely separate entities. Sectors are also well matched, with two of the best universities in the world located on the corridor and thriving knowledge and science economies. Potential for freight to be carried along the corridor too, though the extent of this is as yet unclear.
	Secure inward investment	Domestic-focused connection. International aviation journeys will primarily go through London, and while freight services may operate along the route, it is unlikely to be a major corridor for international freight.
Economic and social inequalities	**Deliver inclusive growth**	Some concentration of above average deprivation on the corridor (eg. around Milton Keynes), but on the whole this is a well-off region and not a priority corridor for levelling-up
Quality of life	**Enhance accessibility**	Currently a 'missing link' in the UKNET. Could significantly increase the catchment of Cambridge, Milton Keynes and Oxford by enabling commuting between these places by public transport, and leisure/tourist travel between the historic university cities.
	Connections to isolated areas	The beneficiaries of this improvement are not separated or isolated. There are good road and rail links to London and further north.

Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted. With a new line, there is the possibility to embrace technology in construction which does not exist for other interventions where the infrastructure is already built.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

U. Exeter - Plymouth/Penzance

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Benefits of better connecting this corridor will be almost entirely in England.
	Transport improvement	Scope to shorten the length of track and improve journey times but need to keep connections to key towns so does not qualify for a Green ranking.
Economic growth and recovery	**Increase productivity**	Not an important corridor for business trips or a high-volume freight route.
	Secure inward investment	Improved access to the port of Plymouth, but the flows of rail freight in the South-West are small.
Economic and social inequalities	**Deliver inclusive growth**	There is a high concentration of above average deprivation in the South-West of England, particularly in and around Plymouth.
Quality of life	**Enhance accessibility**	Population density is sparse in the South-West so improvements to journey times do not bring many more people into the catchment areas for employment or recreation opportunities, though there will be some benefit.
	Connections to isolated areas	The south-west is geographically separated from Wales and the rest of the UK owing to the shape of the country. Connecting these communities better to one another and to family and friends elsewhere in the UK is important.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

V. A2 Dover Access

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Improved efficiency for freight movements throughout the union via secondary benefits
	Transport improvement	Improved resilience
Economic growth and recovery	**Increase productivity**	Significant freight trips on this route that will benefit from improved resilience
	Secure inward investment	Improved access to and resilience for Dover Ports
Economic and social inequalities	**Deliver inclusive growth**	The intervention does not improve connectivity for people in areas with above average deprivation
Quality of life	**Enhance accessibility**	No change to urban catchments expected
	Connections to isolated areas	The intervention does not improve connectivity for people in separated and isolated areas
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

W. M25 South West Quadrant

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Benefits are located wholly within England, however there will be secondary benefits due to improved efficiency for freight movements throughout the union as the M25 provides for freight movements from ports in the South East of England
	Transport improvement	The measures should enable network resilience and travel time savings for the M25 (potentially via alternative routes)
Economic growth and recovery	**Increase productivity**	Travel time savings - current delays and congestion costly to businesses
	Secure inward investment	Improved access to international ports and airports via the western side of the M25 (Southampton and Heathrow)
Economic and social inequalities	**Deliver inclusive growth**	The intervention does not improve connectivity for people in areas with above average deprivation
Quality of life	**Enhance accessibility**	Significant employment already within the area. Additional growth expected by the LEPs in the area

	Connections to isolated areas	The South East of England is well connected, as such the intervention does not improve connectivity for people in separated and isolated areas
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Alternate modes and changes to demand/travel patterns to be considered. Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

X. Birmingham - Solent

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	Located solely within England and the overwhelming majority of the benefits will be England-only.
	Transport improvement	Upon investigation, many of the freight capacity problems have been addressed recently, with improvements (particularly at and close to the port of Southampton) to enable train lengthening meaning 20% more goods can now be transported by rail. Alleviating remaining bottlenecks would bring slight improvements to capacity.
Economic growth and recovery	**Increase productivity**	This is a key rail freight corridor, connecting the West Coast Main Line to the Solent.
	Secure inward investment	Better connections to international freight to/from Solent ports, which is now also a proposed freeport region. However, as discussed, recent improvements have dealt with many of the capacity issues on the route.
Economic and social inequalities	**Deliver inclusive growth**	Deprivation concentrated in and around Birmingham, and in Portsmouth/Southampton, though this will not be alleviated significantly by slightly increasing freight capacity.
Quality of life	**Enhance accessibility**	Not focused on passenger improvements, though these could be a secondary benefit. No significant improvement in employment catchments unless this is combined with journey time improvements.
	Connections to isolated areas	This route does not connect isolated areas and does not focus on passenger benefits.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

Y. Belfast – Dublin (Rail)

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	This is considered here as a through route for onward trips to/from Great Britain. Freight along the corridor is dominated by HGVs, so the benefit would be for passengers travelling along the Belfast-Dublin-Holyhead route. For most passengers in the UK however, the Belfast-Loch Ryan route is more convenient so overall, the Union significance of this corridor for rail is limited.
	Transport improvement	Potential for major journey time reductions and frequency improvements. An all-island rail study has been commissioned to look into the best way to improve connections.
Economic growth and recovery	**Increase productivity**	Considering the corridor on a Union basis, the importance of this route for freight is low. There could be a significant increase in business and commuting flows between Dublin and Belfast with reduced journey times.
	Secure inward investment	The border into the Republic of Ireland is an international gateway, so this is clearly a major benefit for international links.
Economic and social inequalities	**Deliver inclusive growth**	There is a concentration of above average deprivation around Belfast and in the south-east of Northern Ireland, through which this route runs.
Quality of life	**Enhance accessibility**	Investment in this route would enable better connectivity for the areas south of Belfast to access job and recreation opportunities in the capital, depending on the service and stopping patterns.
	Connections to isolated areas	The corridor between Belfast and Dublin already has road and rail connections, so would not be considered isolated. However, smaller communities along the route will benefit from improved connectivity to community if capacity and frequency were to increase.
Technological innovation	**Embraces emerging technologies**	Neutral impact, potential for innovative performance management or digitally enhanced maintenance on the railway to be adopted.
	Flexible to shifts in demand	Flexibility available through changes in the timetable, stopping patterns and rolling stock, though rail infrastructure itself is inflexible.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

Z. Belfast Dublin (Road)

Objective	Criteria	Rationale
Transport provision across the Union	**Connecting the Union**	This is considered as a through route for onward trips between Northern Ireland and Great Britain in this context, particularly freight trips. The intervention would provide improved connectivity between Belfast and Dublin, which would serve road freight trips between Northern Ireland and GB

	Transport improvement	Journey time improvements are expected due to faster connection between the A1 and M1
Economic growth and recovery	**Increase productivity**	20% of all HGV freight movements between Northern Ireland and Great Britain, in both directions, transit via Dublin <-> Holyhead using the A1/M1 route between Belfast and Dublin. This represents a significant volume of freight trips on this route which would benefit
	Secure inward investment	Improved freight access between GB and Northern Ireland, via the Republic of Ireland. The border into the Republic of Ireland is an international gateway, so this would additionally provide a benefit for international links
Economic and social inequalities	**Deliver inclusive growth**	There is a concentration of above average deprivation in areas along the route, however primary beneficiaries will be longer distance trips such as freight movements. Local traffic likely to benefit through removal of long-distance trips from the existing intersection
Quality of life	**Enhance accessibility**	May be a minor improvement in access to the shopping centres in the junction vicinity
	Connections to isolated areas	The corridor between Belfast and Dublin already has road and rail connections, so would not be considered isolated.
Technological innovation	**Embraces emerging technologies**	Neutral impact. There is potential to adapt the route / design to allow for inclusion of new transport technologies - such as providing charging points for EVs
	Flexible to shifts in demand	Route provision can enable flexibility to changing demand patterns but does not actively encourage this.
Fiscal strategy	**Value for money**	Estimate based on available costs and judgements about changes in demand patterns and travel times.

