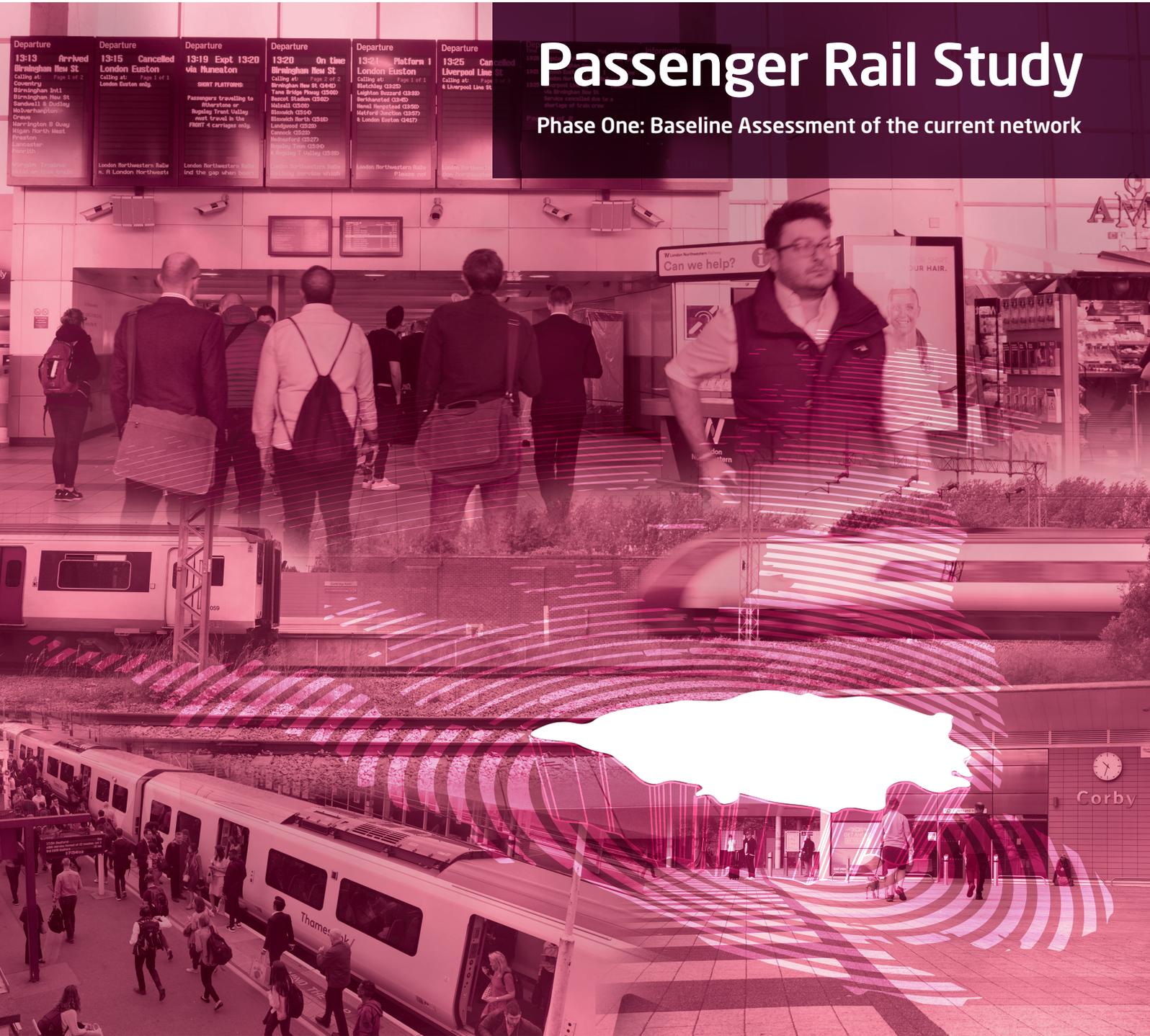


ENGLAND'S
ECONOMIC
HEARTLAND



Passenger Rail Study

Phase One: Baseline Assessment of the current network



A technical report produced by Network Rail
for the EEH evidence base

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Glossary

CML	Chiltern Main Line
CMSP	Continuous Modular Strategic Planning
DFT	Department for Transport
ECML	East Coast Main Line
EEH	England's Economic Heartland
EWR	East West Rail
GDP	Gross Domestic Product
GEML	Great Eastern Main Line
GJS	Generalised Journey Speed
GJT	Generalised Journey Time
GVA	Gross Value Added
GWML	Great Western Main Line
Heartland	Alternative term used to define the EEH region
HS2	High Speed 2
ITSS	Indicative Train Service Specification
LTPP	Long Term Planning Process
MML	Midland Main Line
OLE	Overhead Line Equipment
RNEP	Rail Network Enhancement Pipeline
TfL	Transport for London
TPH	Trains per Hour
WAML	West Anglia Main Line
WCML	West Coast Main Line

Executive Summary

An Area of National Importance

The England's Economic Heartland Passenger Rail Study has been prepared by Network Rail System Operator on behalf of England's Economic Heartland (EEH). The EEH region encompasses some of the most exciting and prominent economic hubs of the United Kingdom. Home to globally renowned companies and world-leading expertise, these burgeoning economic centres are playing an increasing role in the prosperity of the nation, contributing £163 billion in Gross Value Added with plans to increase this by 70% by 2050. Offering high-end manufacturing, technology and digital clusters, leading educational and research institutions, professional and financial industries, as well key logistics hubs, the area boasts a diverse range of thriving employment sectors comprised of 280,000 businesses¹.

The region's economy is not the only part of EEH seeing notable growth, with the area also set to experience an increase of housing stock of national significance. As well as providing homes to a population of 5.1 million, in excess of 535,000 new homes are planned to be built over the next 30 years. The housing stock of EEH is of such notable importance due to the contribution it represents to national new homes targets, whilst also providing external economies with considerable numbers of their respective workforces.

The expansion of both economies and home building in EEH for the foreseeable future highlights the importance of suitable transport links to support this growth over the long-term. With a considerable number of motorways and main lines passing through the region, the development of EEH's transport network will cause impacts to be experienced by large portions of the UK.

The heightened imperative of decarbonisation for the country is consequently shaping the approach taken to providing future improvements to the region's transport network. Whilst capacity and connectivity remain central outputs, decarbonisation has shifted from being a consideration, to becoming an equally important output. This shift in emphasis also presents options to consider how sustainable travel options can be expanded as part of its transport system. With the cities and towns of EEH being important origins and destinations of journey. EEH's location in a national context means that it acts as a gateway for the large parts of the UK, changes here could benefit a significant amount of the nation's population and businesses.

Understand the Railway's Role

Based on the significance of these drivers outlined above, the rail network can play an even more significant role in the transport system of EEH, whilst supporting the continued delivery of these economic and environmental outcomes. This document signifies the first step in understanding the scale of the opportunity and challenge for rail to be the solution to achieve these outcomes. Split into two parts, this opening document (Phase 1) sees the development of a plan for rail that will subsequently feed into the overall Transport Strategy for the EEH region for publication in 2020.

The aim of Phase 1 of the EEH Passenger Rail Study is to conduct a baseline assessment and review of the existing rail network and levels of service in the EEH region. This process will enable EEH and the relevant stakeholders to identify and understand where significant rail connectivity gaps exist, what rail enhancements are in development or delivery and what decarbonised/non decarbonised services

¹ <http://www.englandseconomicheartland.com/Pages/strategic-leadership.aspx>

run on the rail network. The stated baseline components will provide more clarity as to how EEH can ultimately meet its four overarching Transport Strategy principles:

- Achieving net-zero carbon emissions from transport no later than 2050.
- Improving quality of life and wellbeing through an inclusive transport system accessible to all which emphasises sustainable and active travel.
- Supporting the regional economy by connecting people and businesses to markets and opportunities.
- Ensuring the Heartland works for the UK by enabling the efficient movement of people and goods through the region and to/from international gateways.

The Passenger Rail Study's two phases, are outlined in the diagram, below. The completion of Phase 1 will enable Phase 2 of the study, which will continue throughout 2020.



This study was supported by a Steering Group to help guide and shape the workstream. Members of the Steering Group were drawn from the EEH Transport Officer Support Group, the EEH Business Unit, East West Railway Company, Rail Delivery Group and Network Rail. This enabled the professional collaboration and input from all rail and transport industry experts.

All EEH partner authorities submitted their local transport priorities, schemes and associated study work to the Steering Group, this was referred to as the 'call for evidence' exercise. Network Rail analysed these local transport plans and local rail aspirations with a view to understand the future housing sites, areas of projected employment growth and aspirations for rail schemes.

Having completed this literature review, Network Rail set out to define the scope of the study area by defining a list of regionally significant places to begin the baselining process of the rail network. Network Rail developed a list of criteria which was used to shortlist locations deemed suitable for inclusion as a key node. Thus, the scope and spatial coverage of this baseline study was filtered down to 45 key nodes; 29 are places within EEH, 12 are external centres of which 4 are airports. These key nodes were ratified and agreed in partnership with EEH and the study's Steering Group.

With the 45 key nodes established, Network Rail conducted a baseline assessment of the rail services between each of the key nodes using Generalised Journey Time (GJT) and Generalised Journey Speed (GJS).

GJT was selected for this study as it provides a more in-depth assessment of rail connectivity and performance. This is due to the way it accounts for the total station-to-station journey time (including interchange time), the service interval penalty and the sum of the interchange penalties for any rail interchanges required. GJS was chosen as it provides a supplementary measurement of performance by calculating average journey speed, $GJS = \text{Route Distance} \div \text{GJT}$.

The GJT and GJS data for this study has been collated and integrated into Geographical Information System (GIS) maps to help visualise where rail performs well or poorly across the EEH region and wider network.

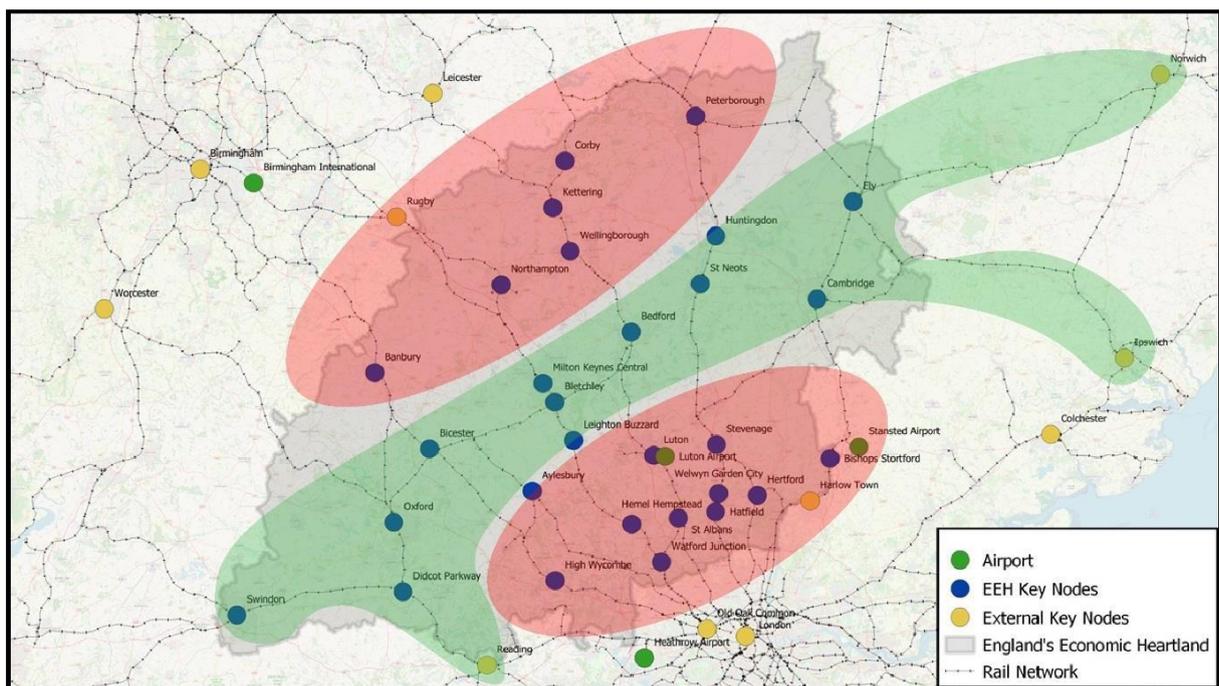
For this study, 10 GIS case study maps were produced that feature some of the most representative locations of the EEH rail network; Aylesbury, Bedford, Cambridge, Hertford, Milton Keynes, Northampton, Oxford, Peterborough, St Albans and Swindon.

This baselining exercise has highlighted some key connectivity gaps that exist across the Heartland. These may inform potential strategic priorities for EEH to consider as part of future rail enhancement projects. These corridors are:

Northern Arc: A corridor linking North Oxfordshire with Northamptonshire and on to Peterborough

Central Arc: Linking Swindon and Reading through Oxford to Cambridge, Ipswich and Norwich via Milton Keynes and Bedford, overlapping with the East West Rail corridor

Southern Arc: Linking the southern edge of EEH north of the M25 corridor



Corridor 1 – Oxfordshire & Swindon: Cross Oxfordshire links and improvements to Swindon

Corridor 2 – Chiltern Main Line: The area covered by the two routes from London Marylebone improving connectivity between intermediate stations on the route and towards Oxford, Banbury and the West Midlands

Corridor 3 – East Midlands – Thames Valley: Linking Old Oak Common through the Chilterns to Aylesbury, Milton Keynes, Northampton towards the East Midlands

Corridor 4 – Milton Keynes – Peterborough Two of the biggest economies and growth in the region are not linked by direct services

Corridor 5 – East Hertfordshire – Cambridgeshire: Improving the connectivity between the towns on the West Anglia and East Coast Main Lines to Cambridge

Corridor 6 – Peterborough – Cambridge-Stansted Airport: Improving upon the hourly service that links these three key employment, leisure and housing centres

Corridor 7 – Peterborough – East Midlands – West Midlands: Improving upon the hourly service that links Peterborough with Leicester and Birmingham

Corridor 8: Bedfordshire & Northamptonshire to the East Midlands: Looking to strengthen the links between Bedfordshire and Northamptonshire to East Midlands cities

Introduction

The England's Economic Heartland Passenger Rail Study has been prepared by Network Rail System Operator on behalf of England's Economic Heartland (EEH). The study is the first stage (Phase 1) development of a Rail Strategy component that will subsequently feed into the overall Transport Strategy for the EEH region.

The England's Economic Heartland region is one of the world's most exciting economic opportunities. It represents a globally renowned hub for science, technology and research and it acts as a region that has innovation at its heart.

Stretching from Swindon across to Cambridgeshire and from Northamptonshire down to Hertfordshire, EEH as a region has a population of more than 5.1 million, with its 280,000 businesses employing 2.7 million people and with an economy currently valued at more than £163 billion per annum.²

The economic importance of the region, as recognised by the National Infrastructure Commission (NIC), and its position at the heart of the UK's knowledge economy is a reflection of its concentration of world leading research facilities, internationally significant business clusters, track record in innovation and entrepreneurship, and the skills of its workforce.

The NIC's key recommendation was that improved infrastructure connectivity within and beyond the EEH region would help to drive the economic performance of the Heartland. There is also a need to invest in the improvement of the Heartland's existing infrastructure in order to support the planned housing growth.

Rail has the potential to provide improved connectivity by widening labour market access, providing connectivity to housing markets and it can also help to initiate new opportunities for economic growth. High quality infrastructure will increase economic capacity of employment hubs, provide greater levels of interaction and integration across the region, and improve the affordability of business and residential space.

The Heartland's location also means that strategic rail infrastructure supports economic activity right across the UK. Improved inter-regional rail connectivity will not only support the other regions and nations within the UK, it will also contribute to the levelling up of the UK economy as a whole.

Improving infrastructure connectivity is at the heart of ensuring that EEH reaches its full economic potential, but that cannot be at the expense of the Heartland's environment. The consideration of improved rail connectivity is central to the delivery of the legal requirement of net-zero greenhouse gas emissions by 2050.

Future economic growth of this scale and the legal target to achieve net-zero greenhouse gas emissions cannot be realised without a comprehensive plan for the rail network that is in harmony with the EEH Heartland's overarching Transport Strategy and its associated key principles.

Aim of Phase 1 of the Passenger Rail Study

In order to determine how the EEH rail network could accommodate improved connectivity and future growth, a detailed understanding of the existing service that it provides is necessary. This will help understand what needs to change to support the ambition of the EEH Transport Strategy.

² <http://www.englandseconomicheartland.com/Pages/strategic-leadership.aspx>

The overall aim of Phase 1 of the EEH Passenger Rail Study is to conduct a baseline assessment and review of the existing rail network and the level of service of the EEH region. This process will enable EEH and the relevant stakeholders to identify and understand where significant rail connectivity gaps exist.

Rail enhancements, relevant to EEH, that are currently in development or delivery are also captured in this study. This provides an overview of the infrastructure changes actively being investigated across the EEH region. This will therefore help EEH and relevant stakeholders to ascertain whether they choose to further support the enhancements or whether they wish to investigate new rail enhancement schemes that could potentially address connectivity gaps.

The study also presents a baseline of the current decarbonised and non-decarbonised passenger services on the key routes that operate within the region. This provides an insight for EEH and relevant stakeholders as to what remaining services and infrastructure requires decarbonising, which will enable the Heartland to meet the 2050 net-zero carbon emissions target.

The combined aim of all baseline components in this study is to help EEH achieve its four overarching key principles, which are derived from the Transport Strategy:

- Achieving net-zero carbon emissions from transport no later than 2050.
- Improving quality of life and wellbeing through an inclusive transport system accessible to all which emphasises sustainable and active travel.
- Supporting the regional economy by connecting people and businesses to markets and opportunities.
- Ensuring the Heartland works for the UK by enabling the efficient movement of people and goods through the region and to/from international gateways.

The rail routes that are examined by this study all form part of a national network and that is why it is imperative that EEH continues to work collaboratively with partner organisations to maximise the benefits of intervention. This approach is typified by Network Rail and EEH working in collaboration on this study but also by wider working relationships with neighbouring Sub-national Transport Bodies. The decisions made on the network in the Heartland will have a direct impact on the rest of the country and this represents opportunities for change, not just in the EEH region but also on a national scale.

[What is the purpose of baselining the existing passenger network?](#)

Baselining is a method of providing an overview of the existing situation for a specific part of the rail network, typically as a starting point for a Continuous Modular Strategic Planning (CMSP) or for a Rail Study workstream.

The overall aim is to help the study leads and the stakeholders involved in the workstream to develop a comprehensive understanding of the current operations and known issues within the scope of their study and the strategic context in which it will sit.

The information used in the baseline is collated from a range of sources, making use of existing data within the business as well as the professional knowledge and expertise of external colleagues and stakeholders. The baseline will reflect Network Rail's view of the rail network and this can then be used to support an eventual final report.

Methodology

The development of this study is being taken forward in two phases, as outlined in the diagram, below. The completion of phase 1, as documented in this report, triggers the process of phase 2 of the study that will continue throughout 2020.



Steering Group

This study was supported by a Steering Group to guide and shape the workstream. Members of the Steering Group were drawn from the EEH Transport Officer Support Group, the EEH Business Unit, East West Railway Company, Rail Delivery Group and Network Rail. The EEH Steering Group held monthly meetings during the developmental stages of the report, this enabled professional collaboration and input from parties that will use the outputs of this study for further development. The Steering Group will continue to meet throughout 2020 to direct and support phase 2 of the study.

Key Nodes

To keep the focus on a wider regional strategy, a methodology of focussing on a number of key nodes that represented the Heartland was implemented. These were selected to give a representation of the Heartland rail network, featuring the major rail lines in the region, important current centres of housing and employment and also major growth centres.

The 45 nodes, some of which are outside the EEH boundary were selected to give a representation of the network without going in to the detail of the exact timetable of all 146 stations in the Heartland, to avoid the broader macro-themes being overlooked in the pursuit of detail at every station. Every station has an important role to play in the Heartland but in support of the aims of EEH, the decision was made at this stage to take this approach of general corridors between the key nodes. The key nodes are listed in Figure 1 and on the map in Figure 2.

EEH Housing and Employment Centres	Centres External to EEH	Airports
Aylesbury	Birmingham	Birmingham International (Airport)
Banbury	Colchester	Heathrow Airport
Bedford	Crewe (HS2)	Luton Airport
Bicester	Harlow Town	Stansted Airport
Bishop	Ipswich	
's Stortford	Leicester	
Bletchley	London	
Cambridge	Norwich	
Corby	Old Oak Common (HS2)	
Didcot	Reading	
Ely	Rugby	
Hatfield	Worcester	
Hemel Hempstead		
Hertford		
High Wycombe		
Huntingdon		
Kettering		
Leighton Buzzard		
Luton		
Milton Keynes		
Northampton		
Oxford		
Peterborough		
St Albans		
St Neots		
Stevenage		
Swindon		
Watford		
Wellingborough		
Welwyn Garden City		
29 Total	12 Total	4 Total

Figure 1: List of the key nodes that have been identified for the focus of this study

The key nodes were sifted and agreed by EEH and the Steering Group that supported the whole of this study.

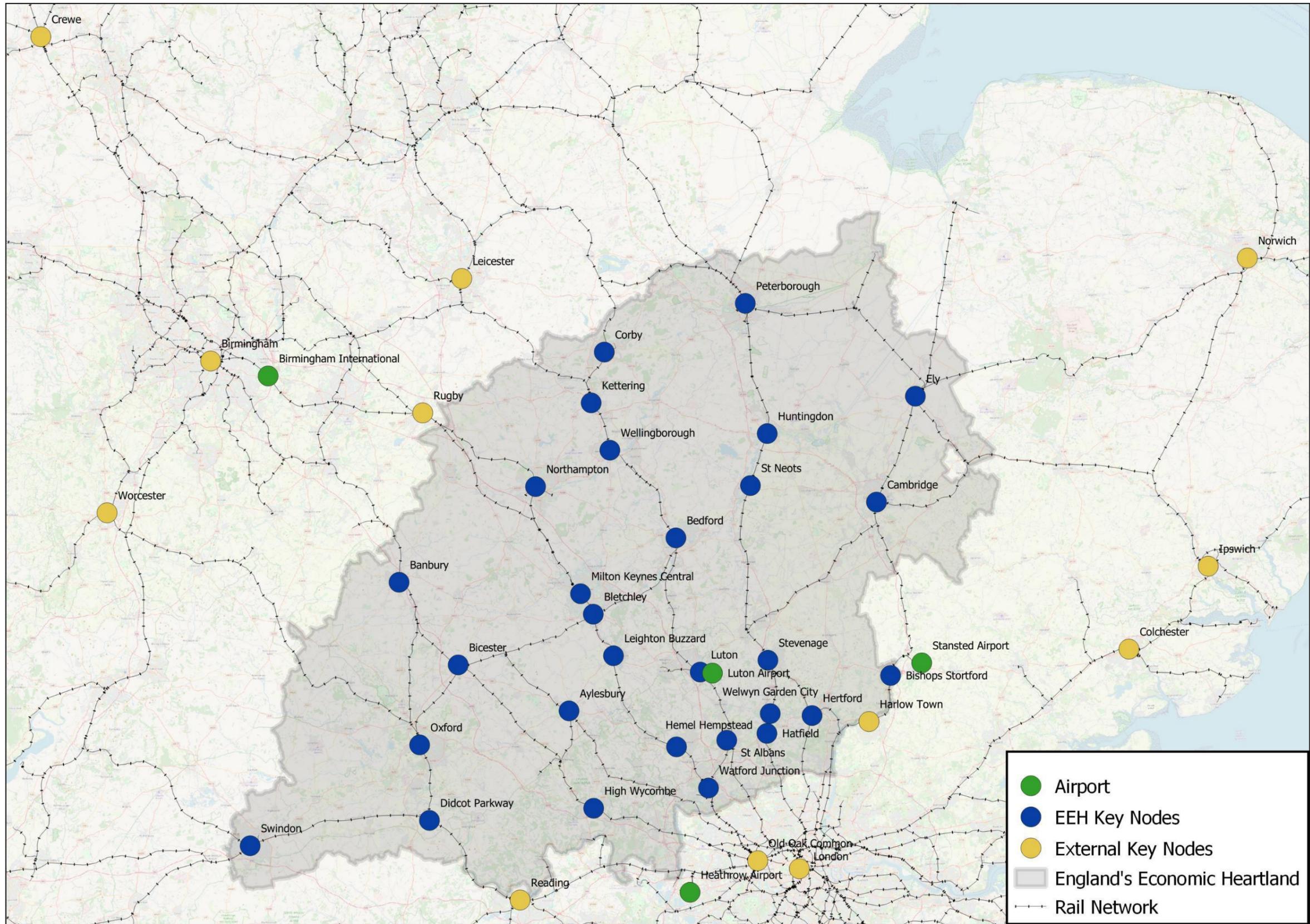


Figure 2: Map showing the geographic spread of the Key Nodes for Passenger Rail Study

Selecting the Key Nodes

A literature review was conducted where all member authorities of EEH were asked to submit their local transport priorities, schemes and associated study for consideration. This was referred to as the 'call for evidence' exercise. This exercise enabled Network Rail to review and analyse the local transport plans and local rail aspirations with the aim to understand which locations within the region were seen as priorities for future development. Partner's Local Plans also highlighted future housing sites, areas of projected employment growth and aspirations for rail schemes, all of which were considered by Network Rail.

Having completed this literature review, Network Rail developed a list of criteria which was used to shortlist locations suitable for inclusion as a key node. Locations within EEH and those that sat outside of the Heartland boundary were selected if they met the relevant profile and criteria. It's important to note that not all of the criteria had to be met for one specific node to be selected, instead, it helped to generate a sifting process, which enabled Network Rail and the Steering Group to identify and develop the final list of the 45 key nodes. The criteria used to assess and identify the 45 key nodes are listed below.

For a location to be considered as a key node, it had to meet at least one of the following criteria:

- Locations within EEH that have significant future housing developments planned.
- Locations within EEH that are expected to experience significant economic and employment growth.
- Locations within EEH that have population levels of at least 30,000.
- Locations that act as key rail interchange hubs, for wider subsequent travel (within EEH or externally).
- Locations that include major airports or High Speed 2 stations.
- Ensuring an even distribution of key nodes across the Heartland that represented as many of the railway lines as possible.

Key Nodes: Supporting Planned Housing Growth

The Oxford-Cambridge Arc (as defined by Government) forms a significant part of the Heartland and EEH is an active member of the initiatives underway at national, regional and local level to improve collaboration on issues of strategic significance in order to deliver sustainable growth for the long term.

The National Infrastructure Commission's 2017 report, *Partnering for Prosperity: a new deal for the Cambridge-Milton Keynes-Oxford Arc*, found that the Oxford-Cambridge Arc is home to some of the UK's most productive and fast-growing cities and has significant potential for transformative growth.

The Commission warned that the region's continued success cannot be taken for granted. Research as part of this study has shown it lacks the necessary infrastructure to connect the corridor and its respective locations together, for example there are no direct train line services available³. In order to realise its economic potential, rail connectivity to and from the associated growth points should be looked upon favourably. This is because rail has the potential to create a modal shift and can consequently reduce car usage.

However, to achieve this, the first/last mile public transport and active travel that feeds rail stations needs to be reliable and of high quality. Advice on best practice principles for sustainable new developments can be found within the Chartered Institute of Highways and Transport's: *Better Planning, Better Transport, Better Places*⁴.

The scale of economic growth within the EEH region reiterates the importance of maintaining or increasing the connectivity of the rail infrastructure across the Heartland, as the unlocking of both housing and employment growth relies heavily on access to a choice of high-quality transport provision.

Following the 'call for evidence' exercise, a number of locations within the EEH region were identified as having significant future housing developments planned. These locations were chosen as part of the key node selection process.

Housing data has been extracted from EEH's Regional Evidence Base, which contains a wide range of strategic information on transport and planned growth.

In 2018, the region's housing stock was estimated to stand at 2,168,520, having grown by 18% (337,975) since 2001 (1,830,545). There is a total of 535,511 new dwellings planned in the region, as identified in Local Plans, which run up to 2036.

When compared with the number of homes in 2018 (2,168,520), the EEH region is expected to experience a 25% (535,511) uplift in housing stock by 2036, with a total of 2,704,031 houses. Housing growth on this scale is predicted to bring about an average increase in dwelling stock within the region of 27,822 new homes per year.

It is important to note that there is provision for a total of 535,511 new homes within the Local Plans of the local planning authorities. However, if the Local Plan annual growth rates were to continue, an estimated total of 862,482 homes would be delivered between 2019 and 2050. This report does not prejudice any discussion a local planning authority will have about levels of growth.

³ Arc Economic Review- <https://pdf.euro.savills.co.uk/uk/residential---other/the-oxford-cambridge-innovation-arc.pdf>

⁴ https://www.ciht.org.uk/media/10218/ciht-better-planning-a4_updated_linked_.pdf

A number of the key nodes identified for this study are shown in Figure 3. The scale of forecasted housing growth set out by each local authority was considered when determining the 45 key nodes.

More specifically, Figure 3 highlights places within the Heartland that are expected to experience the most significant annual increase in new housing developments per year based on committed growth in Local Plans. Aylesbury Vale, Central Bedfordshire, Milton Keynes and Swindon are all expected to experience significant increases in new housing growth. Again, many of the locations as shown in Figure 3 that have a large amount of future housing growth associated with them are reflected in the 45 key nodes of this study.

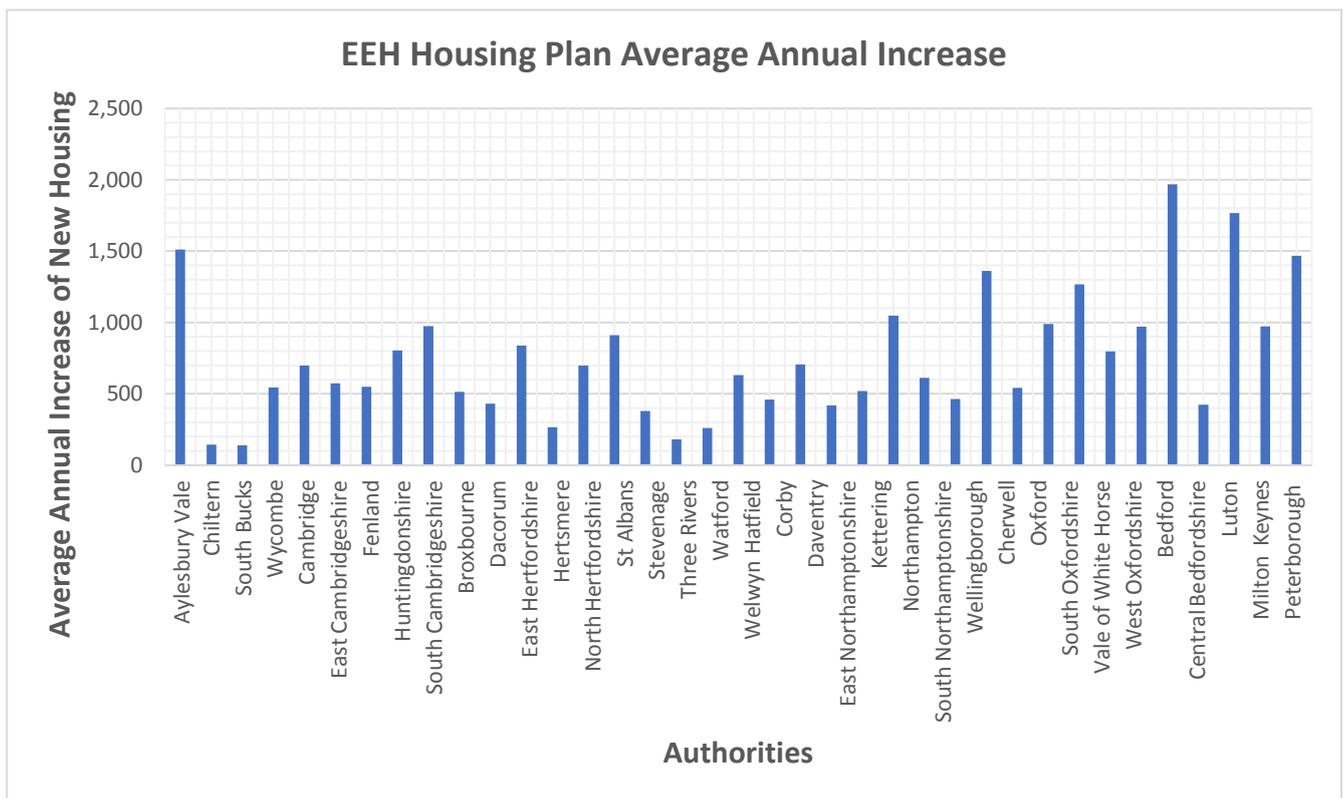


Figure 3: Proposed Average Annual Increase of New Housing Within the EEH Region

A summary of the region's committed housing growth and build out rates taken from Local Plans is mapped in Figure 4. This summarises the incremental buildout rates in committed housing sites from 2016 to 2046. The two maps also provide a visualisation of where the housing development sites will specifically take place in the EEH region. The housing growth data used to produce the two maps has been sourced from EEH's Regional Evidence Base (2019), which is the same source of data used for the proposed average annual housing increase in Figure 4 as previously discussed.

The key nodes selected as part of this study considered places that are delivering large scale strategic housing sites.

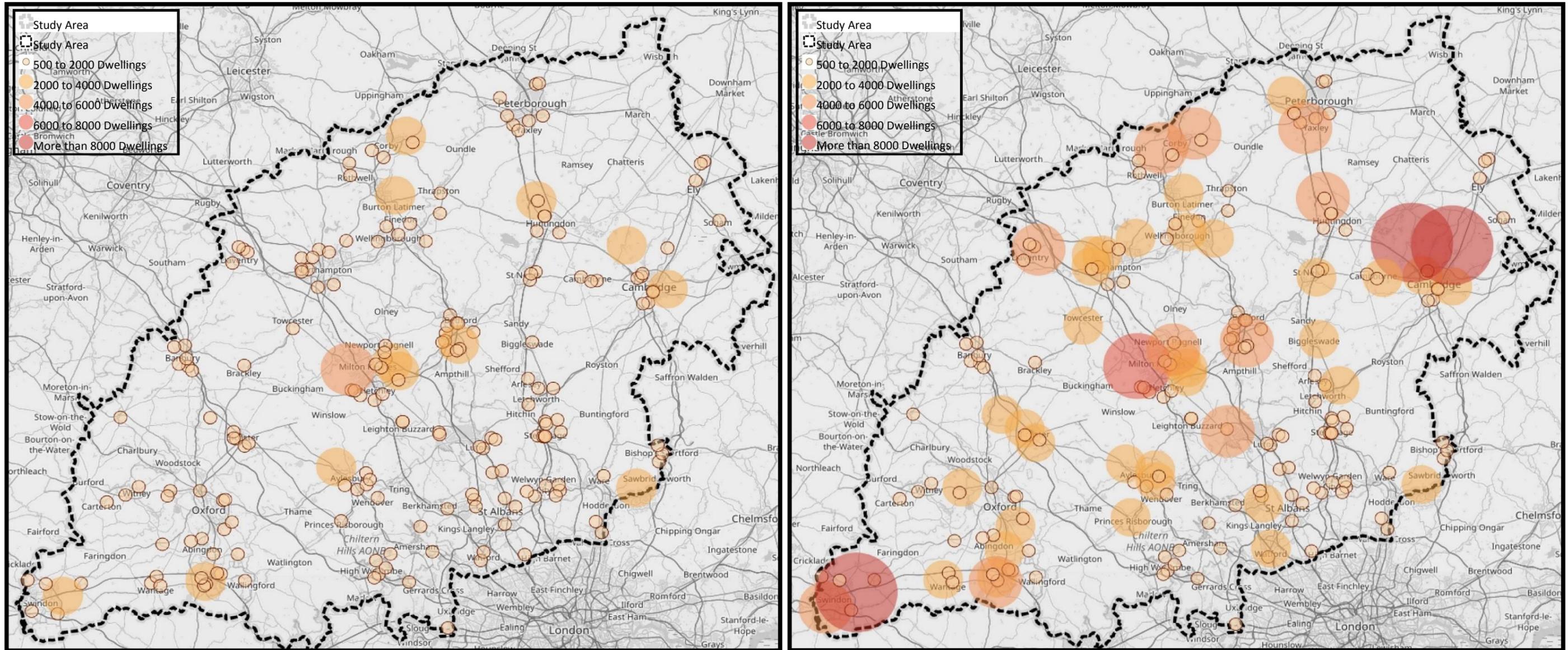


Figure 4: EEH Local Plan Housing Growth for 2016 (left) and 2046 (right)

Key Nodes: Supporting Economic Growth

In addition to new housing growth, the region is expected to experience a significant increase and expansion of economic and employment sites. As previously stated, a number of the key nodes were selected based on the projected employment and economic growth opportunities that were forecasted for such locations. Information is provided below regarding each EEH key node's associated growth and economic potential.

All economic value (GVA) information for the listed key nodes has been extracted from the Office for National Statistics 2018 data, which was released in December 2019.

The additional sources of information used for each key node's economic growth and development attributes can be found in Appendix 1.

Aylesbury

Aylesbury Vale's economy is worth £4.5 billion GVA. Aylesbury Vale has Garden Town status and is set to benefit from East West Rail. Its population is projected to grow from 193,700 (2020) to 220,100 (2037), which is a 13.6% increase.

Aylesbury is set to benefit from the new Aylesbury Vale Enterprise Zone, which will facilitate the strengthening of the infrastructure at the Silverstone Park, Westcott Venture Park and Arla/Woodlands sites. This will attract and develop new business investment, speed up the growth and development of local enterprise; and will ultimately help to address the business-critical infrastructure requirements of the three sites.

The Aylesbury Vale Enterprise Zone aligns with the Buckinghamshire Local Enterprise Partnership's Strategic Economic Plan, which highlights Silverstone Park, Westcott Venture Park and Arla/Woodlands as three key strategic employment sites. The Strategic Economic Plan states that the three sites have untapped potential, and they have the capability to add value to the high-performance technology/motorsport; space propulsion/environmental engineering; and the agri-food/human health sectors.

Specifically, the Arla/Woodlands site gives significant scope for stimulating increased employment in the agricultural, food, and human health sectors to the east of Aylesbury, by building on links with the Arla super dairy industry. The Arla/Woodlands site will facilitate the delivery of approximately 150,000 square metres of new commercial floor space and over 7,000 jobs.

Bedford

Bedford Borough's economy is worth more than £4 billion GVA per annum and is an area of significant planned housing growth. Bedford is home to the Millennium and Cardington Studios, the latter of which has worked on many global blockbusters, such as the Star Wars franchise.

The University of Bedfordshire is well known for its expertise in providing professional and practical advice to local businesses. The university has engaged with more than 800 SMEs in recent years. Its new STEM building, a £40m investment is set out over four storeys and incorporating 6000m² of teaching and laboratory space, allows the University of Bedfordshire to build on its already strong offering to students and local business. Cranfield University and Millbrook Proving Ground are also nearby.

Bedford is also set to become a key transport hub with East West Rail set to provide a number of railway links to other locations from Bedford. This improved infrastructure and connectivity is expected to drive economic growth and development between Bedford and other East West Rail connected locations, e.g. Cambridge and Oxford.

Bicester

Bicester is home to one of the most rapidly growing economic centres of the UK, with a population of approximately 31,000 and this is expected to grow by more than half. Its economy is predominantly focused on storage, defence and distribution activities, food processing and engineering. The Bicester Village shopping outlet is a major UK tourist attraction, drawing in close to six million visitors per annum, including many from overseas. The tourist market highlights the importance of making Bicester an accessible location by rail. East West Rail will provide Bicester with improved connectivity to key economic centres such as Milton Keynes, Bedford and Cambridge. Bicester also has Garden Town status and is part of the Oxfordshire Knowledge Spine.

Bishop's Stortford

Located next to Stansted Airport, Bishop's Stortford lies on the Cambridge-Stansted-London innovation corridor and is also close to the Harlow Enterprise Zone. The key driver of employment growth in Bishop's Stortford and Stansted has been the airport itself. Bishop's Stortford holds economic strengths in transport and storage, retail, motor trading and construction. Bishop's Stortford is also expected to experience growth in both employment and housing, which will in part come about as a result of the £9.6 million funding, which has recently been allocated to regenerate Bishop's Stortford's Old River Lane site. The project will provide 186 high quality homes, a collection of high-quality retailers, an iconic arts and entertainment centre and a new public square. Improving Bishop's Stortford's connectivity by rail to the rest of the EEH region will further benefit the Heartland and the town itself with more employment and economic opportunities.

Cambridge

Cambridge's world-renowned university has created a knowledge intensive economy worth £6.1 billion GVA to the city. Cambridge is experiencing rapid growth of its science parks and it holds world renowned strengths in its life science and digital clusters. The Cambridge life sciences cluster alone is home to over 400 companies, with 15,500 employees, which contribute around £2.9 billion per annum to the UK economy.

Cambridge Research Park, one of the Cambridge Compass Enterprise Zones sites, is located in Waterbeach and Waterbeach New Town, which is situated just north of Cambridge. Cambridge Research Park is an exciting, self-contained community, it has the capability to provide office, laboratory, hi-tech and industrial accommodation. To date, over 330,000 square feet of business space accommodation has been developed or is under construction at Cambridge Research Park and the redevelopment of the nearby Waterbeach Barracks is underway, which is intended to deliver up to 8,000 homes with associated retail and amenity functions.

'Cambridge South' (in the area around Addenbrookes and Trumpington), contains the Cambridge Biomedical Campus, which is the city's biggest employer and the largest centre of medical research and health science in Europe. The UK Government has also announced funding for Cambridge South railway station.

All of the associated economic development and future employment opportunities in Cambridge highlights its importance to the EEH region, as it could provide employment opportunities for many peripheral locations. Excellent rail connectivity to and from Cambridge should therefore be a priority, as it can only help drive the UK economy forward as a whole. East West Rail is set to improve the rail connectivity between Oxford and Cambridge, which are the two major economic and higher education centres within the EEH region and the UK.

Corby

Corby's economy has grown rapidly by 25% between 2013-2018, the Corby borough economy currently generates a GVA value of £1.6 billion. Since 2001, Corby's population has grown by 30% to just under 70,000. The population is expected to grow by a third in the next two decades, which overall, is a rapid and significant increase. With many now labelling Corby as 'the fastest growing town', Corby is building more than 5,000 new homes at Priors Hall. There are also ample brownfield sites within Corby, which hold the potential for future developers, should they wish to invest. This demonstrates the potential that Corby holds and therefore rail connectivity to and from Corby should be prioritised in line with the rapid growth of the town and its population.

Hemel Hempstead

Hemel Hempstead has an Enterprise Zone named Herts Enviro Tech which specialises in green technology and transport. There are also a number of distribution and logistics businesses in the town.

Hertfordshire IQ is an Enterprise Zone based primarily at sites in Hemel Hempstead. The zone holds 3 million square feet of new commercial space, focusing on green technology in partnership with BRE Group, Rothamsted Research and the University of Hertfordshire who are experts in AI, robotics and Big Data.

'East Hemel', which is to be situated on land just west of the M1, next to Hemel Hempstead is a new development that is set to deliver 2,500 new homes, along with new employment space, schools, transport infrastructure and green space. It is expected that the new development will create up to 8,000 new jobs.

'East Hemel' will form the first phase of the 'Hemel Garden Communities' development programme, which aims to transform Hemel Hempstead and ultimately create attractive and sustainable communities to the north and east of Hemel Hempstead. The programme intends to achieve this through the delivery of approximately 11,000 new homes and 10,000 new jobs by 2050.

The planned economic growth in Hemel Hempstead emphasises the importance of providing effective rail connections between it and the rest of the EEH region, as rail has the potential to provide the expected new residents and employees with an effective mode of transport.