Appendix E

Environmental Review

E1 Environmental Review

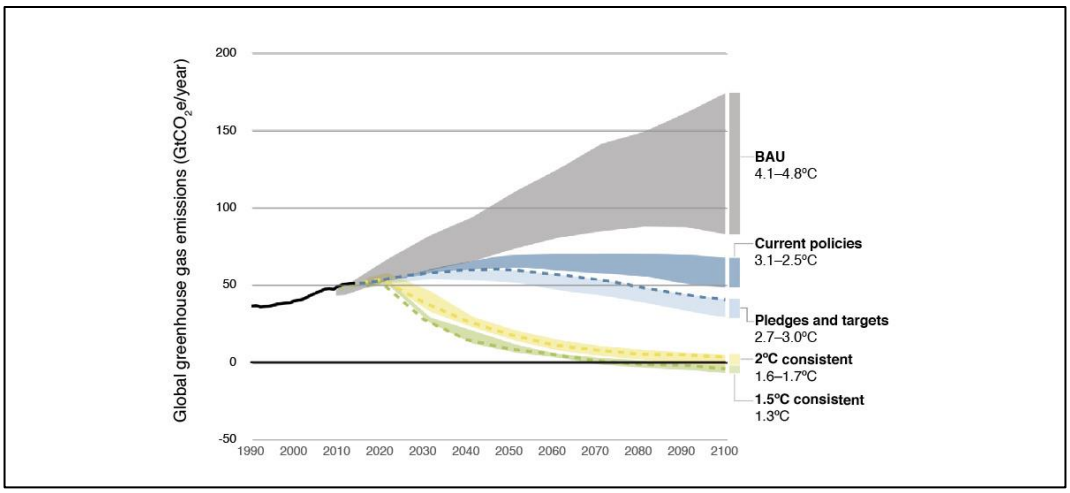
This section sets out how the schemes under consideration align with national and international commitments to reducing greenhouse gas emissions and protecting biodiversity.

A high-level analysis has been undertaken in order to rank the overall environmental impacts of each scheme, allowing DfT to have an overview of the key environmental risks. This environmental assessment will be crucial to the overall assessment of the schemes, as these risks and impacts are likely to become the dominant factor in infrastructure decision making if the UK is to meet its commitments to achieving net-zero.

E2 Policy and pathways

According to the Intergovernmental Panel on Climate Change (IPCC), to avoid overshooting a mean temperature increase of 1.5°C, global net anthropogenic CO_2 emissions will need to decline by 45% before 2030, at to 'net-zero' by 2050. In the case of limiting global warming to below 2°C, CO_2 emissions will need to decline across most decarbonisation pathways by about 25% before 2030 and to 'net-zero' by 2070.

Figure 134 - 2100 Warming projections



Source – Climate Action Tracker

If decarbonisation, limiting global warming to 1.5°C, is to be achieved, the IPCC assert that 'ambitious actions' are required. As such, the capacity for "national and sub-national authorities, civil society, the private sector, indigenous peoples and local communities" to take climate action needs to be strengthened. In particular, the report cites international cooperation in sustainable development as a key requirement to achieving this globally.

E2.1.1 Existing and developing policy – Global level

In 1992, 197 countries adopted the United Nations Framework Convention on Climate Change (UNFCCC), the aim of which is to "prevent dangerous human interference with the climate system". The adoption of the UNFCCC led to the Kyoto Protocol in 1997, which came into force in 2005, proceeded by the Paris Agreement in 2015. The Kyoto Protocol was the first major step in reducing global emissions, establishing a carbon trading scheme which meant that countries had to monitor and record their carbon emissions.

Building on the foundations of the Kyoto Protocol, the Paris Agreement aims to limit global warming to 2°C above pre-industrial levels, whilst making efforts to limit the rise to 1.5°C. It additionally established a goal to enhance adaptive capacity, strengthening resilience and reducing vulnerability to climate change. The Paris Agreement was adopted in 2015 at the 21st Conference of the Parties (COP21) to the UNFCCC and entered into force on November 2016. The guidelines for implementing the Paris Agreement were adopted at the 24th Conference of the Parties (COP24), in Katowice, Poland.

The IPCC's Fifth Assessment Report, published in 2014, provides robust evidence that human influence on climate change is clear and growing. Climate change is the largest inter-related cumulative environmental effect and has the potential to lead to significant environmental degradation, economic disruption and the unravelling of societies across the World.

E2.1.2 Existing and developing policy – UK level

The Climate Change Act 2008 introduced the UK's first legally binding target, to reduce GHG emissions by at least 80% compared to 1990 levels by 2050. To 2017, the Climate Change Act has helped to reduce emissions by 42%, whilst allowing the UK economy to grow by two thirds over the same period.

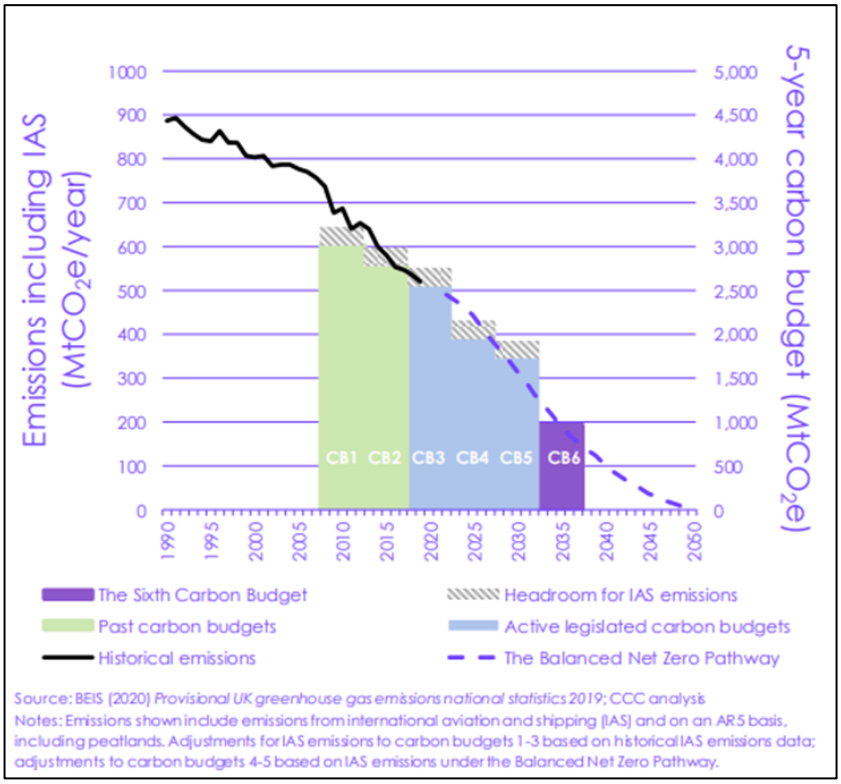
However, in recognition of the need to go further, the Climate Change Act was amended in 2019 to set a legally binding target of achieving net-zero GHG emissions across the UK economy by 2050. This target was recommended by the Climate Change Committee (CCC), the UK's independent climate advisory body.