Huntingdon and St Neots

The Huntingdonshire economy has a GVA value of £4.4 billion, which has grown by 24% since 2013. Since 2003, there have been 8,000 new jobs created in Huntingdonshire, all of which cover a range of different industries. Huntingdon District Council have stated their ambitions to make Huntingdonshire one of the best places to live, work and invest in England.

The market town of Huntingdon serves as the primary service area in Huntingdonshire. The development of the new Alconbury Enterprise Campus is set to cover 150 hectares of land and will provide major investment opportunities for the Huntingdon economy. It is anticipated that the Alconbury Enterprise Campus will accommodate 8,000 new jobs over the coming years to 2036.

St Neots is the largest population centre in the Huntingdonshire District, and it is also home to an established business base, with a number of major employers and an expertise in manufacturing. St Neots is set for a 26% growth in population by 2036, this will primarily be a result of new housing developments through the eastern expansion of the town. The new development will also bring additional commercial floorspace and jobs.

Both Huntingdon and St Neots have direct connectivity via rail into London and this is important for both town's economic development. In addition, St Neots is located 10 miles from the Enterprise Zone

site at Cambourne, which is set to receive a new rail station as part of East West Rail (in the St Neots/Sandy area). East West Rail will provide direct access by rail to a number of key economic hubs, such as Bedford, Bicester and Oxford; this can only be beneficial for the two Huntingdonshire towns.

Kettering

Kettering borough has a GVA of more than £2.2 billion and has strengths within the health and social care sector. Transport, storage and wholesaling represent the other larger employment sectors in the local economy. Kettering is expected to deliver 8,100 jobs and associated infrastructure between 2011 – 2031 and some large employers are already located in Kettering, these include Weetabix, Alpro, Knights Of Old and Wicksteed Park.

There is also significant locally planned growth set to take place, with Hanwood Park or ‘East Kettering’, which is a mixed-use development containing up to 5,500 new dwellings, a secondary school, up to 4 primary schools, open space (covering parks and play areas), employment areas, local centre facilities (e.g. shops and health care) and associated infrastructure.

The forecasted job growth in Kettering and the associated economic developments highlights the importance of improving rail connectivity between Kettering and the EEH region, as it will facilitate the movement of employees, residents and businesses.

Luton and Luton Airport

Luton’s economy is worth £6 billion GVA, with particular strengths in aerospace technology centred around its airport, which has an Enterprise Zone. Luton is a key logistics hub and The University of Bedfordshire is also based in Luton.

Luton Airport’s Enterprise Zone, specialising in aerospace, engineering and advanced manufacturing will create over 7,200 direct jobs. The airport currently supports 27,500 jobs and contributes £1.8 billion a year to the UK economy, including more than £1.1 billion for Luton, Bedfordshire, Buckinghamshire and Hertfordshire. Expansion plans could provide 5,600 new jobs at the airport and an additional 10,400 new jobs in supply chains, adding nearly £1.3 billion to the economy of the three counties each year. Luton Airport Parkway represents the major calling point for rail services to the airport via the MML. As of 2021 the station will be linked directly via the airport via a new people mover that will halve the current bus transit time.

Milton Keynes

Milton Keynes has the single largest economy in the Heartland, worth more than £14 billion GVA per annum. The population of Milton Keynes is expected to grow from 270,000 (2018) to 500,000 (2050). Milton Keynes also has the highest productivity per worker (GVA per head), almost 45% higher than the national average outside London.

The composition of the Milton Keynes business base is evolving. Although the largest sector by employee number is in both retail and wholesale, there are now growing concentrations of jobs in administration, education, professional services and warehousing and transportation. More than 34% of Milton Keynes’s employment is part of the ‘knowledge-based sector’, this includes creative industries, knowledge services, science and technology. Milton Keynes is also home to many global brands, most notably Coca Cola, Fossil Group, Volkswagen and Santander. It is also a key logistics hub and The Open University is also based in Milton Keynes.

As it is the single largest economy in EEH, it is imperative to ensure that the rail connectivity between Milton Keynes and the Heartland continues to improve. East West Rail will unlock direct connectivity

between Milton Keynes, Aylesbury and Oxford; this can only be beneficial for the EEH regional economy.

Northampton

Northampton's economy is worth more than £7.6 billion GVA. It has strengths in high performance technology and motorsport and is a key logistics hub. Northampton is the second-most populated settlement in the Heartland and is set for significant levels of planned housing growth.

Northampton's Rushden Lakes, which is a newly constructed shopping centre has since brought major retail businesses into the area, such as House of Fraser, Marks and Spencers and H&M.

Northampton has an Enterprise Zone located near its university site called Northampton Waterside. The Enterprise Zone boasts a strong high-performance technology and automotive sector with companies such as Cosworth, Mahle Powertrain and GE Precision Engineering.

With its strong economy and expected growth, Northampton and its contemporary and future rail connectivity to the rest of the EEH region is of great importance.

Oxford and Didcot

Oxfordshire has one of the most robust economies in the UK, it contributed £23 billion GVA to the UK economy. The economy is also growing rapidly, with an average of 3.9% growth year-on-year since 2006. With over 31,000 VAT registered businesses across a wide variety of sectors, it is clear to see the economic strength in Oxfordshire. Oxfordshire is also home to a world-renowned bioscience cluster, with an estimated 180 R&D companies and over 150 firms in associated industries. It has first class R&D facilities, with four innovation centres; the Oxford BioEscalator, the Begbroke Accelerator, Harwell Science and Innovation Campus and Culham Science Centre. The Harwell Science and Innovation Campus comprises 89 space organisations, which employs roughly 1,000 people and is the largest space cluster in Europe. It incorporates the European Space Agency, the Space Applications Catapult and the National Satellite Testing Facility. Oxford is also home to the production of the Mini car.

More specifically, the city of Oxford, home to the world's leading university, is a major centre of the UK's knowledge economy with a GVA of around £6 billion. Oxford Brookes University is also based in the city.

Didcot is a part of the wider Science Vale and is set to double in size. The Science Vale is one of the Heartland's major economic growth hubs, it encompasses Didcot, Wantage, Harwell and Culham. Science Vale has two specific enterprise zones, Science Vale Oxford and the Didcot Growth Accelerator. A number of distribution businesses are based in the area and it will experience significant planned growth, for example Valley Park to the south of Didcot has more than 4,200 dwellings.

The current and anticipated economic growth in both Oxford and Didcot highlights the importance of the two locations in relation to the rest of the Heartland. It also emphasises the importance of improving EEH's rail connectivity, so that local and nationwide economies can improve their interaction with both Oxford and Didcot.

Peterborough

Peterborough has a diverse population, with just under 200,000 residents and its economy is worth £6.6 billion GVA per annum.

Peterborough is also a cost-effective location for business investment due to its ease of access to London. Its economy has strengths in advanced engineering, manufacturing, food and drink, digital

creativity, energy and environment, financial services and it is also a key logistics hub. Peterborough is predicted to be the sixth fastest growing economy in 2020 by Irwin Mitchell and it is experiencing significant planned housing growth. Peterborough is also home to a campus of Anglia Ruskin University.

As Peterborough is an attractive location for business investment, the importance of providing excellent rail connectivity between it and the EEH regional economy is paramount as this will be likely to assist the economic development of both Peterborough and EEH as a whole.

St Albans

St Albans's economy has recently experienced rapid growth, with a 38% increase in GVA, £3.15 billion (2013) to £4.3 billion (2018). The local population stands at roughly 147,000.

The St Albans workforce specialises in building, construction and landscaping; management & consultancy activities and legal/accounting services. In addition, 24% of the St Albans workforce operates in knowledge-based industries.

It's important to ensure that the rail network helps to accelerate the continued growth of the St Albans economy, by moving commuters and residents to and from wider EEH locations.

Stevenage

Stevenage is a major sub-regional centre in Hertfordshire, and it has GVA of £2.7 billion. There is a proposed £1 billion regeneration programme for Stevenage over the next 20 years. The project, named the SG1 scheme is comprised of a series of developments that will introduce new residential, retail and leisure opportunities to the local economy, along with a complete transformation of the town centre. In total, it is expected that over 3,000 companies will offer jobs and training opportunities in Stevenage as a part of this redevelopment programme.

It is clear to see that Stevenage is set for significant levels of investment and rejuvenation, all of which emphasises the importance of improving its connectivity to the rest of EEH by rail.

Swindon

At £9.6 billion GVA per annum, Swindon has the second largest economy in the Heartland. Swindon is the fourth-most populated settlement in the Heartland and is an area of significant planned housing growth, its population is expected to grow by 22% by 2031.

It is home to key knowledge sector clusters, for example Intel is based in the town. It also has strengths in financial and professional services, with Zurich, Capita and Nationwide present. Advanced manufacturing and engineering are also strengths of the Swindon economy, with the Honda plant currently located there.

Watford

Watford is a major sub-regional centre in Hertfordshire and is one of the Heartland's fastest growing economies, with a 2018 GVA of £5.3 billion, this has grown by 41% since 2013.

Over £1 billion of local investment has been taking place in and on the edge of Watford itself. This includes the regeneration of existing commercial areas and the development of new, high quality contemporary spaces for a number of different businesses. This investment will help to meet growing demand and will broaden the town's position as a sub-regional commercial hub. The £200 million redevelopment of the intu centre illustrates the town centre's continued attractiveness to the retail market as one of the premier retailing destinations.

Watford also has strengths in creative industries due to its proximity to film studios such as Warner Bros in Leavesden. Located near to Watford, Elstree and Borehamwood are home to Elstree Studios, which has an associated University Technical College, while the £270 million Watford Health Campus scheme is expected to create 1,300 jobs.

Connectivity by rail can only further accelerate the economic growth and potential of Watford by moving people and businesses to and from it and the rest of the EEH region.

Wellingborough

Wellingborough district has a £1.8 billion GVA value. It is set to benefit from a number of key opportunities, one being Stanton Cross, which is expected to provide 3,650 dwellings and 10 hectares of employment space. With this, Stanton Cross will provide new leisure, and retail amenities along with commercial offices and employment opportunities. Another development is Wellingborough North, which is expected to deliver 3,000 dwellings and 6.69 hectares of employment land.

Future employment sites around the Wellingborough area have the potential to deliver over 10,000 new jobs. One example of such an employment site is Appleby Lodge, which is predicted to deliver over 200,000 square metres of employment space.

Welwyn and Hatfield

The Borough, Welwyn Hatfield has an economic value of £4.5 billion GVA, its value has grown by 34% since 2013. It has several high technology businesses such as Ocado, Tesco and GE Healthcare. The Welwyn Hatfield economy boasts a large and well-educated workforce and it supports a number of small to medium businesses. Welwyn Hatfield is also home to the University of Hertfordshire.

More specifically, Welwyn Garden City holds a population of roughly 45,000. It has been identified as a historic town and consequently receives thousands of overseas visitors each year. The key employers of the town include Quantum Care, Xerox (Technical Centre), Roche Products, John Lewis (Welwyn), Tesco (Head Office) and Thresher Group-First Quench. The main industrial estates and business parks are found at Shire Park, City Park, Bessemer Road and Burrowfields.

Hertfordshire Local Enterprise Partnership, as part of the Hatfield Renewal Partnership, is set to invest in the regeneration of Hatfield's town centre, the project is named Hatfield 2030+. The scheme will transform the town centre through residential regeneration and by providing new space and infrastructure for business start-ups. Hatfield 2030+ will also enhance the range and quality of housing, it will create safe, quality public spaces and will set out to improve walking, cycling and public transport connectivity. This as a whole will create new opportunities for leisure and culture provision and will ultimately unlock the economic potential of Hatfield.

It is clear to see that both Welwyn Garden City and Hatfield have economic strengths and potential. Ensuring that they are both well connected by rail to the EEH region is important, as this will only further benefit the economic growth of the two towns and of the Heartland.

Wycombe

Wycombe is the largest town in Buckinghamshire and is a key economic hub for the south of the county, with the former Wycombe district having a GVA of £5.2 billion. The Wycombe Economic Development Strategy has set a challenge for the economy to grow to £7 billion GVA by the year 2027. The local economy holds strengths in advanced engineering, life sciences/medical devices/biopharmaceuticals; software/ IT/ telecoms; and Food/Drink. High Wycombe is the home of a highly developed software and a digital consultancy cluster and it is also home to Buckinghamshire New University.

The EEH region's key economic and employment growth sites are mapped in Figure 5. The sites on the map correlate to the employment and economic opportunities as stated previously for each EEH key node.

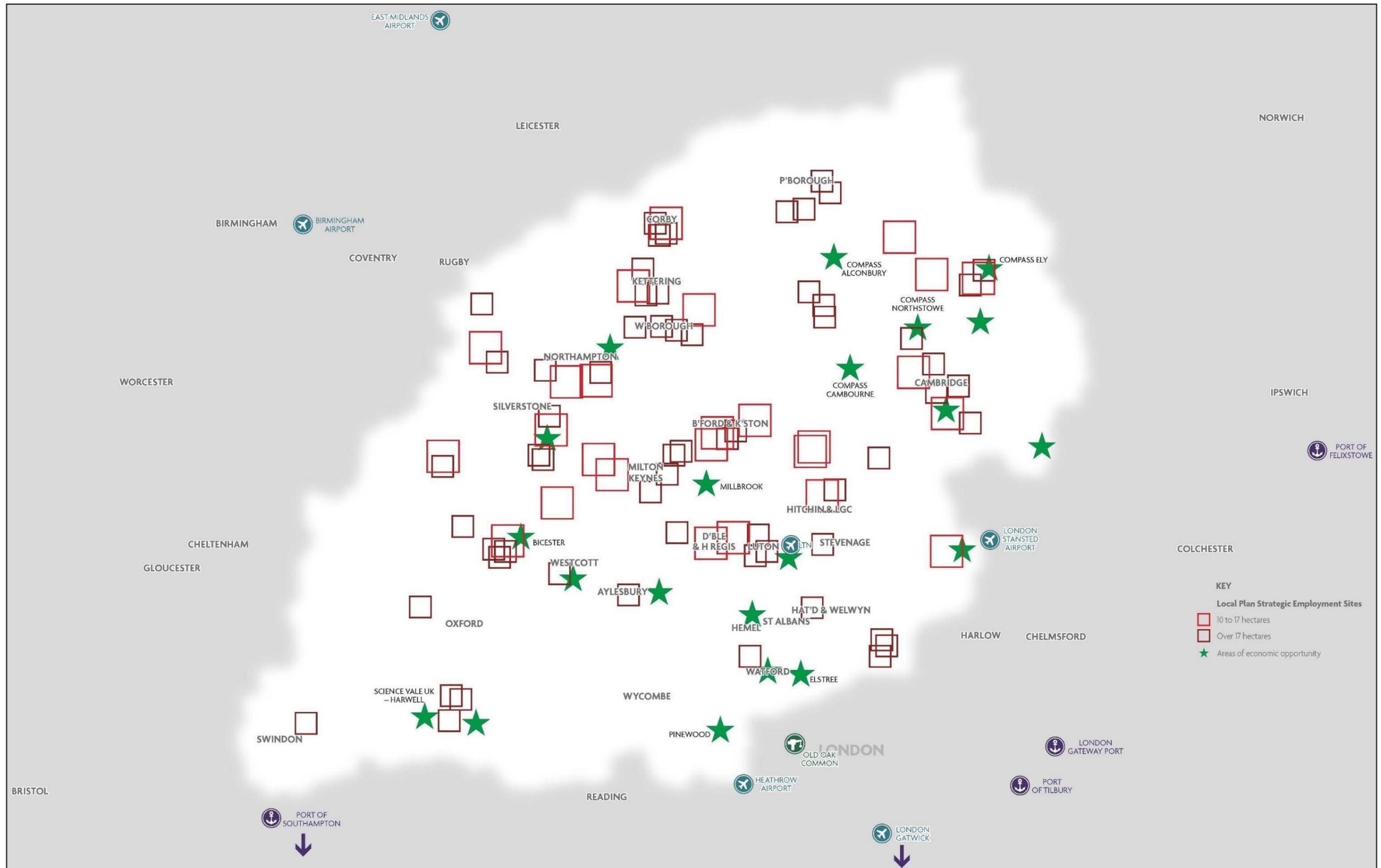


Figure 5: Projected Economic and Employment Growth Sites in EEH

Key Nodes: External to the Heartland

Of the 45 key nodes identified, 14 of them sit outside of the EEH region. These external nodes were selected based on their economic developments and ability to provide rail passengers with interchange and subsequent wider connectivity options.

A summary of each external node is provided below, highlighting the rationale and reasoning as to why each was specifically selected.

London

London has six rail main lines that serve EEH that conclude in specific terminal stations, as shown. There are also other London stations that are not listed below, with Moorgate providing a second London Terminus for some services and Thameslink, Elizabeth Line and Metropolitan Line services from EEH continuing through Central London.

Route	Station
Great Western Main Line	London Paddington
Chiltern Main Line	London Marylebone
West Coast Main Line	London Euston
Midland Main Line	London St Pancras
East Coast Main Line	London Kings Cross
West Anglian Main Line	London Liverpool Street

Figure 6: Primary London Terminal for EEH Main Lines

London's underground network also provides passengers with the capability to interchange from one London terminus station to another. For example, a rail passenger can use the underground network to interchange from London Paddington London Kings Cross station. Between some terminals, walking can be a viable option.

London is represented by the Sub-national Transport Body (STB) Transport for London, which is continuously looking to improve and expand its transport services. The STB is heavily involved in the upgrades to its rail network, the Tube, buses, London Overground, DLR, trams and roads.

As there are six specific London Main Line terminus stations, the EEH Passenger Rail Study refers to them all as one node, being 'London', this is in part for simplicity but also a recognition that many journeys from the Heartland to the capital do not end at their relevant Main Line terminal but involve further transfer to other parts of the city. The nuances of these travel patterns are not a consideration for this study.

In addition to London's interchange and wider connectivity, the capital holds a total population of 8.9 million people and with that it is the UK's biggest employment hub. London's GDP value in 2018 (£ 487 billion) was 23% of the entire UK's GDP value (£2.14 trillion in 2018)⁵.

⁵ London GDP ONS-

<https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/regionaleconomicactivitybygrossdomesticproductuk/1998to2018/>

Birmingham

Birmingham is a key transport and logistics hub. The Birmingham City Centre Enterprise Zone comprises 26 sites across the city centre and is focussed on the Information Communications Technology, Creative Industries and Digital Media sectors.

With three major city centre stations (Birmingham New Street, Birmingham Moor Street and Birmingham Snow Hill), Birmingham as a node represents another major interchange hub for wider subsequent railway travel.

Birmingham is represented by the Sub-national Transport Body (STB), Midlands Connect, which sets out to develop and recommend new infrastructure projects which will provide significant economic and social benefits for the Midlands and the rest of the UK. The Midlands Rail Hub project represents one of the key transport schemes that the STB is driving forward.

Midlands Connect is also planning and developing the best ways of maximising access to HS2 services. HS2 will build new stations at Birmingham Curzon Street and Birmingham Interchange which will act as enablers for wider connectivity to the rest of the UK via the rail network. This will also help to initiate growth in housing and employment around these locations.

In the context of the Heartland, Birmingham New Street is a major interchange hub and destination on the national rail network with direct services to a large number of destinations throughout the UK. Birmingham New Street is also a prominent location on the West Coast Main Line.

Birmingham New Street is a major hub for the Cross-Country network, which provides long-distance train services across the UK, stretching from Penzance to Aberdeen. Again, this extensive rail network provides passengers with the capability to travel from various EEH nodes, interchange at Birmingham New Street and to then subsequently connect with key hubs such as Cardiff, Bristol, Manchester, Leeds and Newcastle.

Leicester

Leicester also falls within the Midlands Connect STB scope. It provides interchange options for journeys between Peterborough and northern based MML locations. It also provides direct connectivity to the wider network, with services available to the West Midlands, Loughborough, Derby and Sheffield. Although it sits externally to the EEH region, Leicester has a major part to play in helping EEH to improve overall rail connectivity.

Irwin Mitchel (2020) reports that Leicester has an economy worth more than £8 billion GVA. Leicester has two significant Enterprise Zones: MIRA Technology Park and the Loughborough and Leicester Science and Innovation Enterprise Zone. Loughborough University Science and Enterprise Park is one of the UK's largest science parks, while the MIRA Technology Park is a world leading automotive research and development park.

Reading

Reading is located in the area covered by Transport for the South East STB. Transport for the South East is striving to create better connectivity, more reliable journeys and more environmentally friendly transport solutions for the region as a whole. The STB has a long term vision of transforming the South East infrastructure to boost the economy, coupled with net-zero carbon emissions.

Reading is a major interchange hub for passengers who wish to travel to the wider rail network, with a high frequency of direct services per hour available to London Paddington. There are a number of direct services available from Reading to major destinations, such as Southampton, Cheltenham,

Gloucester, Bristol, Wales and the West Midlands. Connections to Reading enables access to much of the South and South-West of the country.

In the context of economic development, Reading borders South Oxfordshire and is just 25 miles away from Oxford. Reading tops the Irwin Mitchell fastest growing economies of 2020, with an economy worth more than £8 billion GVA. It is a commercial centre in the Thames Valley region and is home to the University of Reading and the Thames Valley Science Park.

Norwich

Lying at the eastern end of the rail route from Liverpool via Sheffield, Nottingham and Peterborough; Norwich is a key regional city, particularly for the eastern section of Heartland. There are services from Norwich that provide connectivity to much of the Heartland. Norwich is represented by the STB Transport East.

Norwich has a £3.10 billion economy according to Irwin Mitchell 2020 and it is home to several sites in the Space to Innovate Enterprise Zone which specialises in agricultural technology, food and health, offshore energy, and digital/creative sectors.

Ipswich

Transport East also covers Ipswich, which is a major rail junction for access to the ports of Felixstowe and Harwich. Like Norwich, services originating from Ipswich provide a key element of the service provision in the eastern section of the Heartland.

Irwin and Mitchell reports Ipswich as being the 7th fastest growing UK economy, with a GVA of £5 billion.

Colchester

Colchester is also covered by the STB Transport East and it is a major calling point on the Great Eastern Main Line. Colchester is where a large number of the outer suburban services from London terminate or diverge from the Main Line. Colchester was identified as a key destination for locations that are based in the south-eastern reaches of the Heartland.

Colchester is also set to experience an ambitious £3 billion transformation programme. This will include the delivery of new sport and leisure experiences, along with attractive new housing. The town centre is also set to be rejuvenated which makes it an exciting and dynamic location for business development and growth⁶.

Worcester

Lying at the end of the North Cotswold line (NCL), the EEH boundary sits about half way along the route itself and as such, the NCL forms a key part of the EEH infrastructure. The majority of services that serve the NCL originate in or west of Worcester, therefore the city has an important role in relation to the service provision to the west of the Heartland. Worcester is also represented by the Midlands Connect STB.

Rugby

Rugby lies just outside the EEH boundary but acts as an important rail head for the northern parts of the Heartland. It is a major junction on the West Coast Main Line where the route via the West Midlands diverges from the main line. The capacity released by the delivery of High Speed 2 services

⁶ Colchester Ready for Business- <https://colchesterultraready.co.uk/home/regeneration-projects-growth-area/>

will greatly improve the service for the Warwickshire town and increase its attractiveness. Rugby is also represented by the STB Midlands Connect.

Crewe

Crewe is represented by the Sub-national Transport Body, Transport for the North, which is driving forward some of the most significant and transformational infrastructure developments within the UK, e.g. Northern Power House Rail. Crewe is the access location for Liverpool, Manchester and Scotland on the West Coast Main Line, as such it acts as a proxy for EEH passengers who wish to gain access to the North West of the UK as well as being a destination in its own right. It will also be a Major High Speed Hub station and the Crewe Masterplan is set to create a new commercial hub that will surround the new station. The planned development is expected to deliver 37,000 new jobs and an additional 7,000 new homes by 2043⁷, which reflects the power of Crewe's strategic location on the HS2 network.

Old Oak Common

Old Oak Common, in west London, will be a major interchange hub for HS2, Crossrail and the Heathrow Express. It will also connect directly to the Great Western Main Line and a proposed connection to the Chiltern Main Line via a new infrastructure link, which emphasises the role of Old Oak Common as a future major rail hub. It stands as the UK's largest regeneration project, which aims to transform the former railway and industrial area into an innovative neighbourhood, supporting up to 65,000 jobs and 25,500 new homes⁸

Birmingham International Airport & Interchange

Birmingham Airport grew by 40% between 2013 and 2018, to around 13 million passengers per year. The airport is expected to experience a further increase in passenger numbers by the year 2033. The airport's net economic impact is £1.5 billion GVA and it provides 30,900 jobs; this is expected to rise to £2.1 billion GVA and 34,400 jobs by 2033.

Birmingham Airport currently delivers flights to over 150 direct destinations and a further 340 one-stop global connections through the world's major hubs including; Paris, Madrid, Brussels, Amsterdam, Zurich, Frankfurt, Munich, Istanbul, Dubai, Doha and Copenhagen. The airport also provides connectivity to global hubs, with frequent flights to Delhi, Amritsar, Islamabad and Ashgabat. Birmingham Airport provides access to a wide variety of key holiday destinations and the airport also acts as an important gateway for both inbound tourism and the rising number of overseas students who attend the UK's Higher Education Institutions⁹.

Birmingham International station currently provides rail passengers with access to Birmingham Airport and in the future it will have a direct connection to the High Speed 2 Network via Birmingham Interchange station.

Heathrow Airport

Heathrow Airport, just outside of EEH, is the UK's major airport with just over 80 million passengers per annum as of 2018. There are 203 destinations that are served directly by the airport, with New York, Dubai, Dublin, Amsterdam and Hong Kong amongst the most popular.

⁷ HS2 Crewe- <https://www.hs2.org.uk/stations/crewe/>

⁸ HS2 Old Oak Common- <https://www.hs2.org.uk/stations/old-oak-common/>

⁹ Birmingham Airport Master Plan- <https://www.birminghamairport.co.uk/media/5538/birmingham-airport-master-plan-2018-webres.pdf>

The same planes that carry people also carry exports to many global destinations. Almost 30% of all non-EU exports are transported via Heathrow, which makes it the UK's biggest port by value. As a result, Heathrow Airport boosts the UK's connections with the rest of the world by supporting global exports, trade and job opportunities¹⁰.

Heathrow also acts as a major contributor to the regional economy as it has 400 businesses that operate on its site, with a further 76,000 people that work in different roles at the airport¹¹.

Heathrow Airport is connected by rail via TfL and Heathrow Express services, with a number of direct trains available to the airport from London Paddington. It is also set to benefit from an increased service level through the Western Rail Link to Heathrow.

Stansted Airport

Stansted Airport is London's third largest airport, with around 28 million passengers per year, it also boasts one of the fastest passenger growth volumes in the UK and plans to serve 43 million annual passengers in the years to come. In 2019, London Stansted served just over 200 destinations across 40 countries.

Stansted is the only major London airport that can supply operators with the runway capacity and consistent slots needed for long-term growth and the airport is set to undergo a £125 million refurbishment project. The new arrivals terminal is the centre piece of the project and it will provide passengers with direct access to the railway station and other travel modes.

Stansted aims to target the untapped potential of the business traveller market, for example, there are over 94,000 people travelling from the Stansted catchment area to Hong Kong via alternative airports. The airport is in close proximity to the UK's innovation corridor, with Cambridge, the financial power house of Canary Wharf and the technology hub of East London with in easy reach. There is untapped demand from the UK's innovation corridor for long haul business travel, which is another attractive prospect for carriers¹².

Stansted Airport has direct rail services to and from London Liverpool Street, via the West Anglia Main Line. There are also direct services available to Birmingham, Leicester, Peterborough, Cambridge, Ely and Norwich.

Harlow

Harlow sits just outside of the EEH region but has close ties with Eastern. Harlow is situated in the Cambridge to London Innovation corridor and it holds 41,000 jobs. Harlow's business population has also grown at almost twice the rate of the national average and it specialises in the Information Computer Technology sector, Advanced Manufacturing and Life Sciences¹³.

¹⁰ Heathrow Facts and Figures- <https://www.heathrow.com/company/about-heathrow/facts-and-figures>

¹¹ Heathrow's Strategic Brief- https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/about/Heathrow_Strategic_Brief.pdf

¹² Gate Way to Growth Stansted- <https://www.surveygizmo.eu/s3/90168569/Gateway-to-Growth>

¹³ Harlow Economic Development Strategy- <https://modern.gov.harlow.gov.uk/documents/s9153/Appendix%20A%20-%20Harlow%20Economic%20Development%20Strategy.pdf>

Service Levels

Generalised Journey Time (GJT)

Having identified the 45 locations across the region to focus the study, Generalised Journey Times (GJT) between these nodes have been calculated to give an indication of the level of service that exists between these locations. The intention here is to identify areas that are well served and areas that are less well served and places where rail just isn't a practical option. This method of assessing connectivity will enable effective narrowing down of corridors to consider the benefits of improvement in the Phase 2.

GJT is often used in transport planning as it takes multiple effects and amalgamates them into one metric. It is calculated using a combination of average train frequency, in vehicle time and interchange time between destinations. GJT considers services across the whole day for each origin, destination and ticket type, and the average of journey times throughout the day, weighted by a profile of passenger journeys and giving greater weight to the speed and frequency of journey opportunities at peak times. When passengers are required to change trains, it also applies an interchange penalty. These penalties and the service interval penalties are sourced from the Passenger Demand Forecasting Handbook (PDFH) and the penalty increases the longer the total journey is.

Generalised Journey Time = $T + S + I$ where;

T = the total station-to-station journey time (including interchange time)

S = the service interval penalty

I = the sum of the interchange penalties for any interchanges required.

It is best to think of GJT as a measure of how long a journey will take without knowledge of the timetable. This is why a GJT can often be significantly worse than a headline journey time, as headline journey time assumes that the service arrives exactly when required.

GJT is not necessarily reversible, i.e. the GJT from A to B may not be the same as the GJT B to A, especially when changes are required to complete the journey. This is because the initial service intervals will vary and the interchange penalties also vary depending on direction.

By its very nature, GJT does not tell the whole story as over longer distances journey time will be longer by virtue of having travelled further. An alternative method is, Generalised Journey Speed (GJS) which can be used as a comparator by controlling for distance. This helps identify areas where the GJT is long because of slow journeys or poor frequencies rather than just being a factor of distance.

Generalised Journey Speed = $D \div GJT$ where;

D = Distance travelled by the route the rail journey takes (not the 'crow flies' distance)

GJT = Generalised Journey Time as described above.

GJS records an average speed of the journey taken, so if that journey takes a convoluted route, then that large detour to the straight-line distance will be included in the calculation. The result is that on some journey pairs the GJS is quite high because of the routing taking where the constituent legs are quite fast despite being a long route. Where there is particularly stark disparity between the GJS and the average speed when using the straight-line distance in each case study, these will be highlighted in the explanation text supporting the maps

Assumptions

This analysis uses the December 2019 Timetable as a source for the analysis. Changes to services as a result of COVID-19 containment measures are not featured in this analysis. Whilst it is currently impossible to tell what the long-term impacts of COVID-19 will be on society as a whole, the assumption is that rail service provision will at some point return to the level seen before restrictions were imposed, at which point the same issues around connectivity identified in this study will remain.

Changes in service from the previously planned timetable change in May 2020, including franchise commitments that are due to be implemented from the May 2020 timetable and timetable changes in the future are **not** captured in this analysis, the most notable in relation to this work study are:

- **Greater Anglia Franchise Commitments in Train Service Requirement 3:** particularly the doubling of the frequency to hourly of services between Peterborough and Ipswich via Ely with some extensions to Colchester. Although a franchise commitment, this increase is reliant on infrastructure upgrades in the Ely area, that are still being developed, in order to be delivered.
- **East Midlands Railway enhanced timetable;** particularly the doubling of the frequency for London to Corby. The latter will change GJTs on the MML, improving the GJT to Corby but will change those south of Kettering as a result of changes to stopping patterns.
- **Elizabeth Line:** The introduction of Crossrail services through London will have an impact on GJT particularly for journeys on the GWML and GEML where through connections will exist or the journey time from Paddington to Liverpool Street is greatly improved, however for the most part, there will still be the need to change twice to complete a cross-London journey.
- **Stevenage Platform 5:** This will allow up to 4tph to operate from Stevenage to Hertford North alongside an upgraded East Coast Main Line timetable.

East West Rail

For the purposes of this study, East West Rail refers to the creation of a direct rail service between Oxford, Cambridge, Milton Keynes and Aylesbury. The assumed GJT calculations referring to East West Rail in the subsequent sections are derived from East West Railway Company's proposed service structure that does not have services operating beyond Oxford, Cambridge, Aylesbury or Milton Keynes, known as the Western and Central sections of the project. It is envisioned that services will be operating between these locations by 2030.

The Transport and Works Act Order for the Western section between Bicester and Bletchley was granted in 2020 with the aspiration for services to commence between Oxford and Milton Keynes in 2024.

East West Railway Company announced the preferred route corridor for the Central Section in 2020, with new stations on the ECML between Sandy and St Neots along with a planned new station at Cambourne before approaching Cambridge from the south. Over the coming years it will continue to develop and define the routing before applying for a Development Consent Order to construct the new line.

This analysis does not include the prospect of an Eastern Section as currently being investigated by the East West Consortium although some conclusions of this study may support the ongoing business case development of an Eastern Section of East West Rail.

General Service Levels

Most frequently, the biggest impact on GJT is the frequency of the service. An hourly service frequency contributes 30 minutes of initial service frequency, as that is the average wait for a train, but a half-hourly frequency contributes just 15 minutes to the GJT as the average wait is halved compared to an hourly frequency. The above is true when considering frequency as an even interval, however some stations have trains at uneven intervals and this has their own impact on the service level frequency.

On a metro type line where all trains stop at each station at an even frequency, the expectation would be for GJT to increase in a linear fashion as distance from origin increases. As will be displayed over the following graphs, this is not always the case, as the variety of services and frequencies have a big impact on GJT.

What we see is that on each Main Line, as the different types of service groups all combine, locations that are of different distances from London have similar GJTs. This is caused by some locations receiving faster services that call at fewer locations on the way to their destination. This brings them temporally closer to a location than the stations that are omitted from these fast journeys.

As the EEH rail network is dominated by the arterial nature of the rail network radiating from London and many journeys are completed by travelling via the capital, most of the GJTs between two nodes are a construct of the two legs in and out of London. To understand the EEH network means understanding the service levels on the Main Lines and their connection to London.

Throughout this study, the GJT to London refers to the GJT to the relevant Terminal Station in London.

Paddington to EEH

The GWML service offering is dominated by fast services to the West of England, consequently, the EEH key nodes located along the route benefit as result of these faster services. The high service frequency and fast calling patterns mean that the GJTs are quite low for GWML locations as shown in Figure 7.

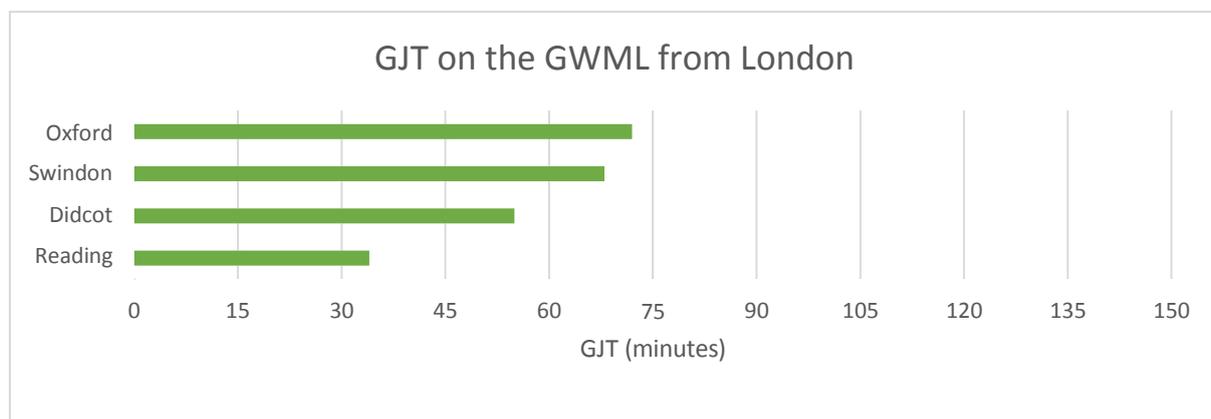


Figure 7: GWML GJTs from London to EEH Nodes from London Paddington

As demonstrated in Figure 7, the GJTs increase in proportion to the distance travelled, but the GJTs also increase due to the lower levels of service frequency as the distance from London increases. For example, Reading does particularly well for GJT as nearly all services originating from London call there meaning that the GJT is nearly the same as the actual journey time by virtue of the frequency, meaning that the requirement to check a timetable is not really necessary as the service is effectively 'turn up and go'.

Marylebone to EEH

Despite the differences in distance, the GJT is fairly consistent across all the locations (Figure 8), in part due to the provision of a number of services that run with limited stops to High Wycombe, Bicester and Banbury meaning they have a high average speed. Aylesbury is the outlier, as it is closer to London than Bicester, Banbury and Oxford, yet it has an equivalent GJT as a result of services calling at making many intermediate stops, extending the journey time.

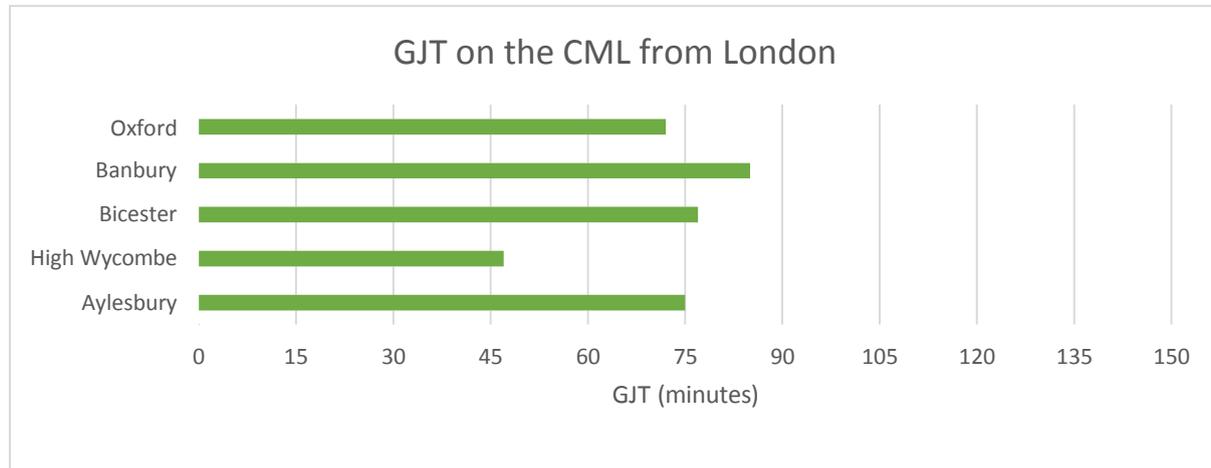


Figure 8: Chiltern Main Line GJTs to EEH Nodes from London Marylebone

High Wycombe has a relatively low GJT from London as it served by five services an hour, often being the first stop on trains to Birmingham and Oxford, which operate the fastest services on the route, after leaving Marylebone.

Marylebone GJTs to EEH do not include the fact that Marylebone is poorly connected to the London Underground network with only one line serving the station directly. For transfers on lines other than the Bakerloo line, passengers are required to walk to Baker Street station to pick up London Underground connections, especially for the other main EEH London Terminals of Euston and Kings Cross/St Pancras. These poor connections extend the GJT when transferring to other terminals.

Euston to EEH

Fast services on the WCML typically call at Watford Junction, Milton Keynes and Rugby, with the remaining stops picked up by a mixture of semi-fast and slow services. The result is a generally increasing GJT in proportion to the distance travelled. The exception is Milton Keynes, where the 4 fast trains per hour (one each to Birmingham, Manchester, Chester and Crewe) means that despite being further in distance from London than Bletchley, the GJT for Milton Keynes is comparatively lower. Unfortunately, because the fast services to Milton Keynes bunch together in the hour, the full effect is not realised.

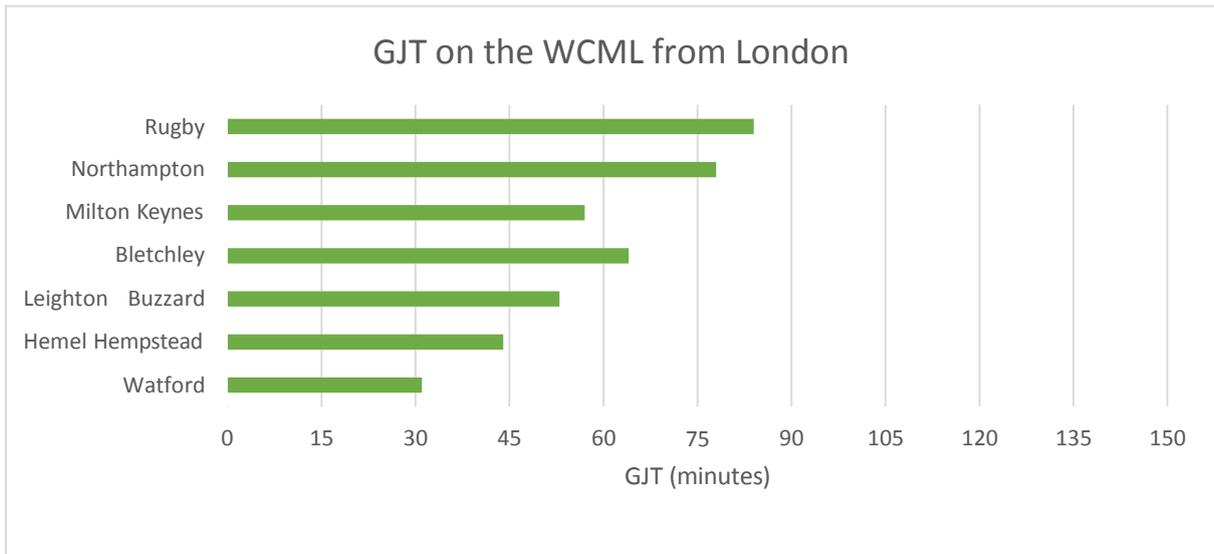


Figure 9: West Coast Main Line GJTs to EEH Nodes from London Euston

There is one train per hour from London that runs non-stop to Rugby and one per hour that stops only at Milton Keynes. These two services off-set the negative effect of the three slower services to Northampton meaning that, although it takes 20 minutes by train to travel between Northampton and Rugby, the GJT from London to Rugby is only 6 minutes longer than the GJT from London to Northampton. This is because Northampton lies on a loop off the main line meaning the fastest services to the West Midlands and the North West (that provide the fastest services to Milton Keynes and Rugby) do not call at Northampton.

St Pancras to EEH

Figure 10 shows the GJT for EEH nodes on the MML from London St Pancras. This doesn't include the MML Upgrade Programme, which enables two trains per hour to Corby.