Achieving net-zero means will require national emissions to be reduced as far as practicable, with any residual emissions balanced by schemes to offset an equivalent amount of GHGs from the atmosphere, to ensure the system is balanced. For example, offsetting measures include tree planting or the use of technologies such as carbon capture and storage (CCS).

5-yearly carbon budgets provide a statutory cap on total GHG emissions and are the instrument by which the government sets the scale of required reductions, and the measures to be implemented. Carbon budgets are set by Parliament on the advice of the CCC with each given 12 years lead time to provide sufficiently long-term guidance to economic actors. When aggregated, these sequential carbon budgets define a cost-effective pathway towards the UK's long-term goal of net-zero. So far, five carbon budgets have been set in law, covering the period 2008 to 2032 (inclusive).

The CCC has reported that the first and second budget were met, and the UK is on track to meet the third; however, the UK is not on track to meet the fourth of fifth. The sixth carbon budget, which is due to be enshrined in law by the end of June 2021, will be the first to be set in line with the new net-zero target.

Figure 135 - UK trajectory to net-zero and carbon budgets



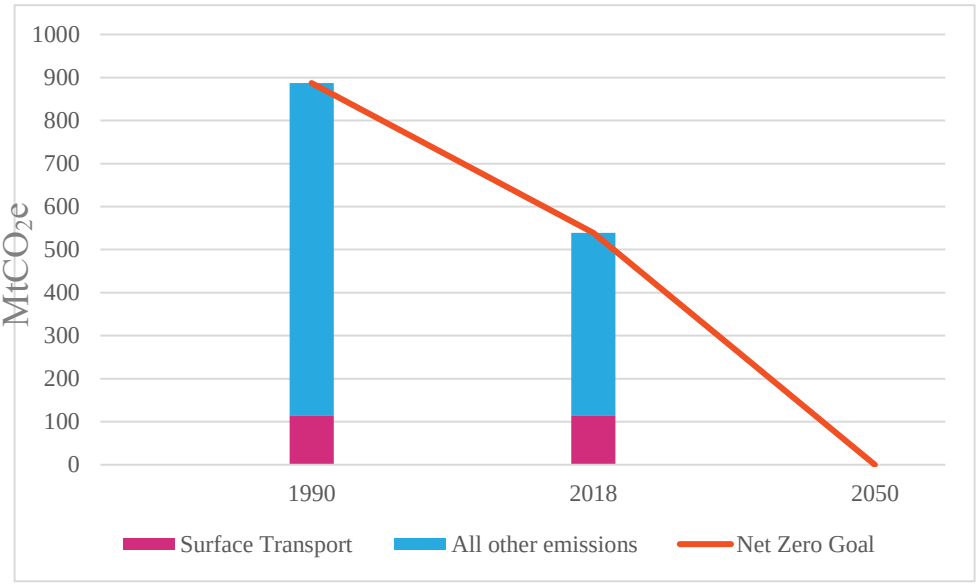
Source – CCC 6th Carbon Budget report https://www.theccc.org.uk/publication/sixth-carbon-budget/

It is now widely acknowledged that biodiversity has an impact on climate change and vice versa, with well-functioning and biodiverse ecosystems positively impacting both climate-change mitigation and adaptation. As such, in addition to achieving net-zero, the government has also committed to the interrelated goal of conserving the UK's biodiversity, with national and international legislation imposing restrictions of the planning and development of protected habitats or sites containing protected species.

E3 The impact of surface transport

In 2016, transport emissions accounted for 16.2% of global GHG emissions, with road transport the largest emitting sub-sector, contributing to 11.9% of emissions. The transport sector has a similar impact on UK emissions, with surface transport accounting for 22% of the UK's GHG emissions in 2019. This share has notably increased from 13% in 1990, primarily because other sectors, such as energy, have more effectively decarbonised, with surface transport's absolute emissions only increasing slightly.

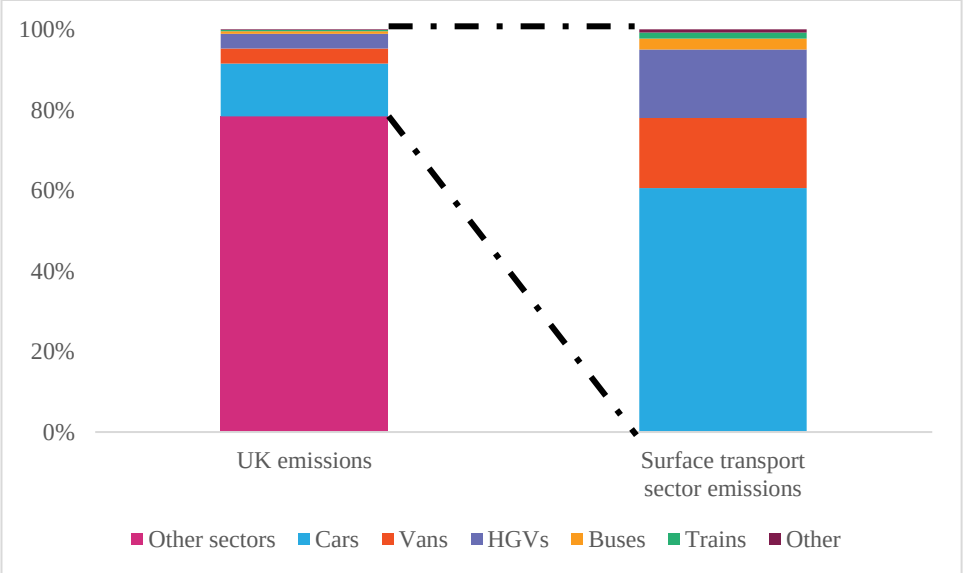
Figure 136 – Net zero decarbonisation - transport v all other sectors source: CCC 6th Carbon budget



Source – CCC 6th Carbon Budget Report https://www.theccc.org.uk/publication/sixth-carbon-budget/

Within the surface transport sector, GHG emissions from car travel account for 61% (68MtCO2e) of the total. HGVs and vans account for 17% each, with buses and rail accounting for 3% and 2% respectively.