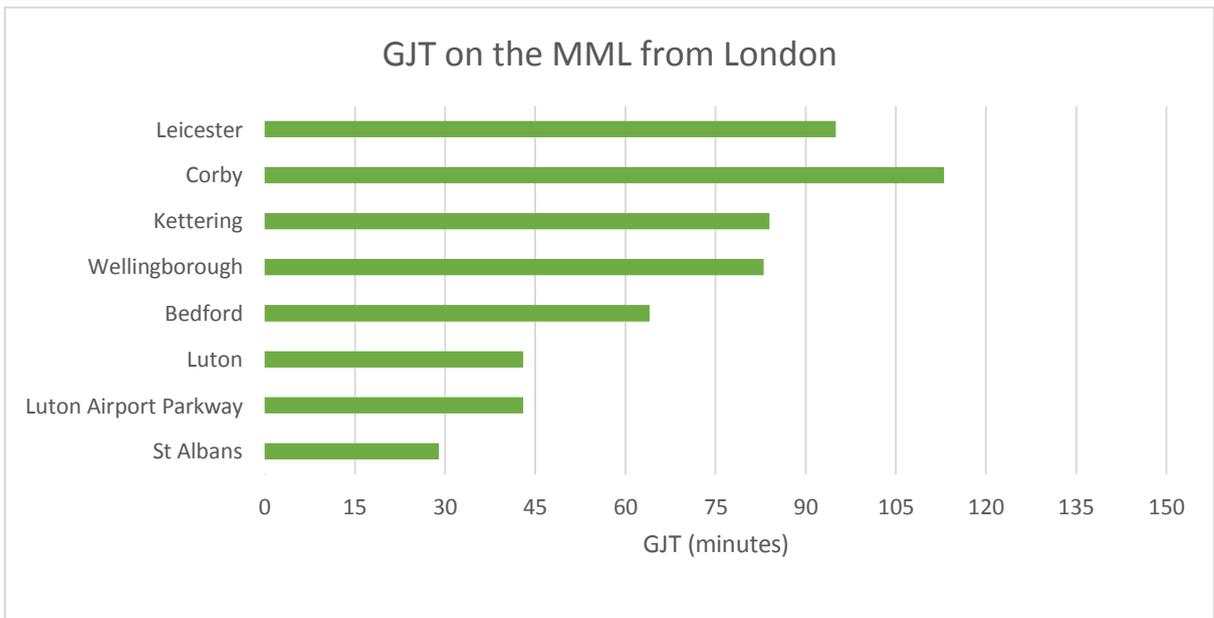


Figure 10: Midland Main Line GJTs to EEH Nodes from London St Pancras

What stands out is the impact that the high frequency of the Thameslink services has on GJT. South of Bedford, the high frequencies do a good job of keeping GJT closer to the actual travel time (the fastest

journeys to St Albans take just 20 minutes from London), this is enhanced by the addition of some fast service calls at the stations to contribute.

North of Bedford there is a balance between keeping the speed high to give fast journeys between London and the East Midlands and the ability to serve the stations of Wellingborough and Kettering. The result is that not all of the four fast trains per trains call at intermediate stations, meaning that the GJT is negatively affected.

The actual timetabled time between Kettering and Corby stations is only about eight minutes, however, because of the hourly frequency, the GJT differential between the two stands at 29 minutes between the two locations. This is because Kettering gets twice as many trains to London as Corby. The enhancement of service (2tph) to Corby will greatly improve the existing GJT. This provides a good example of how service frequency can have a very big impact on GJT.

Kings Cross to EEH

Figure 11 shows that the GJTs from London to East Coast Main Line destinations are dictated by the mixture of service types. Locations such as Stevenage and Peterborough benefit from a mixture of high frequency and fast services. Similarly, Cambridge with a large number of services to choose from also benefits. The GJTs to the other locations on the route are comparatively longer, usually as a result of being on stopping, or semi-fast calling services. This typically contributes to a lengthened journey time, although in some cases a high frequency of service off-sets that.

Ely has a notably higher GJT than Cambridge due to fewer direct services being available from London. However, the services that are available (London to Ely) tend to be continuations of the fast services to Cambridge, this helps to offset some of the GJT increase caused by the lower levels of service frequency.

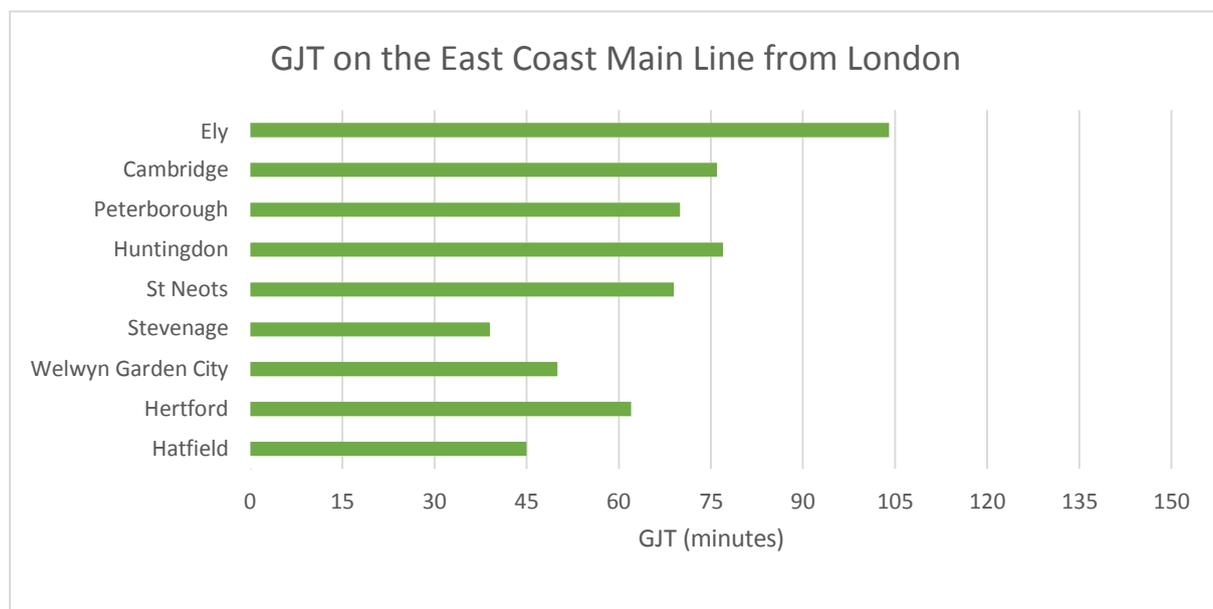


Figure 11: ECML GJTs to EEH Nodes from London Kings Cross, St Pancras or Moorgate

St Neots, Huntingdon and Cambridge are of similar distances from London, so it is perhaps not unexpected that these locations have similar GJTs. Peterborough sits in this grouping of GJT, despite being quite some distance further from London. This is due to the fast services that call there en-route to the North which have a high average speed, Peterborough often being their first stop after Kings Cross.

Hertford North is served by all stopping services, usually from Moorgate. Although frequent, the all stop nature, with no faster alternatives means that the GJT to Hertford North is abnormally long compared to other locations of a comparative distance from London, both on the ECML and other main lines.

Liverpool Street to EEH

Liverpool Street provides services to East Anglia via the West Anglia Main Line and Great Eastern Main Line. Despite the big differences between distance of the locations identified in Figure 12, the GJTs are all in and around the 1 hour to 90-minute bracket except for Norwich, where the long distance counts strongest towards the GJT.

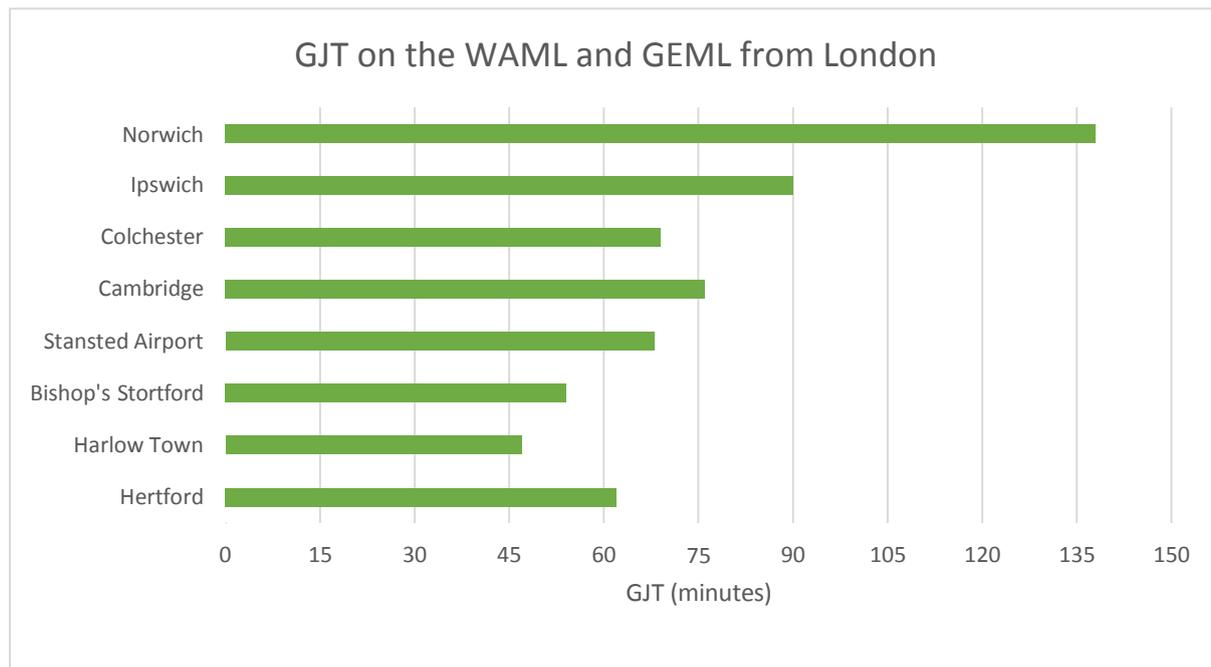


Figure 12: WAML & GEML GJTs to EEH nodes from London Liverpool Street

Journey Times from London

When plotting these Generalised Journey Times on a map (next page), it is clear to see the concentric rings of connectivity as the railway routes emanate from London. Locations that are of a similar distance from London have, in the most part, similar GJTs from the capital. This is shown on the map in Figure 13. Generally, this follows a linear progression but there are some locations where the GJT can be described as out of sequence. In some cases, this is because the service is notably better than you would expect, in others it is worse. Examples of these would be Milton Keynes, Peterborough and Swindon which have better GJTs than many locations that lie closer to London. Conversely, Hertford and Aylesbury have GJTs that are worse than other locations of a similar distance to London.

All the locations that will lie on the core East West Rail route, Oxford, Bicester, Bletchley, Bedford and Cambridge have very similar GJTs of between an hour to one hour 15 minutes from their respective London termini.

In terms of rail connectivity to the capital, the offering is very good, however when planning journeys by rail between two locations in EEH especially on different main lines, the increases in GJT often rules rail out as a realistic option.

Generalised Journey Times to EEH Nodes from London

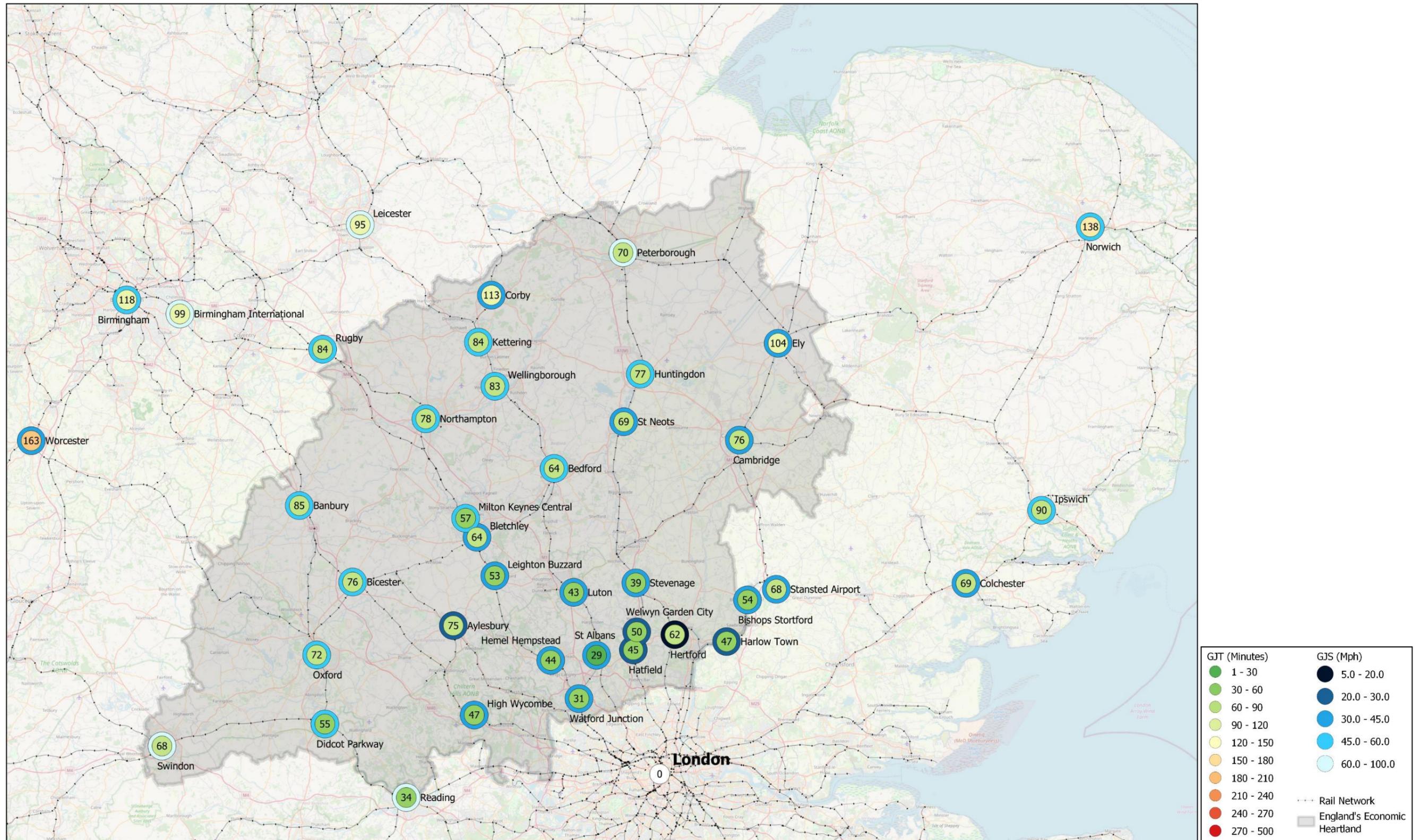


Figure 13: Generalised Journey Times and Speeds from London Terminals to EEH Key Nodes

Case Studies

Having established the EEH key nodes relationship with London, it is now important to understand their relationship with each other. The timetables that operate on each of the main lines is typically geared towards providing capacity and fast journey times in to London. Often point to point connectivity along the route is a secondary consideration to provision of the London services. To demonstrate this, 10 Case Studies, from across the EEH region have been selected to show how journeys from one EEH location vary depending upon their location in the region.

The ten Case Studies that are looked at in more detail are:

Aylesbury
Oxford
Swindon
Milton Keynes
Northampton
Bedford
St Albans
Peterborough
Hertford
Cambridge

These locations represent a spread across the entire rail network of the Heartland. The list picks out some of the best and worst connected nodes on the rail network and shows the differing fortunes depending upon location in the region and the current railway service offering.

The case studies also represent some of the largest employment and housing growth areas in the Heartland.

Each Case Study is presented with a summary overview followed by a detailed breakdown of what factors are affecting the GJT to the other nodes in the region and how each node could potentially benefit from the addition of East West Rail in narrative form. Additionally, comparisons to road journey times to each other Case Study node plus other local key nodes. The full suite of Road Journey Times that are used in this analysis are included in Appendix 4.

A further Case Study then looks specifically at East West Rail and the indicative GJTs that the new railway will deliver between the key nodes that lie on its route.

Case Study 1: Aylesbury

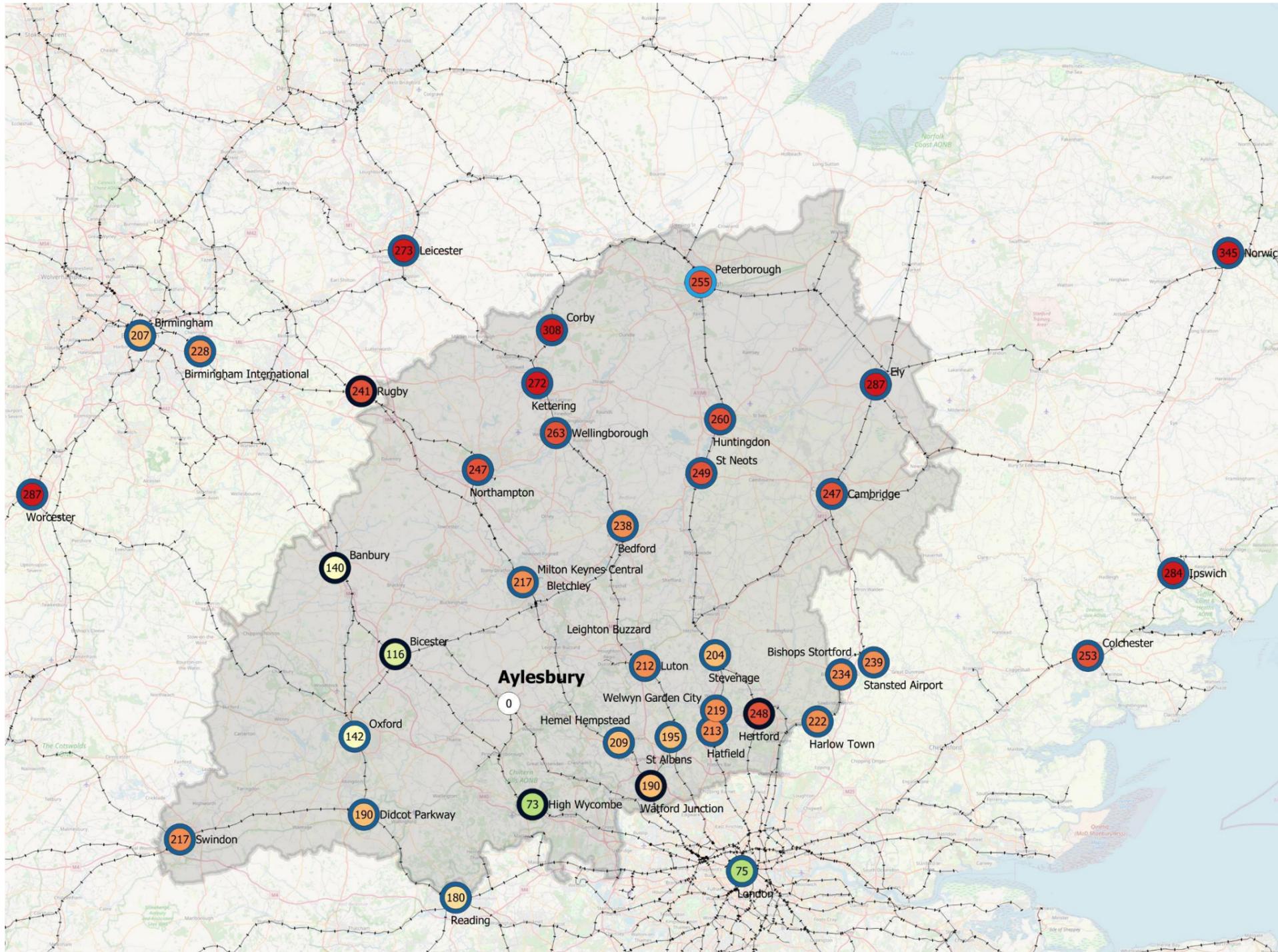
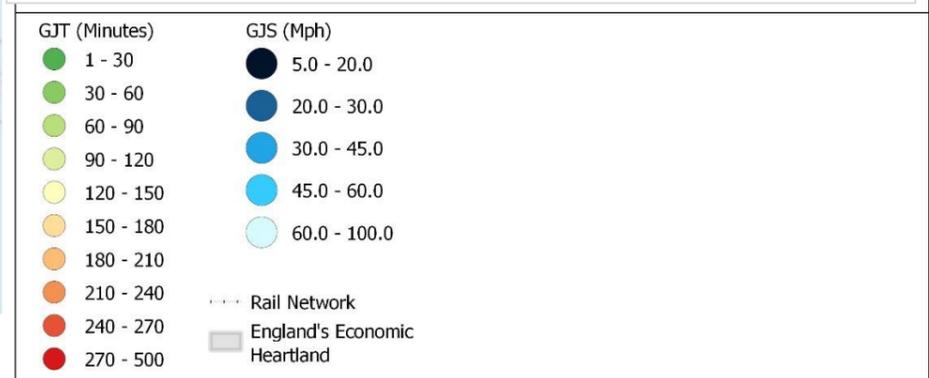
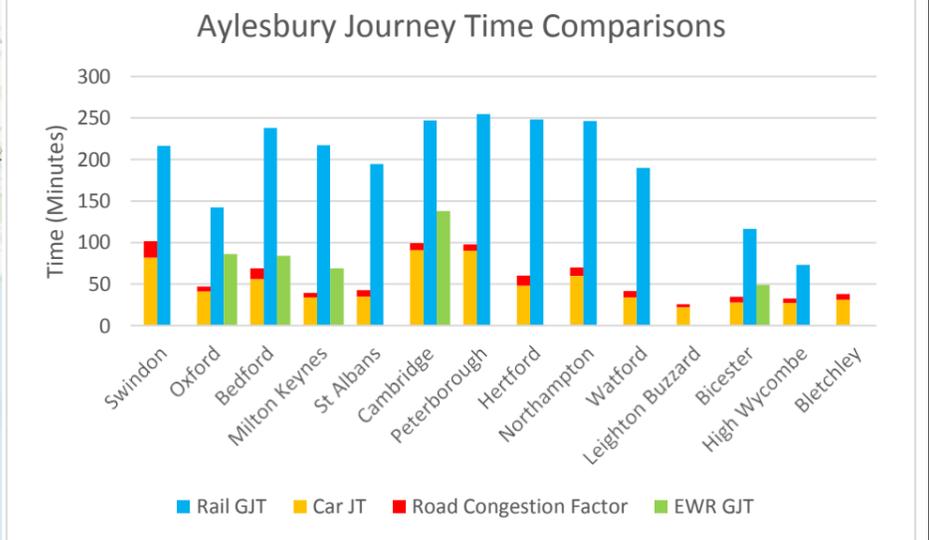


Figure 14: Generalised Journey Times and Speeds to EEH Key Nodes from Aylesbury

Aylesbury is located at the end of two different routes to London Marylebone. Served by Chiltern Railways with typically three trains an hour to London, two via Amersham and one via High Wycombe, end to end journey times are long due to low line speed and frequent stops via both routes, with most journeys taking around an hour. There are additional services in the peaks that provide some faster links to London.

There are direct services to Aylesbury from the following EEH Nodes:
 London (3tph)
 High Wycombe (1tph)

In the future, East West Rail will provide connectivity to Milton Keynes via Winslow and Bletchley



Chiltern Main Line

Aylesbury is located on the London to Aylesbury line, which runs with a maximum speed of 75mph and with frequent stops, resulting in journey times from Aylesbury to Marylebone of approximately one hour on average. Despite three trains per hour running, only two of the trains take the fastest route via Amersham to London. The GJT of Aylesbury to Marylebone being 1 hour 15 minutes. The GJS stands at just 30 mph between Aylesbury and London, which is a result of the slow line speed (75 mph max) and the frequent stopping pattern of the three services each hour.

The third train an hour from Aylesbury operates via High Wycombe and is the only train to link these two regionally important Buckinghamshire towns. The journey is slow calling at all stations on the way and is hampered by slow line speed between Aylesbury and Princes Risborough (just 40mph). This is what limits the GJT to 1 hour 13 minutes, despite the two locations being just 13 miles apart. By comparison, the same journey by car takes 27 minutes without traffic, 33 minutes with traffic.

To reach other locations on the Chiltern route by rail, passengers from Aylesbury face a lengthy journey, which is mainly due to Aylesbury's inconvenient location on the rail network, with no route North. This means that passengers must use the hourly service that connects to the Chiltern Main Line at Princes Risborough via the Aylesbury-Princes Risborough line. Once at Princes Risborough, there is an hourly service available to both Bicester and Banbury. However, as a result of the interchange and slow overall journey pattern, the GJT of Aylesbury to Bicester stands at 1 hour 56 minutes and the GJT to Banbury stands at 2 hours 20 minutes. The car journey to Bicester takes 28 minutes without congestion and 35 minutes with traffic.

Another problem in relation to the rail connectivity of Aylesbury is that Princes Risborough is not a viable interchange hub for Aylesbury based passengers who wish to travel to Oxford or Birmingham. This is because there are only a handful of direct services per day from Princes Risborough to either of the locations, therefore, passengers must usually interchange at High Wycombe instead, where there is one direct service per hour available to Oxford and to Birmingham Moor Street. This is quite a significant detour, i.e. travelling south to High Wycombe before heading north. As a consequence of the interchange at High Wycombe, the low service frequency and the lengthy detour, the GJT of Aylesbury to Oxford stands at 2 hours 22 minutes compared to a car journey of 41 minutes (congestion adds a further 6 minutes) and the GJT to Birmingham stands at 3 hours 27 minutes.

Great Western Main Line

Access for Aylesbury to the GWML locations, i.e. Reading, Didcot and Swindon and in the future, Old Oak Common, involves a journey in to Marylebone, an inconvenient transfer to Paddington (typically taking around 20 minutes) before picking up fast services to the West and South-West. As a consequence, the GJTs to these locations is strongly affected by the slow connection Aylesbury has to London.

An example of this is the rail journey of Aylesbury to Swindon, which has GJT of 3 hours 37 minutes. However, the road journey takes just 1 hour 22 minutes and even with congestion factored in, takes 1 hour 42 minutes.

West Coast Main Line

The south of the WCML is geographically very close to Aylesbury but, the GJTs from Aylesbury to the WCML locations does not reflect this proximity. The lack of a direct connection to the WCML means that the GJTs from Aylesbury to the WCML suffer as a result of a convoluted route and the already slow GJT of Aylesbury into London. The two interchanges required at both Marylebone and Euston and a lengthy, out of station Underground journey between the two London stations (Baker Street to

Euston Square with) also adds to the GJT to WCML locations. Thus, despite their proximity to Aylesbury, the WCML locations have a GJT starting in excess of 3 hours. This means rail is not a viable option for these journey pairings currently.

For example, the GJT of Aylesbury to Milton Keynes stands at 3 hours 37 minutes, this is despite the two locations being around 16 miles apart 'as the crow flies'. The GJS via London of 26 mph, can be recalculated to provide a more accurate representation of the average speed of the journey when done by rail. (16 miles distance with a GJT of 3 hours 37 minutes), giving a speed of just over 4mph. This suggests that the average speed of the journey by rail between Aylesbury and Milton Keynes in the context of the 'as the crow flies' distance is essentially walking pace. By contrast, the same journey by car takes just 34 minutes (39 minutes with congestion).

[Midland Main Line, East Coast Main Line, West Anglia Main Line and Great Eastern Main Line](#)
The lengthy transfer via London Underground between Marylebone and St Pancras, Kings Cross and Liverpool Street to reach the MML, ECML, WAML and GEML respectively drives the majority of the extended GJTs to locations on these routes. The high level of service on the southern end of the MML and ECML means that this is not a major contributing factor on these lines, although the lack of fast services to the likes of Welwyn, Harlow and Hertford, means that the GJTs to these locations are quite slow, at around three and a half hours.

It is notable how journeys of Aylesbury to Peterborough have a GJT of 4 hours 15 minutes. This journey is far from competitive with road which can achieve the same journey in 90 minutes (98 with congestion).

On the MML, the offering of frequent and fast services to all stations south of Bedford helps to keep the GJT down. However, the GJTs for locations that sit north of Bedford increase significantly which is due to the lower service frequency available from St Pancras (2tph to Kettering and Wellingborough and 1tph to Corby).

The GJTs to Ipswich and Norwich, whilst long, are reflective of the large distances involved. Whilst not the most direct, the routing via London is not as convoluted for these journeys as it is for the other arterial Main Lines. Here the big factor is the low service frequency available from Liverpool Street, especially to Norwich (2tph) and the long passenger waiting time to change stations in London.

[East West Rail Impact](#)

East West Rail will introduce an hourly train from Aylesbury to Milton Keynes. This has the potential to make some big differences to the GJT for Aylesbury beyond this service offering by opening up new connectivity to the North. This will reduce the need for all but the most local rail journeys to travel via London.

- Oxford will be reachable via an interchange at Winslow giving a faster but still circuitous connection.
- WCML stations can be reached by an interchange at Bletchley or Milton Keynes although the benefit of interchanging for stations south of Bletchley will be limited by the long route required.
- MML, ECML and WAML will be accessible via an interchange at Bletchley on to the East West Rail central section services. A further interchange will be required for journeys to other destinations, excluding Bedford, the ECML interchange station and Cambridge.

The current specification for East West Rail is for just one train an hour from Aylesbury. While this will undoubtedly improve some of the existing rail options and crucially, make them competitive with

road, the low frequency will mean that the service interval penalty will feature as a large component of all journeys from Aylesbury that utilise East West Rail.

Access to HS2

In the future, a direct connection to Old Oak Common on the GWML to the Chiltern Main Line, as outlined in Network Rail's West Midlands and Chiltern Route Study¹⁴ (2016) will provide access to HS2 for fast services to the North of the country. This will potentially benefit Aylesbury, with significantly improved GJTs to the GWML. This would also enable Aylesbury to have access the same choice of direct services from Paddington with the added benefit of eliminating the need to travel all the way in to London and transfer between Marylebone and Paddington via the Underground.

Summary

Aylesbury's rail connectivity to the rest of the EEH region is poor with limited direct connectivity to other EEH locations as a result of being situated at the end of a commuter line from London. The vast majority of journeys require transit via London and while East West Rail will improve upon that, reaching anywhere other than a handful of locations from Aylesbury will still require a number of changes of trains.

It is worth noting that whilst currently, the road network provides the best option for journeys from Aylesbury, the journey times on road are in themselves, not particularly quick which gives rail an opportunity to be much more competitive on a wide range of journeys.

¹⁴ West Midlands and Chilterns Route Study <https://cdn.networkrail.co.uk/wp-content/uploads/2017/08/West-Midlands-and-Chilterns-Route-Study-Final.pdf>

Case Study 2: Oxford

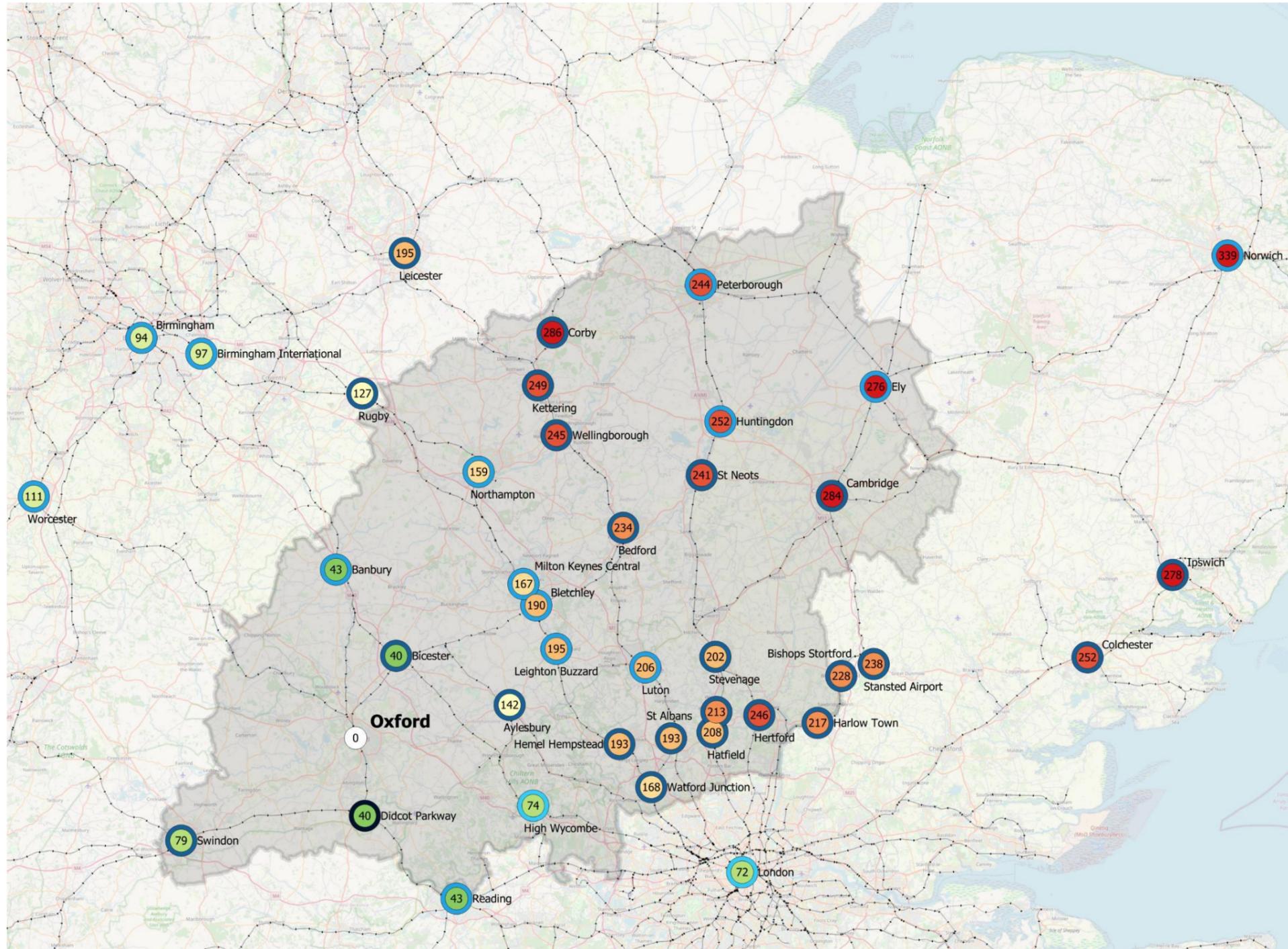


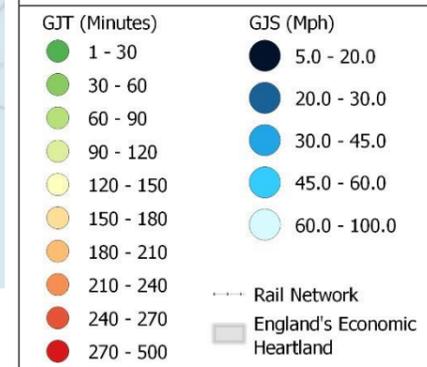
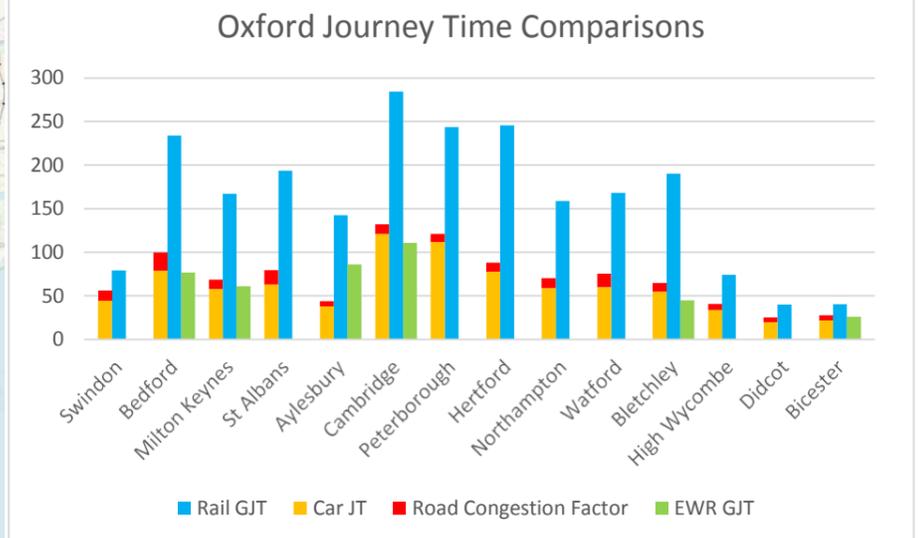
Figure 15: Generalised Journey Times and Speeds to EEH Key Nodes from Oxford

Oxford is located on an important cross-country rail route that links the South Coast with the Midlands and the North.

Trains are provided by three train operating companies, Great Western Railway, Chiltern Railways and CrossCountry Trains. In the off-peak there are typically direct services to the following EEH Nodes:

- Banbury (2tph)
- Bicester (2tph)
- Birmingham International (1tph)
- Birmingham New Street (2tph)
- Didcot (2tph)
- High Wycombe (1tph)
- London (4tph)
- Reading (4tph)
- Worcester (1tph)

In the future East West Rail will provide direct connectivity to Milton Keynes, Bedford and Cambridge.



Oxford Corridor, Great Western Main Line and Chiltern Main Line

Local services to Didcot and the two trains an hour to Banbury (the latter supplemented by a sporadic third train in some hours) mean that the GJT to these locations is 40 minutes and 43 minutes respectively. In the case of Banbury, the GJS is 32mph.

The major GWML hub of Reading is served by four direct trains per hour, typically these run non-stop from Oxford to Reading with the potential to reach 125mph meaning that the GJT to Reading is also 43 minutes despite being slightly further away than Banbury from Oxford, hence a slightly faster GJS.

There are no direct services to Swindon meaning that this rail journey requires an interchange at Didcot Parkway to reach Swindon and places west there of (e.g. Bristol and Cardiff). The lack of a direct connection is reflected in the GJT of 1 hour 19 minutes. The journey between Oxford and Didcot typically takes around 15 minutes and the Didcot Swindon leg is around 15 minutes. Therefore well over half of the GJT is attributed to the interchange penalty and service interval penalty. In comparison, the road journey to Swindon takes 45 minutes (extended to 56 minutes with congestion).

London is accessible via two routes, either to Paddington direct (via Reading) which is the faster, or to Marylebone via Bicester. From Oxford, there are two trains per hour available to Marylebone and two trains per hour to Paddington, making a total of four direct services available to the capital in the off-peak (up to seven an hour in the peak). The route to Marylebone takes longer due to it being a less direct route and is limited to 100mph. However, the route to Marylebone provides important connectivity to Bicester (twice an hour, giving a GJT of 40 minutes) and High Wycombe (once an hour direct, giving a GJT of 1 hour 14 minutes). The four direct services to London provide passengers with options for reaching the rest of the EEH region via interchange. In the future, the presence of the Elizabeth Line at Paddington, Old Oak Common and Reading will improve the TfL offering for the GWML and should make connections across the capital and beyond easier.

Despite the GWML passing close to Heathrow Airport, access to it by rail is currently from the east only, this means that passengers need to travel in to Paddington and back out again (eight trains an hour run to the airport from Paddington). Alternatively, passengers can use slower services (of which there are four trains per hour) to reach Hayes & Harlington to access the Airport, or in the future, interchange at Old Oak Common for Elizabeth Line services. The more common link for passengers from the west to reach Heathrow is the RailAir bus link to Heathrow which runs with 3 buses an hour from Reading station to the airport.

The Western Rail Link to Heathrow project will address some of these issues by providing 4tph between Reading and Heathrow. This will enable Oxford based passengers to interchange at Reading, as opposed to the inconvenience of travelling into Paddington and back out again.

The HS2 station at Old Oak Common will give Oxford direct connectivity to the redevelopment of this area and all the opportunities that it provides as it is assumed that all services to Paddington will call at the new station.

West Coast Main Line

The two direct Cross Country trains per hour to Birmingham New Street give a GJT of 1 hour 34 minutes and a 42mph GJS. From Birmingham New Street a huge variety of destinations can be reached all over the country. One of the two Cross Country trains is routed via Birmingham International (GJT of 1 hour 37 minutes), which gives access to Birmingham Airport, in the future this will provide an interchange with HS2 for destinations North of Birmingham. The same Cross-Country train also serves Coventry where passengers can interchange to access to Rugby (GJT 2 hours 7 minutes), Northampton (GJT 2 hours 39 minutes) and one of the routes to Milton Keynes (GJT 2 hours 47 minutes). At present there

is only one train per hour via this route so for most destinations on the southern end of the WCML, travelling via London is often the best option. By comparison the road journey from Oxford to Milton Keynes is 58 minutes, extended to 1 hour 8 minutes by congestion. The X5 bus also provides connectivity from Oxford to Milton Keynes with a half-hourly frequency, giving a GJT of 1 hour 45 minutes in good traffic.

The underground interchange between London Paddington and London Euston poses a problem, as there is no direct line between the two London stations. The fastest option available is the Circle Hammersmith and City line to Euston Square, followed by a walk to the main line station. This at least 20 minutes to complete, which ultimately adds to the GJT.

The service frequency from Euston northwards to all EEH locations is at least 3tph. Therefore, the interchange in London and indirect routing is the biggest barrier to better GJTs to the WCML.

Midland Main Line and East Coast Main Line

Access to the MML and ECML from Oxford is similar to that of the WCML journey, i.e. via Paddington and using the Underground to reach Kings Cross or St Pancras.

There is a high frequency of service running out of St Pancras to both St Albans and Luton. For example, there are ten trains per hour that run from St Pancras to St Albans City and seven trains per hour that run from St Pancras to Luton. This high frequency is reflected by the GJT figures from Oxford to south lying MML stations, e.g. St Albans (3 hours 13 minutes) and Luton (3 hours 26 minutes). There are currently six trains per hour that run from St Pancras to Bedford, however, the GJT of Oxford to Bedford stands at 3 hours 54 minutes. From this, it is clear to see that the convoluted route and increase in distance from London results in a poor GJT. This GJT increase trend continues on to Corby.

For the ECML GJTs, journeys to the southern based locations along the ECML are very much similar to those on the south of the MML and of the WCML. This demonstrates how there is an arc of locations just north of London that are all equally similar in terms of GJT from Oxford.

More specifically, there is a high frequency of service that runs from London Kings Cross directly to Stevenage (4 trains per hour off peak) and there are also two trains per hour that run from London St Pancras to Stevenage. Thus, there are typically six trains available per hour that run directly from London to Stevenage, which is why the GJT from Oxford stands at 3 hours 22 minutes.

Both St Neots and Huntingdon are both served by London St Pancras, where two trains per hour are available in the off peak. This is a significantly lower frequency of service in comparison to that of Stevenage, which is reflected in the longer GJTs from Oxford (Oxford to St Neots 4 hours 1 minute and Oxford to Huntingdon 4 hours 12 minutes). Peterborough has a comparatively faster GJT than Huntingdon at 4 hours 6 minutes, this is despite it being located further north. This is due to the higher frequency of service available from London, with two direct trains per hour from St Pancras and three direct trains per hour from Kings Cross. This high service frequency means that journeys from Oxford to Peterborough suffer less on interchange penalties and as a result, the GJT remains reasonable.

As well as linking Oxford with Milton Keynes, the X5 bus provides direct services to Bedford and Cambridge with a half hourly frequency. Bedford takes around 2 hours and Cambridge takes nearly 4 hours on the bus (GJT of around 2 hours 15 minutes and 4 hours 15 minutes respectively). This demonstrates that not only is rail not competitive with the car on these journeys, it is not competitive with the bus either.

West Anglia Main Line and Great Eastern Main Line

For destinations further to the east, the routing via London becomes less illogical but is off-set by a lengthy, transit between Paddington and Liverpool Street station. As a consequence, the GJT to WAML and GEML locations is long but this is broadly in line with the physical distance travelled, although the GJS to all locations are steadfastly below 30mph.

The introduction of Elizabeth Line services will benefit connections between Paddington and Liverpool Street stations with a faster journey across the capital but will not eliminate the need for two changes to complete most journeys.

East West Rail

East West Rail will deliver direct services to Milton Keynes, Bedford, a new interchange station with the ECML and to Cambridge. Direct trains to these locations will see GJTs dramatically improve to these locations. The addition of East West Rail will bring the following EEH nodes within one change of train from Oxford where previously two or more were required:

Change at Bletchley/Milton Keynes: Leighton Buzzard, Hemel Hempstead, Watford, Rugby, Birmingham stations and Northampton.

Change at Bedford: Wellingborough, Kettering, Corby, Luton, St Albans.

Change at ECML station: St Neots, Huntingdon, Stevenage, Peterborough.