Figure 137 – Contribution of transport sub-sectors to UK emissions



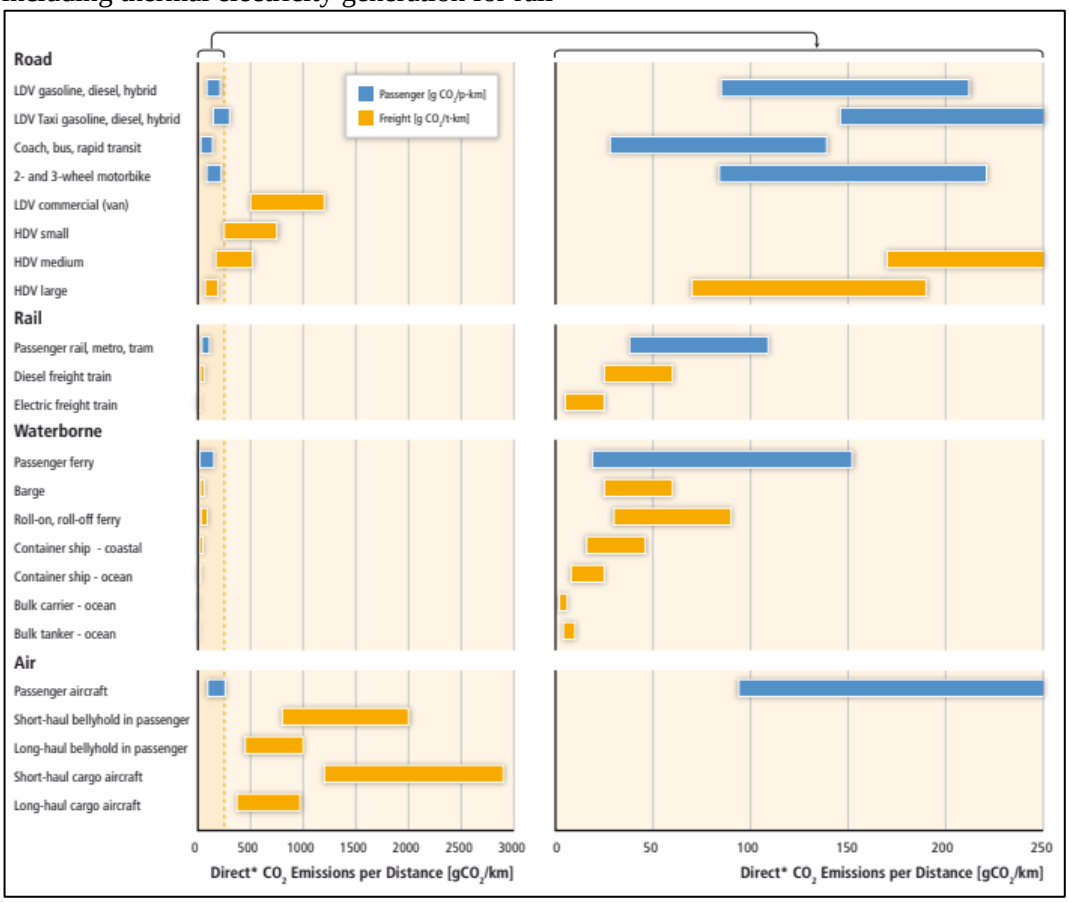
Source – CCC 6th Carbon Budget Report https://www.theccc.org.uk/publication/sixth-carbon-budget/

The figure below, highlights the per km and per tonne-km GHG emissions of various transport types. In the context of land-based modes, rail generally has a lower impact than road-based transport for both freight and passengers. This

points to the potential benefits of specifying land-based infrastructure and inducing a modal shift from road-based to rail-based transport.

Typical ranges of direct CO_2 emissions per passenger kilometre and per tonne-kilometre for freight, for the main transport modes when fuelled by fossil fuels

Figure 138 – Typical ranges of direct CO2 emissions per passenger kilometre and per tonne-kilometre for freight, for the main transport modes when fuelled by fossil fuels including thermal electricity generation for rail



Source – IPCC WG3 AR5 Transport Chapter

The Climate Change Committee's 6th Carbon Budget Report (2020) outlines a series of potential interventions to achieve the UK's legally binding target net-zero GHG emissions by 2050. Those intervention related to the surface transport sector include:

- demand reduction and modal shift;
- improvements in conventional vehicle efficiency; and
- zero emission vehicles.

Vehicle efficiency and the penetration of zero-emission vehicles will significantly improve the emission profile of the UK's surface transport as a function of time; however, this is largely out of the control of those responsible for the design and development of the UK's surface transport system.

To a greater extent, what can be influenced are the choices which determine the type and location of infrastructure, and the impact that this infrastructure has on increasing modal shift to less polluting forms of transport, as well as reducing overall demand.

- The CCC assess that between 2-4% of car-kilometres by 2030 can be switched to either bus or rail, increasing to 5-8% by 2050.
- In 2019, 154 billion tonne-kilometres of goods were moved by road in the UK. Shifting this to rail can be up to 76% less carbon intensive. The tonne-kilometres of freight moved by rail decreased by 27% over the seven years to 2020.

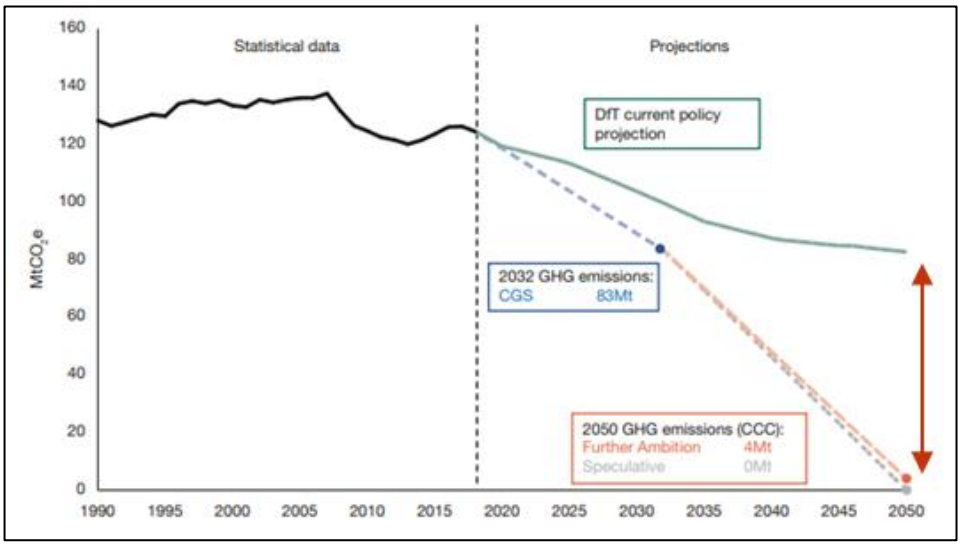
When assessing the relative merits of each new scheme it is important to consider the likely impacts on modal shift of both people and freight from more polluting modes of transport across the local network in order to get a sense of the impact it will have on national emissions and the UK Government's ability to meet its future legislated carbon budgets.