Change at Cambridge: Ely, Stansted Airport, Norwich, Ipswich

By bringing a greater number of places within one interchange from Oxford, East West Rail will make some significant changes to Generalised Journey Time. Even for journeys to the south of the East West Rail route, where the routing will be quite indirect still, the removal of an interchange should bring some quite significant improvements.

Access to HS2

Oxford will have the option to access HS2 via Old Oak Common with a new station on the GWML that will be served by the same selection of services that operate to Paddington. However there will be the option to travel north to Birmingham to access the rest of the UK via the High-Speed Network at Curzon Street or Birmingham Interchange to avoid doubling back on the journey.

Summary

Oxford enjoys some reasonable GJTs on the routes where it has direct services with more than one train per hour, i.e. Didcot, Reading, Banbury, Birmingham and London. These services give the city several options to complete journeys, either via London or the West Midlands. However, the GJS of these connections is low suggesting that there is room for improvement. As with many EEH nodes, there is a strong reliance on journeys via London to get across the region.

East West Rail has the potential to change the connectivity that the city has with the rest of the region and therefore the country and the Oxfordshire Rail Corridor Study (ORCS) highlights ways, and the benefits of improving the connectivity towards Birmingham and particularly to the South and West, including connectivity to Swindon which is currently severely lacking.

Case Study 3: Swindon

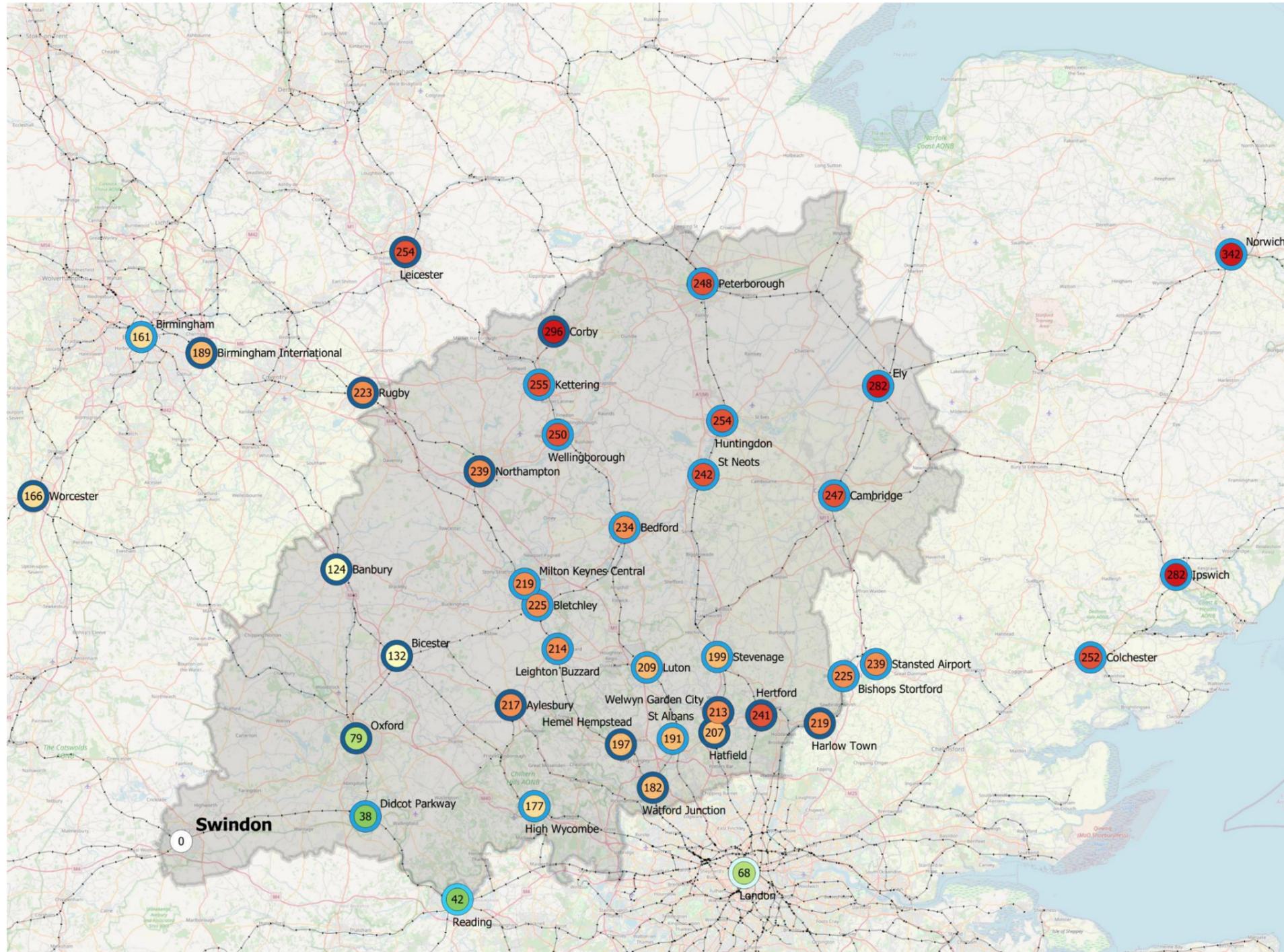
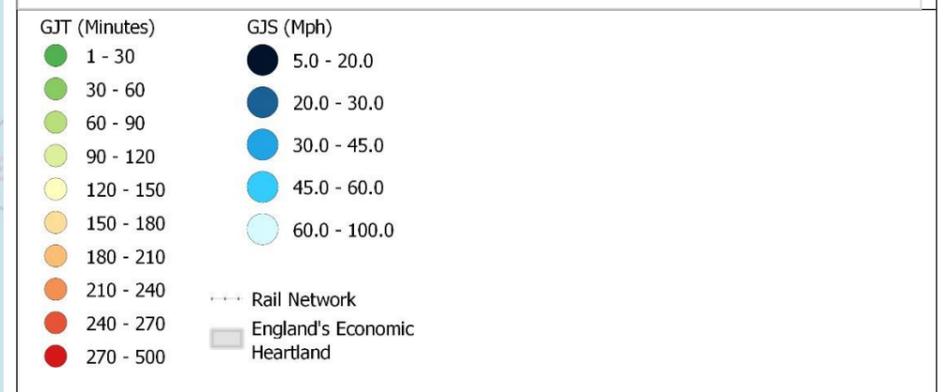
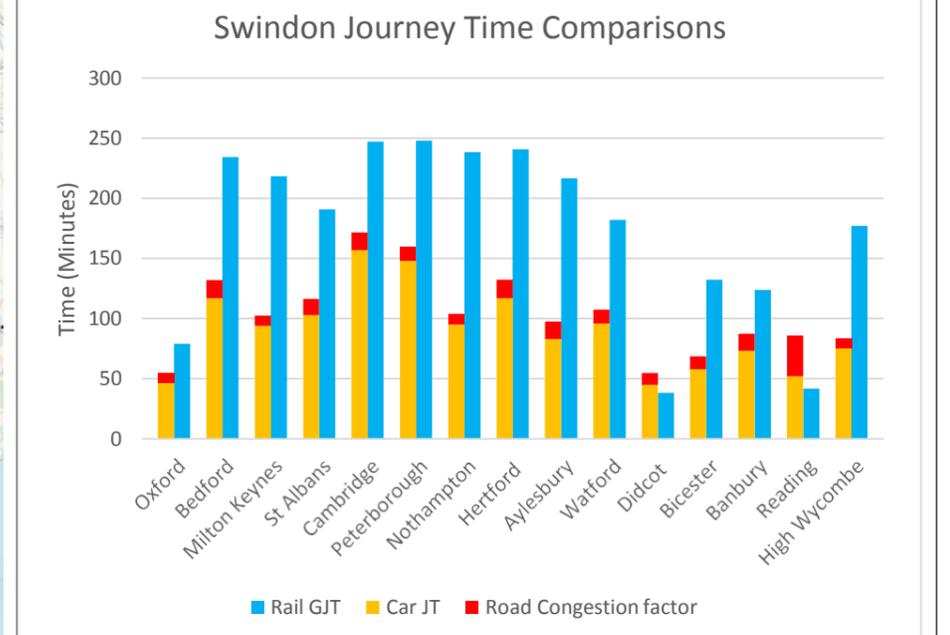


Figure 16: Generalised Journey Times and Speeds to EEH Key Nodes from Swindon

Swindon is an important calling point on the GWML with fast direct connections to London and Reading to the east. There are a range of connections to the west to Cheltenham, Bath, Bristol, Cardiff and destinations beyond, additionally there are services to Salisbury and the South Coast. Services are provided exclusively by Great Western Railway.

There are direct services to the following EEH key nodes:
 London (5tph)
 Reading (5tph)
 Didcot (3tph)

East West Rail does not propose to extend as far as Swindon



Great Western Main Line

Due to its important location on the GWML, Swindon enjoys excellent connections to Reading and London. This is due to the limited calls on the fast services that travel to both locations, with speeds of up to 125mph. There are a large range of options available as a result of Swindon's important location as a junction of routes heading to the West, South West, South Wales and South Coast.

London can be reached with a GJT of just 68 minutes with a GJS of 68mph, which is amongst the fastest seen in this study. Journeys from Swindon to both Didcot Parkway and Reading are equally well served along the GWML. The GJS of Swindon to Didcot Parkway (40 mph, GJT of 38 minutes) and of Swindon to Reading (59mph, GJT 42 minutes) are both comparatively fast. The Didcot service is comparatively slower to Reading because of the reduction in frequency as there aren't as many trains from Swindon to Didcot.

Heathrow Airport can be reached from Swindon by rail with a GJT of 140 minutes. The journey requires an interchange at London Paddington, which results in passengers doubling back on themselves to reach the airport. The result is a greatly extended GJT, although the Western Rail Link to Heathrow project would obviate going via London and should contribute to a greatly improved GJT. Currently the best way to access the airport is to use the RailAir Link bus from Reading station that runs up to three times an hour.

Given this excellent connectivity, the expectation would be that the connectivity would be good across the board, however this assumption fails away from the main route to London. Oxford is around 26 miles away from Swindon and Didcot is approximately 23 miles from Swindon. However, there is a significant difference in the GJT when travelling to the two destinations from Swindon because the route to Oxford requires an interchange at Didcot. The GJT is 79 minutes, over twice the GJT of to just Didcot whereas the journey by road is 47 minutes (extended to 55 minutes with congestion).

Some of the Didcot trains to Oxford extend to Banbury so passengers can remain on the same service to reach Banbury with a GJT of 2 hours 4 minutes, however this train runs infrequently, so more often than not an extra change is required at Oxford to reach Banbury.

Bicester is similarly best reached via Didcot and an interchange at Oxford, giving a GJT of 2 hours 12 minutes.

To head north, to the West Midlands, there are a range of options. Swindon based passengers can head west to Bristol Parkway or Cheltenham Spa to pick up direct services to Birmingham, or they can head Eastwards to Reading before backtracking via Oxford. Whilst these options contribute to having a number of trains an hour available, each individual route only has a maximum of two trains per hour and the journeys all require interchanges which results in a GJT of 2 hours 41 minutes to Birmingham.

Chiltern Main Line, West Coast Main Line and Midland Main Line

Aside from Bicester, Banbury and the West Midlands, the nodes along these routes are accessed by rail via an interchange in the London termini stations. The GJTs are long due to the interchange requirement and the indirect nature of the routing, i.e. the journey in to London and back out can be twice the distance compared to the as the crow flies distance, which ultimately results in journeys that are very uncompetitive despite the fast individual legs from Swindon to London and London to other nodes.

For all these connections, a limiting factor is the poor location of Paddington station compared to the other London based terminals and the lengthy transfer that is required between them, this negates

the benefits of the fast GWML services. This in addition to the indirect routes means that rail largely struggles to compete for these journey profiles.

West Anglia Main Line & Great Eastern Main Line

Services for these lines originate from London Liverpool Street and journeys via London are not overly indirect from Swindon. As previously shown, the Swindon to Paddington journey can be completed very quickly and the fast services on offer from Liverpool Street also give good access to the East of England. Unfortunately, the distance between Paddington and Liverpool Street is nearly the longest between any London Terminal stations and this is where the GJT is affected resulting in GJTs in the excess of 4-5 hours. The introduction of Elizabeth line services should reduce the transfer time between the two stations, however there will still be a need for passengers to make two interchanges, so there will still be a large element of the interchange penalty component of the GJT.

The introduction of Elizabeth Line services will benefit connections between Paddington and Liverpool Street stations with a faster journey across the capital but, as with Oxford, won't eliminate the need for two changes to complete most journeys.

East West Rail Impact

With the current proposals for East-West Rail, there will be little benefit to GJT for Swindon. While it will provide lower mileage journeys, the need to change at both Didcot and Oxford to even access the East West Main Line means that that to reach destinations off the core East West route, i.e. not Milton Keynes, Bedford and Cambridge, will require three interchange. As stated previously, the GJT from Swindon to Oxford is already not very competitive and even if there are good GJTs from Oxford to the east via the new link, the weak link will remain, i.e. the Swindon – Oxford element and East West will not impact this part of the journeys. It is likely that the preferred rail routing will still be via London for Swindon, should passengers wish to access most EEH areas. The result is that rail will likely remain as a non-option for journeys from Swindon to EEH.

Access to HS2

Swindon will be able to access HS2 via Old Oak Common on the same services that serve Paddington. Without direct services to Birmingham, this will be the fastest way to access the High-Speed Network to reach Birmingham and the North.

Summary

Swindon's location on the far western edge means that journeys to the rest of EEH should be expected to be relatively long because of the mileage incurred. Despite strong connections westwards and in to Paddington, these don't translate well to good connectivity to the rest of the region and therefore the rest of the country that isn't on the GWML. Given the importance of the Swindon economy to EEH rail links should be better and more direct and single interchange options should be available.

The Oxfordshire Rail Corridor Study proposes a number of changes that would significantly improve the connectivity of Swindon by giving it access directly to Oxford and East West services which in turn would greatly improve the GJT more so than the current proposals for East West Rail.

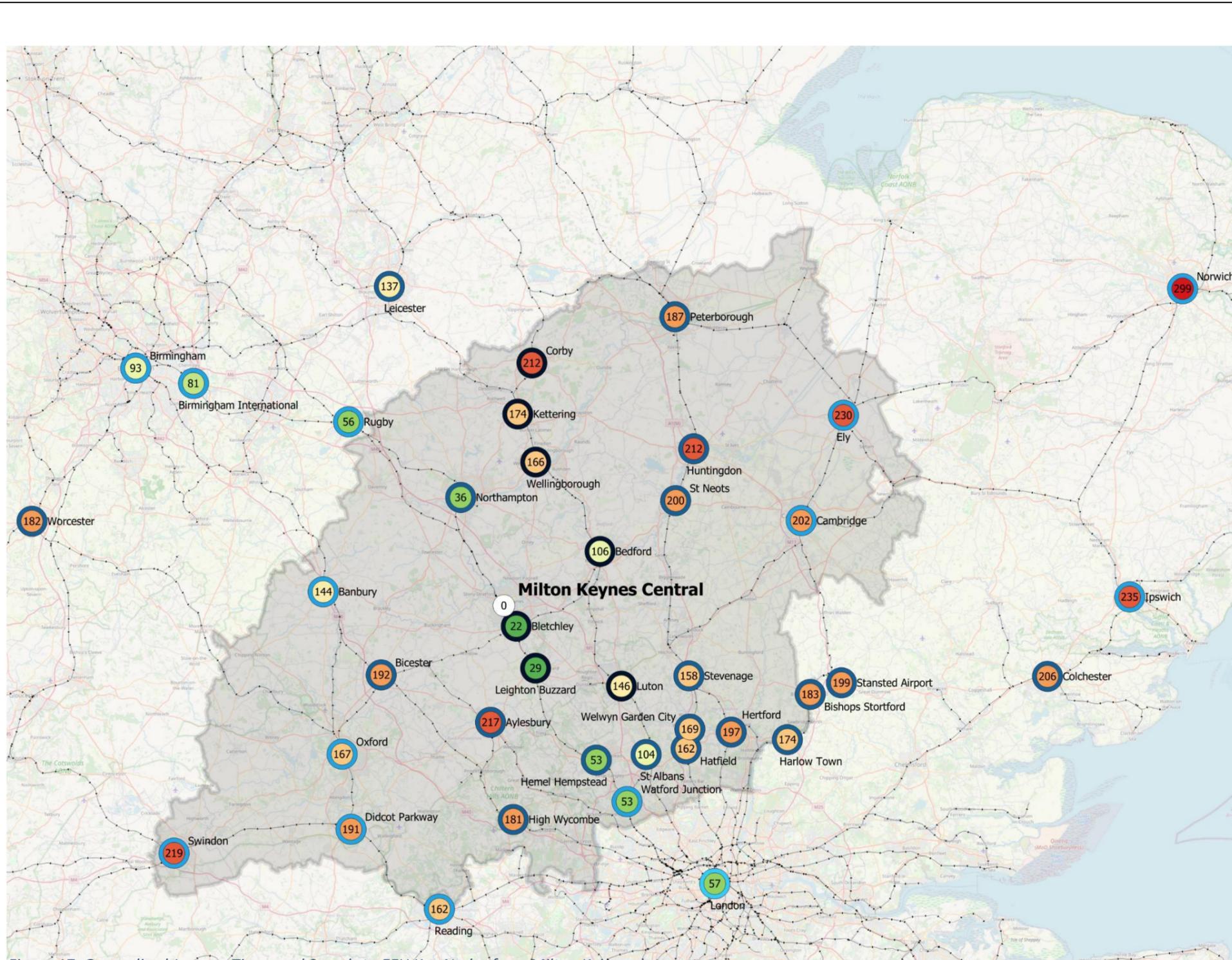
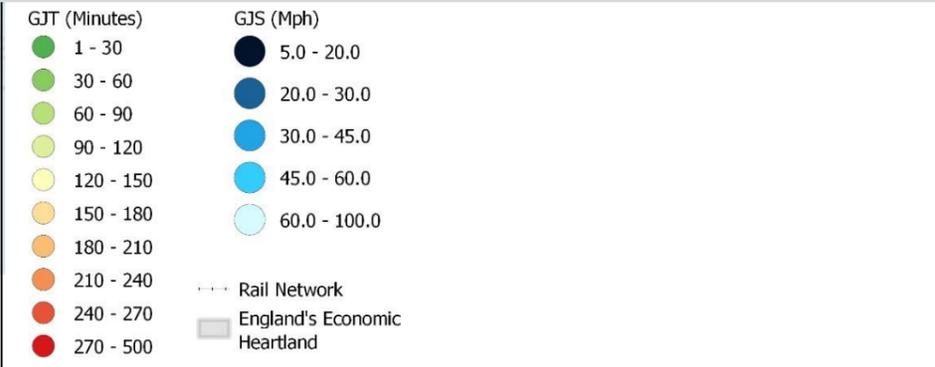
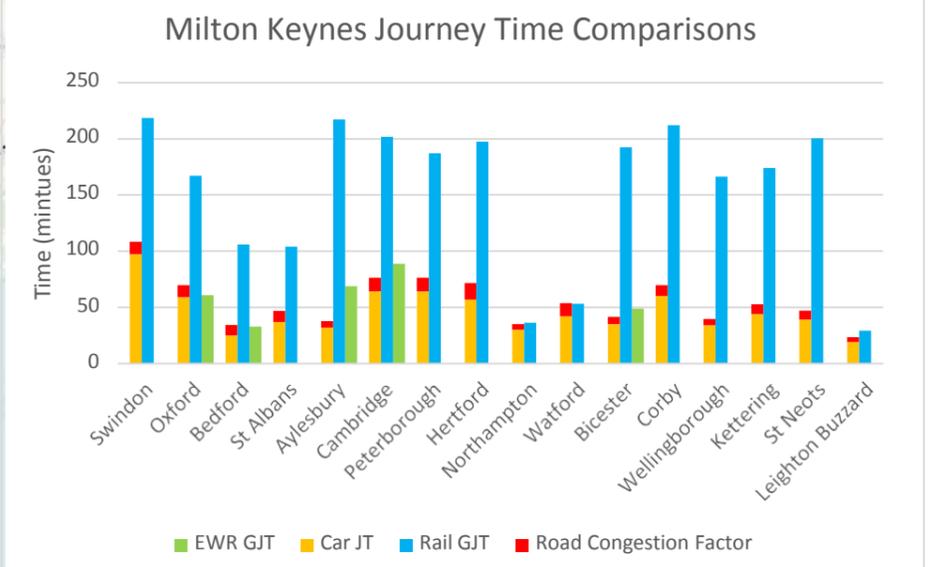


Figure 17: Generalised Journey Times and Speeds to EEH Key Nodes from Milton Keynes

Milton Keynes is a major calling point on the West Coast Main Line from London with a large array of services to Euston. Services are provided by Avanti West Coast, London NorthWestern Railway and Southern Railway. There are direct services to Birmingham, Manchester and Scotland from the station meaning it plays a key role as gateway for the region.

The following EEH key nodes can be reached directly from Milton Keynes:
 London (8tph)
 Watford (4tph)
 Hemel Hempstead (3tph)
 Leighton Buzzard (4tph)
 Bletchley (4tph)
 Northampton (3tph)
 Rugby (4tph)
 Birmingham (4tph)
 Crewe (5tph)
 In the future, East West Rail will connect Milton Keynes directly with Oxford and Aylesbury and High Speed 2 released capacity will increase the number of services that will call at the station improving the service offering.



West Coast Main Line

As would be expected for a principal station with a wide variety of services, the GJTs are very good along the corridor on which Milton Keynes sits. The high frequency of local services on the Northampton – Euston section give strong connectivity southwards with Bletchley and Leighton Buzzard enjoying GJTs of less than 30 minutes and Hemel Hempstead and Watford Junction reachable in under an hour. Heading north, Northampton can be reached with a GJT of 36 minutes and Rugby in less than hour.

The high frequency (8 trains an hour off peak) and fast journeys to London (non-stop trains complete the journey in around 35 minutes) means that London is easily reachable with a GJT of just 57 minutes. Euston is well located on the Underground network with a relatively quick transfer available to all other London Terminals.