E4 Operational Carbon

Operational carbon is defined as the carbon emissions associated with the use, management, and maintenance of an infrastructure asset. For transport infrastructure, the emissions associated with the ongoing use of these assets typically accounts for the majority of the environmental impact over their whole life cycle. In 2018, transport was the largest carbon emitting sectors of the UK economy, producing around 33% of the countries GHG emissions. While the energy sector has achieved large decreases in its emissions; transport emissions in the UK have remained relatively static.

In March 2020 the UK DfT identified a significant gap between predicted emissions, current policy, and the national target of net zero by 2050.

Figure 139 – transport emissions trajectory to 2050 for current and required policy



As such, reducing transport's operational emissions has been a key focus for policymakers.

For this assessment, operational carbon focuses primarily on user emissions, such as those produced directly by vehicles or rolling stock, which has been considered in terms of:

- Positive modal shift
- Impact of increased capacity on operational emissions
- Provisions for sustainable last mile journeys

E4.1 Modal Shift

The Environment Review has overwhelmingly prioritised positive modal shift in its assessment of each scheme. While the assessment has highlighted any potential environmental risks, the overall score has assumed that shifting travel patterns from air or road to rail is always favourable, particularly given the relative urgency of achieving net-zero by or before 2050.

This appraisal is based on the fact that, per kilometre, the environmental impact of travelling by train is significantly lower than by either road or air, with cars and taxis contributing the most to overall transport emissions, followed by international aviation, which has more than doubled since 1990. In contrast, rail produced only ~2MtCO$_2$e in 2016, which was equivalent to only ~2% of the UK's total transport emissions.

E4.2 Impact of increased capacity

While increasing transport provision is often assumed to be positive, particularly in the case of rail, this environment assessment has considered how increasing capacity may potentially have unintended and negative impacts on operational emissions.

For example, in the case of rail, it should be noted that around 60% of the UK's rail network has yet to be electrified, with the government pledging to phase out diesel-only trains by 2040. As such, increasing the speed and frequency of services on these sections of the network may also increase the consumption of fossil fuels. Therefore, schemes which are set to improve the speed and capacity of services on electrified sections of the network have been rated Green, while those that include plans to electrify by 2030, or have no plans to electrify, have been rated as Amber and Red respectively. New sections of rail have been assumed to be electrified as standard.

In the case of roads, schemes expected for completion before 2030 will predominantly increase capacity for conventional (petrol and diesel) vehicles. While beyond 2030, the government has planned to phase out the sale of petrol and diesel vehicles, with all new cars and vans to have zero tailpipe emissions from 2035. As such, schemes scheduled for completion before 2030 have been rated as Red, while schemes to be completed between 2030-2040 have been rated as Amber, based on the assumption that there will be a relatively limited number

of conventionally fuelled vehicles (CFVs) on the roads. Schemes to be completed post-2040 are assumed to serve c. 100% electric vehicles (EVs) and have therefore been rated Green.

E4.3 Sustainable last mile journeys

Where major transportation routes terminate can have a significant impact on the modes of transport utilised for ongoing and last mile journeys. For example, isolated transport nodes may be more accessible by private car, causing a knock-on effect to overall operational carbon emissions. As such, schemes have been rated 'Green' where the terminus of transport schemes are served by sustainable last mile journeys, such as urban centres of population, or the scheme itself sustainable options for last mile journeys. Conversely, transport schemes have been rated 'Red' where they have the potential to create deficiencies in sustainable last mile journeys.

E5 Embodied Carbon

Embodied carbon is defined as the carbon associated with construction and/or refurbishment and the end of life treatment of an infrastructure asset, including the emissions resulting from the extraction, refining, transportation and assembly of construction materials. Embodied carbon is particularly pertinent to both road and rail schemes, with steel and concrete amongst the most carbon intensive construction materials. [source]

As transport systems are electrified and operational emissions decrease, embodied carbon will increasingly account for a larger proportion of an assets whole life environmental impact. However, in the near term, as the rail network in particular transitions towards full electrification, the initial financial and carbon cost of refurbishing existing and building new tracks will be high.

As such, embodied carbon has been considered as a factor of the scheme's total length as well as a whether it includes the re-use/refurbishing of existing assets or extensive sections of tunnelling or elevated structures. It should be noted that all schemes will invariably have embodied carbon and those that have been rated Green are those that minimise this impact, typically through the avoidance of completely new construction, or by avoiding the need for carbon intensive construction processes such as tunnelling.

E5.1 Re-use/refurbishing of existing assets

Many of the schemes assessed are primarily aimed at improving the capacity and speed of established services on the existing road/rail network, in turn reducing the need to construct new carbon intensive infrastructure. Where this is the case, schemes have been rated Green.

E5.2 Extensive tunnelling or elevated structures

Where schemes require new sections of road/rail infrastructure, particular consideration has been given to those that may also include extensive tunnelling or elevated structures, which has been rated Red. Schemes are deemed to require extensive sections of tunnelling or elevated structures where the topography is relatively variable.

The unfavourable 'Red' rating is based on the carbon intensity of these forms of construction. For example, tunnelling has 27 (±5) times more embodied carbon per kilometre than the construction of at-grade rail.

E5.3 Total length

For the linear infrastructure schemes considered in this review, total embodied carbon is assumed to be proportional to the length of the scheme. As such, schemes have been categorised as Short, Medium, and Long, and rated as Green, Amber and Red respectively.

E6 Land Take

The Environment Review undertook a high-level assessment to provide insight on the approximate area and type of land required by each proposed scheme. This assessment included a qualitative appraisal of satellite imagery and data mapping to understand some of the potential risks to each scheme's surrounding ecosystem and irreplaceable habitats. Risks have been considered in terms of:

- Potential disturbance of AONBs, National parks and areas of irreplaceable habitat
- Flooding
- The proportion of favourable land-use, such as grass/cultivated land
- Potential disturbance of wood/peat land

It should be noted that none of the schemes under consideration have yet to detail regenerative land management strategies, despite the increasing drive for their inclusion. Therefore, it has been assumed that none of the schemes are likely to have a positive impact on land and biodiversity, and instead the RAG rating adopted provides an indicative ranking of schemes with the least negative impact.

E6.1 AONBs, National parks and areas of irreplaceable habitat

This aspect of the Environmental Review is based on geographic information covering rural, urban, coastal and marine environments from across government including:

- Department for Environment, Food and Rural Affairs

- Historic England
- Natural England
- Environment Agency
- Forestry Commission
- Marine Management Organisation

This data is presented as an interactive map on the website MAGIC (https://magic.defra.gov.uk/MagicMap.aspx), which is managed by the governmental organisations listed above.

For this assessment, particular attention has been paid to the location of schemes in relation to Areas of Outstanding Natural Beauty, National Parks, Ramsar Sites (internationally important wetland) and National Nature reserves, as highlighted in the maps below.

Figure 140 – Significant areas

Map highlighting: Areas of Outstanding Natural Beauty (Red) and National Parks (Green)

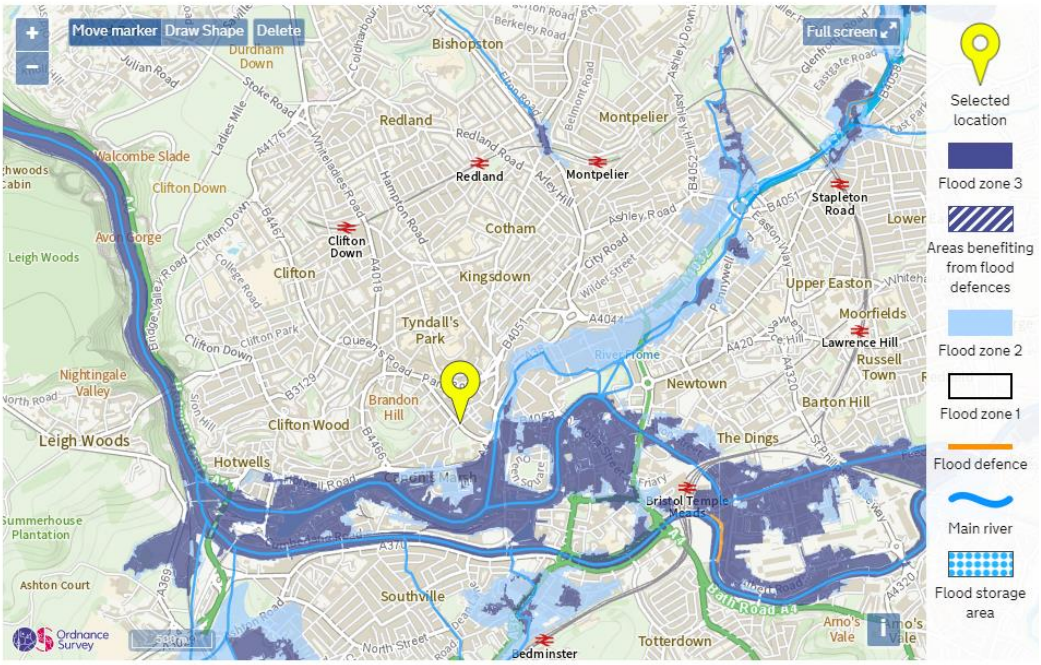
Map highlighting: Ramsar Sites (Green), National Nature Reserves (Yellow)

E6.2 Flood zones

Interaction with flood zones presents a dual concern, firstly the presence of proposed schemes may increase the flood risk in what are already a high risk areas, secondly that the presence of flood hazard presents a risk to the schemes throughout their lives, which may require additional embodied and operational carbon to manage.

The current assessment does not consider the impact of climate change on these flood levels, where in many parts of the UK both riverine and coastal flooding are likely to increase in both frequency and severity.

Figure 141 – DEFRA Flood Map for Planning



Source – https://flood-map-for-planning.service.gov.uk/

Flooding risk was assessed based on the Department for Environment, Food and Rural Affairs (DEFRA)'s flood map for planning, as seen in the map above. The assessment took into consideration areas where schemes may interact with a Flood Zone 3.

Flood Zone 2 - land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.

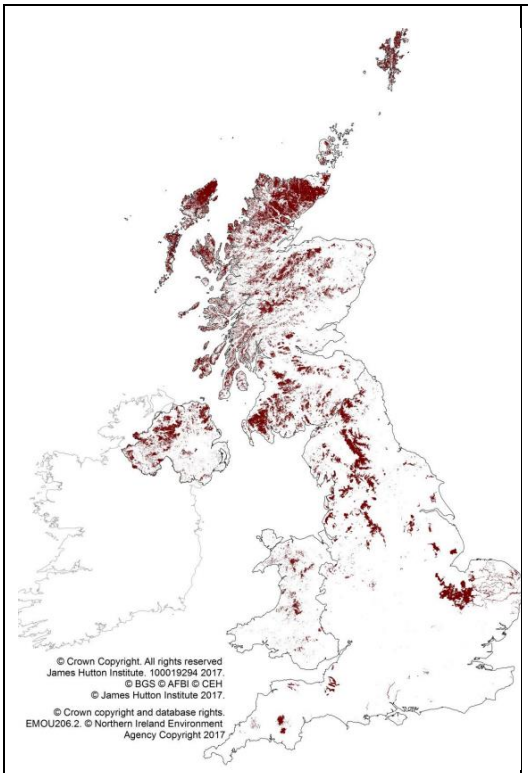
Flood Zone 3 - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

E6.3 Land type

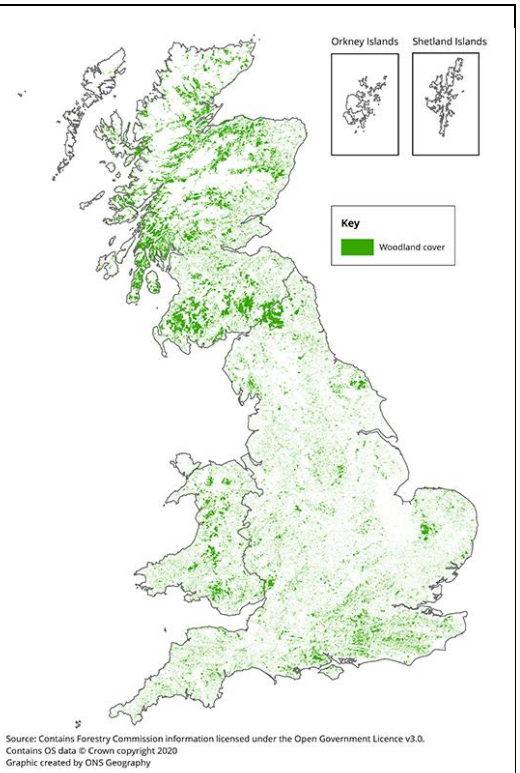
Wood and peat land are both important to the natural environment, in terms of providing habitats for diverse wildlife, preventing flooding, but also as a form of carbon sequestration and long-term storage. Conversely damaged peatlands can become significant sources of greenhouse gas, in the UK emitting over 20 million tonnes of CO_2e each year - around 4% of the UK's total. As such, schemes that have the potential to disturb significant areas of either wood or peat land (20% or morse) have been flagged with a 'Red' rating.

In turn, it is favourable for schemes to be built predominantly on either grass or previously cultivated land. As such, schemes that are expected to utilise primarily grassland or cultivated land (>80%), or those that refurbishing existing infrastructure, have been rated 'Green'.

Figure 142 – Peat and woodland



Map of the extent of peat in the United Kingdom.



Extent of Great British woodland, 2018.

Source – Reproduced from the BEIS Inventory project (left), Forestry Commission National Forest Inventory (right)

E7 Method

To appraise the environmental impacts of each scheme a high-level assessment was carried out using professional judgement based on a narrative description of each scheme.

The below matrix was developed to capture potential benefits and disbenefits across three areas, including:

- Operational Carbon
- Embodied Carbon
- Land Take

Each objective is comprised of various criteria, as described in the preceding sections of this report and detailed in the matrix below.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1		+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat

Objective	Criteria	Red	Amber	Green
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

E8 Results

Collectively for the road scheme projects, the assumption is that there is not a case for a strong positive modal shift as improvements to roads encourages car usage. This has been incorporated into the results for each project and therefore highlighted holistically rather than for each individual project.

A. West Coast Mainline North of Crewe
   Scored strongly across the various objectives with the main risk to be highlighted being the intersection of flood zones for certain sections. Scores highly for encouraging positive modal shift, as well as assuming that the capacity increase will be electric.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10

Objective	Criteria	Red	Amber	Green
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

B. Glasgow-Leeds / Sheffield

A long route, which negatively impacted the results, along with the negative impact of the route intersecting flood zones and environmental/ecological sites of interest. Project scored strongly for offering a positive modal shift and the utilisation of existing assets. Would have scored more strongly were the plans explicit for future use of electric vehicles.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1

Objective	Criteria	Red	Amber	Green
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

C. Carlisle - Edinburgh

Scored moderately well in terms of offering a positive modal shift. Overall scored negatively impacted by the route dissecting some environmentally valuable land assets as well as the potential for sections of tunnelling or

elevated structures to not necessarily be built, but for building work on them to be required to support future electrification.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1

Objective	Criteria	Red	Amber	Green
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

D. A1 Improvements
Scored strongly due to the fact that this project is refurbishment focused, however there is likely more work than some other projects where this is the case – this has not hampered a still strong scoring project.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10

Objective	Criteria	Red	Amber	Green
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

E. East Coast Mainline North of Northallerton
Scored strongly across all objective areas with the only aspect to flag being the intersection of some environmentally high value areas included within the Land Use results section.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1

Objective	Criteria	Red	Amber	Green
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

F. A69 Capacity

Scored strongly due to the fact that this project is refurbishment focused and therefore utilises existing infrastructure and not interrupting any high value land in terms of the environment or ecology.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

G. A75 Capacity

Scored strongly due to the fact that this project is refurbishment focused and therefore utilises existing infrastructure and not interrupting any high value land in terms of the environment or ecology.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1

Objective	Criteria	Red	Amber	Green
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

H. A77 Capacity

Scored strongly due to the fact that this project is refurbishment focused and therefore utilises existing infrastructure and not interrupting any high value land in terms of the environment or ecology.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1

Objective	Criteria	Red	Amber	Green
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

I. Stranraer – Dumfries

Scored strongly in terms of offering a positive modal shift for both freight (predominantly for freight). Mixed scores in terms of other areas due to extensive infrastructure being required to support the project. In terms of Land Use as an objective area, this project scored reasonably as it does not disturb areas of AONB or woodland for example, however, some of the criteria are made not applicable due to the route being over sea.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10

Objective	Criteria	Red	Amber	Green
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

J. Trans-Pennine Corridor

A strong scoring project overall but with some potential drawbacks in terms of requiring structures (to travel through the Pennines) as well as traversing an AONB at certain specific points.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1

Objective	Criteria	Red	Amber	Green
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

K. Rail Connections Between Northern English Cities
Scored strongly in terms of offering a positive modal shift and offering increased electric rail travel. Risk areas to consider are the additional works required to potentially electrify around existing structures (e.g. bridges) as well as the threat to ecologically high value areas along some stretches of the route.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1

Objective	Criteria	Red	Amber	Green
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

L. North Wales Coast Line

Although this project scored highly when considering the modal shift benefits, areas to flag are that the proposal suggests fossil fuel vehicle use on the route, and also some stretches of the line intersect flood zones and some environmentally valuable areas.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10

Objective	Criteria	Red	Amber	Green
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

M. Cardiff-Midlands / Yorkshire & NE

This project's results are predominantly strong with only the future use of fossil fuel vehicles on the route, and some intersection of a flood zone the areas for potential risk.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1

Objective	Criteria	Red	Amber	Green
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

N. Severn Resilience

A strong scoring project in the vast majority of objective areas with the only negative to highlight being that sections of the route proposed will travel through potential flood zones.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

O. Bristol - Cardiff

Scored strongly in most areas with the only consideration being the fact that segments of the route intersect flood zones at certain points. This project looks to use a 'rail-led' network of alternatives to avoid road congestion on the M4 and therefore scored highly in terms of offering a positive modal shift.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

P. South Wales Mainline West of Cardiff

Scored very strongly in terms of land use due to the lack of disturbance of any environmentally or ecologically 'high-value' land. One negative score to highlight is the proposal for the scheme to increase fossil fuel vehicles rather than electric.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1

Objective	Criteria	Red	Amber	Green
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

Q. Western Access to Heathrow

Results indicate lots of positives surrounding the project such as a short route and the encouragement for people to utilise public transport. Areas for potential concern/risk are the requirement of extensive tunnelling/elevated structures along the route and potential flood zone intersection.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

R. Birmingham – Notts/Sheffield/Leeds

As with the previous project, this project has scored very strongly with the only concern area being the potential intersection of stretches of the route intersecting with flood zones. One potential area for easy improvement is the future use of electric vehicles and no fossil fuel options.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

S. Birmingham - Felixstowe

As an upgrade to existing infrastructure, this project scored highly – aided by the proposal for electrification. The reasonable length of the route, as well as the route traversing flood zones at certain stages are the only criteria which partially hampered the project overall.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1

Objective	Criteria	Red	Amber	Green
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

T. Oxford – Cambridge

This project has scored very strongly with the only concern area being the potential intersection of stretches of the route intersecting with flood zones.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

U. Exeter – Plymouth / Penzance

In terms of land use as an objective, this project has scored well due to not interrupting and land which is of high environmental or ecological value. Whilst there is some positive modal shift offered, the case is not as strong as other projects and with some fossil fuel trains planned on the route, there are some areas where the project has not scored so highly.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

V. A2 Dover Access

Scored moderately well in terms of offering a positive modal shift for passenger and commercial (encouraging ferry/sea travel rather than air by improving the route to the port) and scored highly in the majority of other objective areas. Only point to highlight as a negative is that the project with intersect a flood zone.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1

Objective	Criteria	Red	Amber	Green
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

W. M25 South West Quadrant

A strong scoring project across all of the objective areas with the positive highlights being the facilitation for electric vehicles and the road not interrupting any areas of high value in terms of the environment or ecology.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

X. Birmingham - Solent

Offers a strong positive modal shift encouraging public transport use, utilises existing assets and suggests a strong electrification focus. Only potential negative is the route dissecting some high value land in terms of environmental or ecological value, is relatively long and potentially cuts through some flood zones.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains

Objective	Criteria	Red	Amber	Green
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

Y. Belfast - Dublin

With some of the line going through potential flood zones or environmentally/ecologically high value areas, this project has its potential pitfalls. However, it has scored well due to offering a case for a strong positive modal shift. One other shortfall is the proposed use of fossil fuel vehicles to service the route.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1

Objective	Criteria	Red	Amber	Green
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

Z. Belfast - Dublin

This project scored reasonably well across all objective areas with highlights being that the focusing is on improving existing assets rather than building anew. With some sections of the route dissecting areas of high environmental/ecological value there were potential areas where a stronger score could have been achieved.

Objective	Criteria	Red	Amber	Green
Operational Carbon	Positive modal shift	No positive modal shift	Some positive modal shift in either freight or passenger journeys	Significant positive modal shift in either freight and passenger journeys, or leading to significant reduction in use of highways
		-1	+5	+10

Objective	Criteria	Red	Amber	Green
	Provisions for sustainable last mile journeys	Scheme creates deficiencies in sustainable last mile journeys	Schemes does not include the provision of sustainable last mile journeys but does not introduce deficiencies (N/A)/Not Sure	Scheme either includes the provision of sustainable last mile journeys, or in itself provides sustainable options for last mile journeys
		-1	0	+1
	Impact of increased capacity on operational emissions	Scheme is intended to serve/increase capacity for primarily fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for a limited number of fossil fuelled vehicles/trains	Scheme is intended to serve/increase capacity for c. 100% electric fleet of vehicles/trains
		-1	0	+1
Embodied Carbon	Re-use/refurbishing of existing assets		The scheme is not improving capacity/upgrading/re-furbishing existing assets	The scheme is improving capacity/upgrading/re-furbishing existing assets
			0	+1
	Extensive tunnelling or elevated structures	The scheme includes extensive sections of tunnelling or elevated structures		The scheme does not include extensive sections of tunnelling or elevated structures
		-1	0	+1
	Total length	Long	Medium	Short/No change
		-1	0	+1
Land Take	AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat	Scheme dissects AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat		Scheme does not dissect AONBs, SSSIs, Areas of Special Scientific Interest (ASSIs) National parks, areas of irreplaceable habitat
		-1	0	+1
	Flood zones	Sections of the scheme are located within flood zones 2 or 3		Scheme does not interact with any flood zones 2 or 3
		-1	0	+1

Objective	Criteria	Red	Amber	Green
	Grassland/cultivated land	Scheme does not predominantly utilise grassland or cultivated land (<80%)		Scheme predominantly utilises grassland or cultivated land (>80%)
		-1	0	+1
	Wood/peat land	Scheme disturbs some wood or peat land (20% or more)	Scheme disturbs some wood or peat land (less than 20%)	Scheme does not disturb any wood or peat land
		-2	-1	+1

Results Sub-Totals and Total

By considering each category of measurement (Operational Carbon, Embodied Carbon and Land Take) individually, it is possible to see which projects score well according to certain criteria. It is crucial also to consider the project more holistically from an environmental perspective and this is conveyed in the table below.

Project	Operational Carbon Sub-Total	Embodied Sub-Total	Land Take Sub-Total	Grand Total
A – West Coast Mainline North of Crewe	11	3	2	16
B – Glasgow – Leeds/Sheffield	10	0	-3	7
C – Carlisle - Edinburgh	6	-1	-1	4
D – A1 Improvements	1	2	4	7
E – East Coast Mainline North of Northallerton	7	2	2	11
F – A69 Capacity	1	2	4	7
G – A75 Capacity	1	2	4	7
H – A77 Capacity	1	2	4	7
I – Stranraer - Dumfries	9	-1	2	10
J – Trans-Pennine Corridor	1	1	2	4
K – Rail Connections Between Northern English Cities	12	-1	0	11
L – North Wales Coast Line	9	1	0	10
M – Cardiff-Midlands / Yorkshire & NE	10	1	2	13
N – Severn Resilience	1	3	2	6
O – Bristol - Cardiff	12	3	2	17
P – South Wales Mainline West of Cardiff	9	1	4	14
Q – Western Access to Heathrow	12	0	2	14
R – Birmingham – Notts/Sheffield/Leeds	11	2	2	15
S – Birmingham - Felixstowe	12	2	2	16
T – Oxford - Cambridge	12	1	2	15

U – Exeter – Plymouth / Penzance	5	1	4	10
V – A2 Dover Access	6	2	2	10
W – M25 South West Quadrant	1	3	4	8
X – Birmingham - Solent	12	2	0	14
Y – Belfast - Dublin	11	1	0	12
Z – Belfast - Dublin	-1	2	2	3

E9 Summary

8.1.1 Operational Carbon Summary

Typically, the main factor when considering Operational Carbon is the potential for a positive modal shift – will the project encourage a more sustainable mode of transport? In summary, the Operational Carbon table highlights the theme that rail travel offers a clear and positive impact distinction when compared with road travel. Therefore, rail projects naturally achieved a higher (and therefore more encouraging score for this field) when compared to the road projects. Conversely, road projects fared more positively when considering sustainable last mile journeys. This is because a car journey would terminate at the end point, where the user would then have reached their destination. With rail travel, although a user may be able to get close to their end destination, there is still the restriction of station location. This final segment of a rail journey (from station to final destination) is not always provisioned for sustainably.

'Electrification Readiness' was also considered as a key metric when considering operational carbon. This was applicable to both road and rail projects and when considering the final results, it is clear that the road projects are ready to handle electric vehicles in terms of utilising highways, but it is the surrounding infrastructure that would need to be in place to give users the confidence to switch to an electric vehicle if they currently own an internal combustion engine car.

8.1.2 Embodied Carbon Summary

Embodied carbon focused on the project works and whether or not the project utilised existing structures. So, if the project was a refurbishment then it scored highly and as the road projects are focused on refurbishment, they are examples of projects that faired favourably. Lengthy projects scored lower and infrastructures which were already electrified scored higher.

8.1.3 Land Take Summary

Certain projects were flagged with lower scores if they intersected specific environmentally valuable areas such as National Parks or woodland areas but were considered more favourable for avoiding those areas (as well as flood zones).

8.1.4 Final Results Summary

As is clear from the results table, the focus on the potential for a positive modal shift and the emphasis placed on this metric provides a clear distinction between rail and road projects. The rail projects scored 12 on average, a ‘green’ status. Whereas on average the road projects scored an average of 7; an ‘amber’ status. Projects which intersected environmentally valuable areas (such as SSSIs or AONBs) have been flagged, as well as those projects which are likely to intersect significant areas of woodland (or peatland).

In conclusion, for transport infrastructure projects, the key consideration is arguably modal shift. Rail projects that service popular routes and offer a robust alternative to road travel provide a number of positive impacts. Rail travel promotes a deviation away from individual vehicle use and in turn reduces traffic levels on highways. The other additional benefit is that there is an operational carbon benefit in terms of reduced emissions by utilising a shared rail service (or freight rail) compared to a road vehicle. This is not to say that the road projects within scope are to be considered without value as these projects will have benefits across the board as well by improving capacity and potentially shortening journey times and reducing congestion – all of which reduce operational emissions.

The major benefit that can be derived during the project, or after completion is to ensure that the route itself is ready to handle electric vehicles. Whether they be cars or trains. This will drastically reduce operation emissions and safeguard the project in this respect for the future. Embodied carbon as an area of focus produced results which concluded shorter routes, which utilised as much of the pre-existing infrastructure as possible offered less environmental risk.