Midland Main Line

Locations along the Midland Main Line (MML) are arguably poorly served by rail from Milton Keynes given their geographical proximity to Milton Keynes. Despite the Marston Vale line from Bletchley to Bedford in theory providing a good connection between the WCML and MML, the frequency (1 train per hour) and long journey time (42 minutes from Bletchley to Bedford) means that the journey from Milton Keynes to Bedford results in a poor GJT of 1 hour 46 minutes. In comparison, the X5 can do this journey with a GJT of approximately 65 minutes. The same journey can be done by car in 25 minutes (34 minutes with congestion). The interchange penalty at Bletchley and a further interchange at Bedford to reach other stations on the MML, means that rail subsequently becomes a less attractive option for such journeys. This issue is clearly demonstrated where Corby, Kettering, Wellingborough and Luton have GJTs well in the excess of 2 hours (Corby beyond 3 hours), despite their geographical proximity to Milton Keynes. For example, the GJS to Corby, Kettering, Wellingborough and Luton fails to surpass 16mph.

The MML Electrification Programme and proposed doubling of the frequency of services to Corby will improve the GJTs a little, but the hourly service on the Bedford – Bletchley section will still be the biggest factor affecting the GJT here.

Milton Keynes to Leicester has a GJT of 2 hours 17 minutes. The journey can be made via an interchange at Nuneaton, however, the low frequency of Milton Keynes to Nuneaton services (just hourly) and the need to interchange means that the GJT ultimately suffers. In practise there is a greater choice of services to Leicester via London, which means that this may well be the more favourable option. The road journey along the M1 to Leicester makes it difficult for the current rail offering to compete with a car journey taking around an hour to 90 minute.

Luton with a GJT of around of 2 hours can be reached via Bedford although, it can often be quicker to travel via London where the high frequency of services from St Pancras (a short transfer from Euston) can make this the better option rather than interchanging via Bletchley and Bedford.

The St Albans Abbey branch line from Watford Junction provides a link to St Albans that contributes to the St Albans GJT (1 hour 44 minutes) being lower than other locations that are of similar distance from London. The service on this line runs every 45 minutes and passengers from Milton Keynes have to change at Watford, which adds to the GJT. As things stand, this is not viable means to reach other MML destinations as the St Albans Abbey and St Albans City stations are over a mile apart, which leaves passengers with lengthy connection times as a result.

For both Luton and St Albans, the GJT is significantly slower than the road option as the M1 provides a very fast alternative to rail on this corridor, with car journeys to St Albans completed in 37 minutes,

however the road can be susceptible to poor reliability in journey times as a result of congestion, with journeys likely to be extending by 25% to 47 minutes as a result of the congestion.

Chiltern Main Line and East Coast Main Line

To reach Banbury the fastest route is to travel via Coventry, but for all other locations on the Chiltern Main Line and the ECML, the fastest way to reach these locations by rail is via an interchange in London and in all of such cases it is a circuitous route.

There is a lack of a high-quality road alternatives, yet the road connections are still significantly better than the rail journeys. Peterborough can be reached in 1 hour 4 minutes (by road 1 hour 16 minutes with congestion), Bicester in just 35 minutes (42 minutes with congestion). The net result is that rail is uncompetitive for these markets as the GJTs for rail are often in the range of 3 hours or more.

West Anglia Main Line, Great Eastern Main Line and Great Western Main Line

The GJTs for nodes on the WAML, GEML and GWML are all in excess of three hours except for Oxford and Reading (2 hours 47 minutes and 2 hour 42 minutes respectively) where their high frequency and fast services means that they are temporally closer to London than other locations, e.g. Cambridge. The destinations at a further distance are closer to the four-hour GJT mark. This is largely as a result of the double interchange of routing via London and large elements of doubling back to reach the final destination.

The X5 bus provides a half hourly frequency to Oxford, providing a GJT of 1 hour 50 minutes versus rail GJT of 2 hours 47 minutes. Even accounting for a service interval penalty of 15 minutes to be added to the bus time, this is notably faster than the rail offering. Similarly, Cambridge where the journey time of 2 hours 40 minutes versus a rail GJT of 3 hours 22 minutes means the bus provides a better option than rail for these journeys.

East West Rail Impact

Milton Keynes will be served directly by East West Rail with direct services to Aylesbury and Oxford. These services will greatly improve connectivity to Aylesbury, Bicester and Oxford, however, from other EEH locations will need an interchange. The following EEH nodes will be within one change of train from Oxford once East West Rail is constructed, where currently two or more changes are required:

Change at Oxford: Didcot and Banbury

Change at Bicester/Aylesbury: High Wycombe

Change at Bletchley: Bedford and Cambridge

As can be seen by the above list, the lack of direct services from the east (Bedford and Cambridge side) to Milton Keynes means that the transformational impact of East West Rail for the town is limited. Given Milton Keynes' already important role as a regional interchange hub with connectivity to the West Midlands and North West, and the fact that Milton Keynes is in one of the top 10 UK economies, this is a missed opportunity. This is not just specific to Milton Keynes but to all locations east of the WCML, i.e. MML, ECML and WAML locations. Passengers from such locations will need to interchange at Bletchley and travel to Milton Keynes if they wish to reach the full complement of WCML services, even with an enhanced service offering on the WCML as a result of capacity released by HS2.

Whilst a reduction in GJT for the whole of EEH from Milton Keynes is highly likely by nature of eliminating significant portions of doubling back to reach destinations, they will, in the most part still require two interchanges to complete the full journey. Therefore, the service interchange penalty will still be a large component of overall GJT, even in a post East West Rail scenario.

To reach the South -West of England and South Wales, the fastest way to get there from Milton Keynes will probably stay as it is currently, that being an interchange via London. This is because the options available from Didcot (reachable by two changes via East West Rail) are likely to be less appealing than the full complement of options from London.

Access to HS2

Milton Keynes will be able to access the HS2 network very easily at Birmingham Curzon Street or Birmingham Interchange, especially when heading to the North-East of the country via the Eastern Leg of Phase 2B. Travelling to London will be of little benefit as the journey time in to Euston will eliminate most of the saving made by HS2 between London and Birmingham.

Summary

Milton Keynes does very well for connectivity on the WCML as a result of the fast services with intensive frequencies. However, by the nature of sitting quite centrally in a region with very few east to west connections, most rail journeys require a large detour and consequential extended mileage that the high frequency and speed can't offset. High Speed Two released capacity will improve the offering as will the introduction of services on East West Rail, yet there will still be some significant gaps, especially on the northern and southern peripheries of the EEH region.

East West Rail will improve the connectivity to the west but with services only going to Aylesbury and Oxford there won't be a drastic improvement other than to these locations and the lack of eastwards connectivity will limit the improvements the rail link delivers for Milton Keynes.

Case Study 5: Northampton

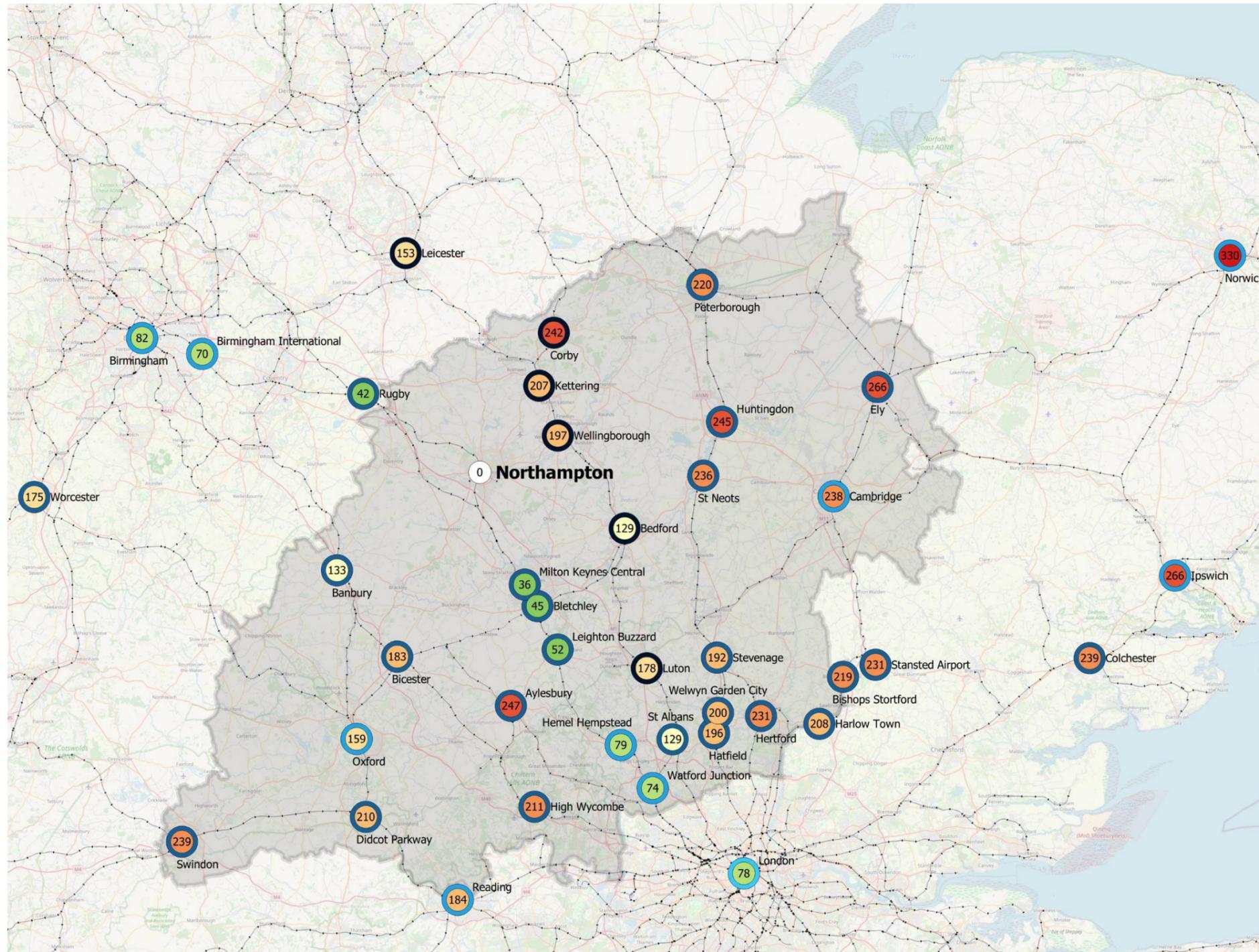


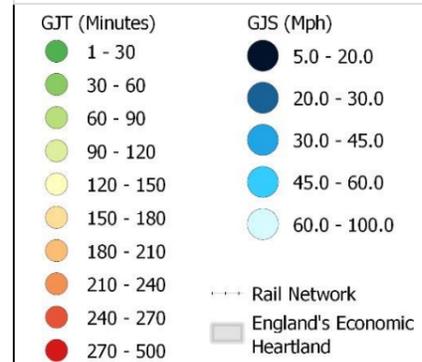
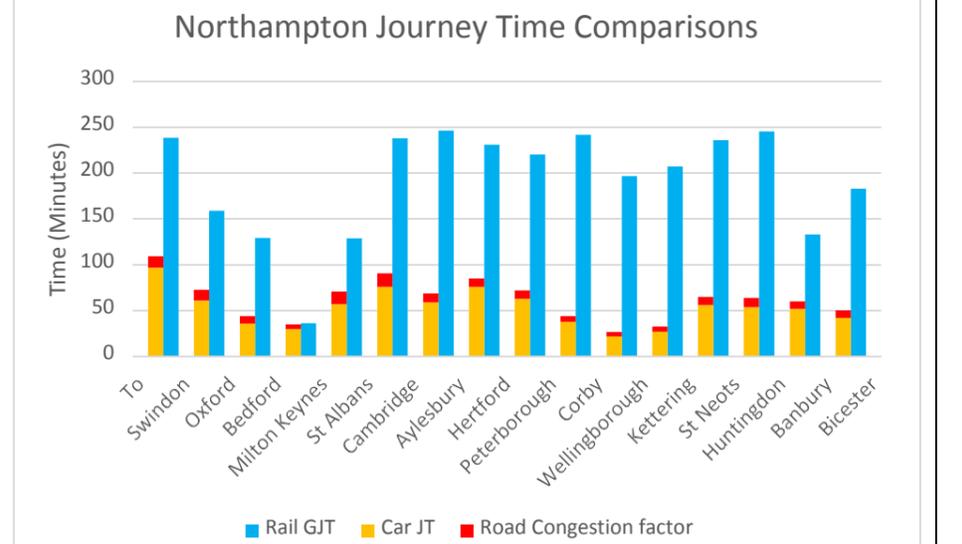
Figure 18: Generalised Journey Times and Speeds to EEH Key Nodes from Northampton

Northampton is located on the Northampton loop of the WCML which means that fast services on the line typically by-pass the town with services provided almost exclusively by London NorthWestern Railway.

Services northwards only head towards Birmingham meaning that EEH key nodes that can be reached directly from Northampton are:

- London (3tph)
- Watford (2tph)
- Hemel Hempstead (1tph)
- Leighton Buzzard (2tph)
- Bletchley (2tph)
- Milton Keynes (3tph)
- Rugby (3tph)
- Birmingham (3tph)

In the future, released capacity as a result of HS2 will bring new opportunities for improved services and greater connectivity by providing additional trains to the town.



West Coast Main Line

Despite Northampton being a town of similar size to Milton Keynes and not very far away, the disparity in rail offering between the two places is notable. The absence of the fastest trains to London and the provision a lower service frequency offering (just 3tph) dramatically impacts the GJTs from Northampton to the southern end of the West Coast Main Line. London has a GJT of 1 hour 18 minutes. Despite having 2 trains per hour fewer than Milton Keynes does to London, the GJT is only about 20 minutes longer. Considering that the journey to Milton Keynes is itself around 15 minutes, this demonstrates the value of providing services with relatively few stops.

On the other hand, by being further north and still having three trains per hour, the GJT on this corridor is relatively good to Birmingham (GJT 1 hour 22 minutes). The services to Birmingham help to provide further connectivity as passengers can interchange at Coventry to reach both Banbury and Oxford. A drawback is the trains from Northampton to Birmingham also act as the local services for stations between Coventry and Birmingham which negatively affects journey times on this route. This is because there is a need to maximise the track capacity of the route which negatively affects the journey times for services from Northampton.

There are no services that travel north and avoid Birmingham from Northampton, therefore journeys have to route via the West Midlands or change at Rugby for an hourly stopping service serving intermediate stations towards Crewe.

Overall, the low service frequency and long journey times is the root cause of the extended GJTs to the whole EEH region.

Midland Main Line

Northampton lies very close geographically to the Midland Main Line, but the lack of a physical connection makes all journeys uncompetitive with the road offering. At best, rail offers the opportunity to go via Bletchley to reach Bedford but the slow service along the Marston Vale Line with the low frequencies on both legs results in a GJT of 2 hours 9 minutes to Bedford compared to a road time of 36 minutes (44 minutes with congestion).

A similar picture exists for the connectivity between Northampton and St Albans, i.e. the St Albans Abbey Line causes the GJT to stand at 2 hours 9 minutes, as the line provides a more direct route to St Albans, as opposed to going into London and back out via the MML.

The rest of the MML has GJTs in the region of 3 hours or higher and this is where rail cannot compete as the M1 largely parallels the route giving much faster journey times than rail can currently offer.

Chiltern and Great Western Main Line

While going via Coventry is not an overly indirect route for rail, the low service frequency and interchange at Coventry means that the GJT is long to Banbury and Oxford (in excess of 2 hours) and is nothing near as quick as the direct route via the A43 road which can offer car journey times of 52 minutes (an hour with congestion) and 1 hour 1 minute (1 hour 13 minutes with congestion).

South of Oxford and Banbury, the best way to reach the GWML or CML is via London. However, the long GJT of Northampton to Euston and the lengthy transfer to Marylebone or Paddington means that the GJTs suffer considerably.

East Coast Main Line, West Anglia Main Line and Great Eastern Main Line

Like the Chiltern and Great Western Main Lines, the lack of a direct route to the ECML, WAML and GEML is the biggest factor that contributes to the long GJTs to these parts of the region.

To access the more northern key nodes e.g. Peterborough and Ely, there is a lack of northward connectivity available. This rules out the option of heading to Nuneaton and travelling east through the East Midlands, to reach Ely or Peterborough. Instead, passengers are better placed to travel down the WCML, interchange in London and back up via the relevant Main Line route. Although the interchange between Euston and Kings Cross is relatively easy, the journey from Euston to Liverpool Street is quite lengthy. All in all, the sheer length of the detour from Northampton to the east means that the GJTs to many of these locations are around four-hours.

East West Rail Impact

Currently East West Rail is not proposed to serve Northampton meaning that the change brought about by the introduction of new services will not be as impactful when compared to other locations within the region. That said, the direct services to Bletchley that Northampton currently has will enable Oxford, Bicester, Aylesbury, Bedford and Cambridge to all be reached within one change. Currently these journeys require two or more changes (except for Oxford). In the most part, these locations should see a significant improvement in GJT although it is doubtful that a journey from Northampton to Bedford will improve enough to be competitive with road.

The interchange provided at Bletchley will provide Northampton with better access the east of the region. For example, following an interchange at Bletchley, passengers will have access to Bedford, the new ECML station, and Cambridge. However, for destinations that sit beyond the East West Rail route, the two interchanges required will still contribute heavily to extended GJTs.

The termination of East West Rail services at Oxford means that access to the GWML for Northampton will be hampered by needing to change three times (at Bletchley, Oxford and then either Didcot or Reading) which will make travelling west via this route uncompetitive with travelling via London, especially should released capacity on the WCML as a result of HS2 result in improved GJTs to Euston.

Access to HS2

Northampton's best access to HS2 will be via Birmingham Interchange or Curzon Street for access to the High-Speed Network, it will not be worth travelling in to London to reach these destinations.

Summary

Northampton's location on the rail network means it gets a sparse service currently. It effectively lies at the end of two commuter routes, one to the West Midlands and the other to London. These trains make frequent stops and therefore are only rarely competitive with road over very short distances or in to the city centres of London and Birmingham. For almost all other journeys, especially those without direct connectivity, rail just can't compete with road from Northampton.

Case Study 6: Bedford

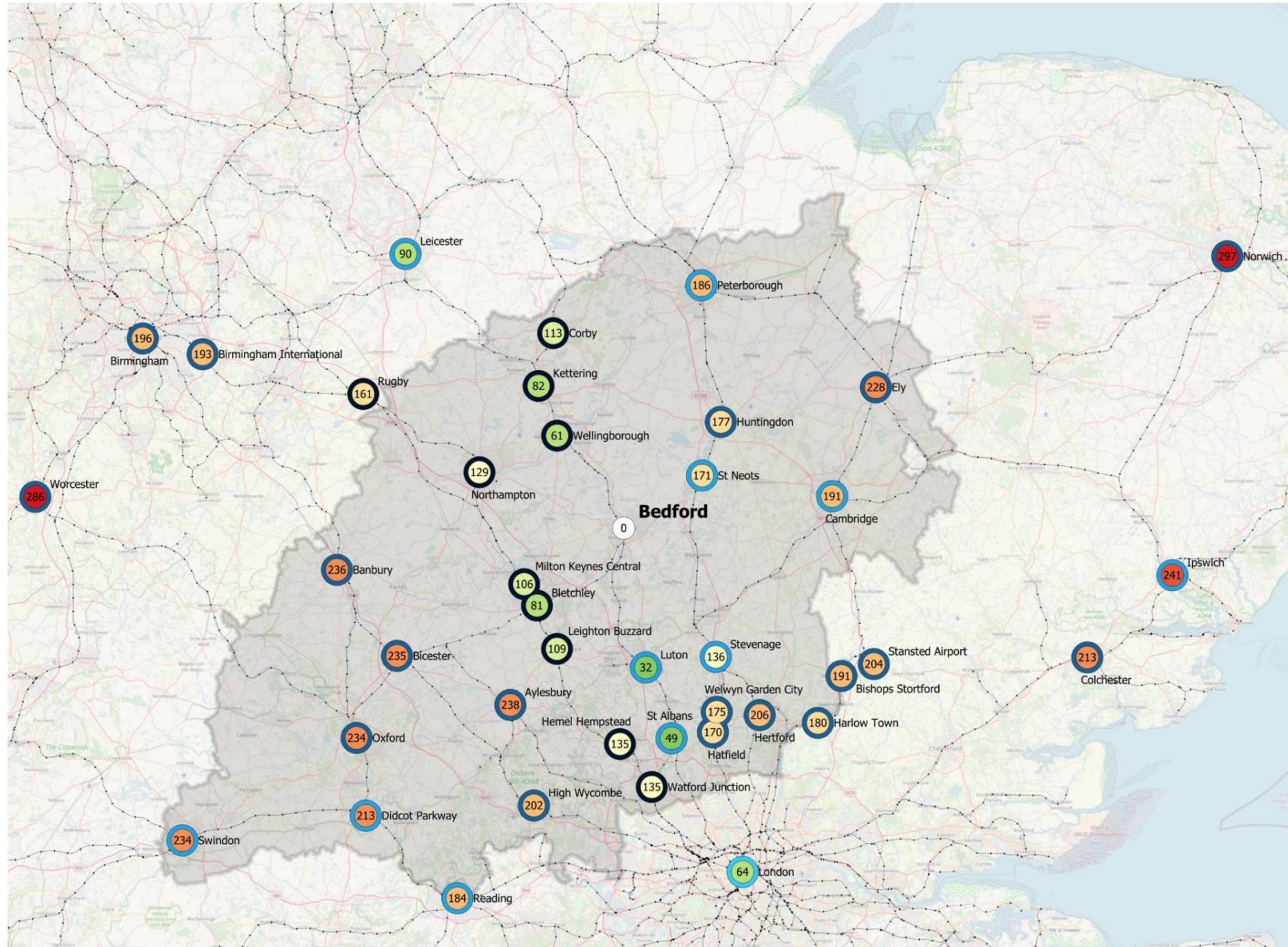


Figure 19: Generalised Journey Times and Speeds to EEH Key Nodes from Bedford

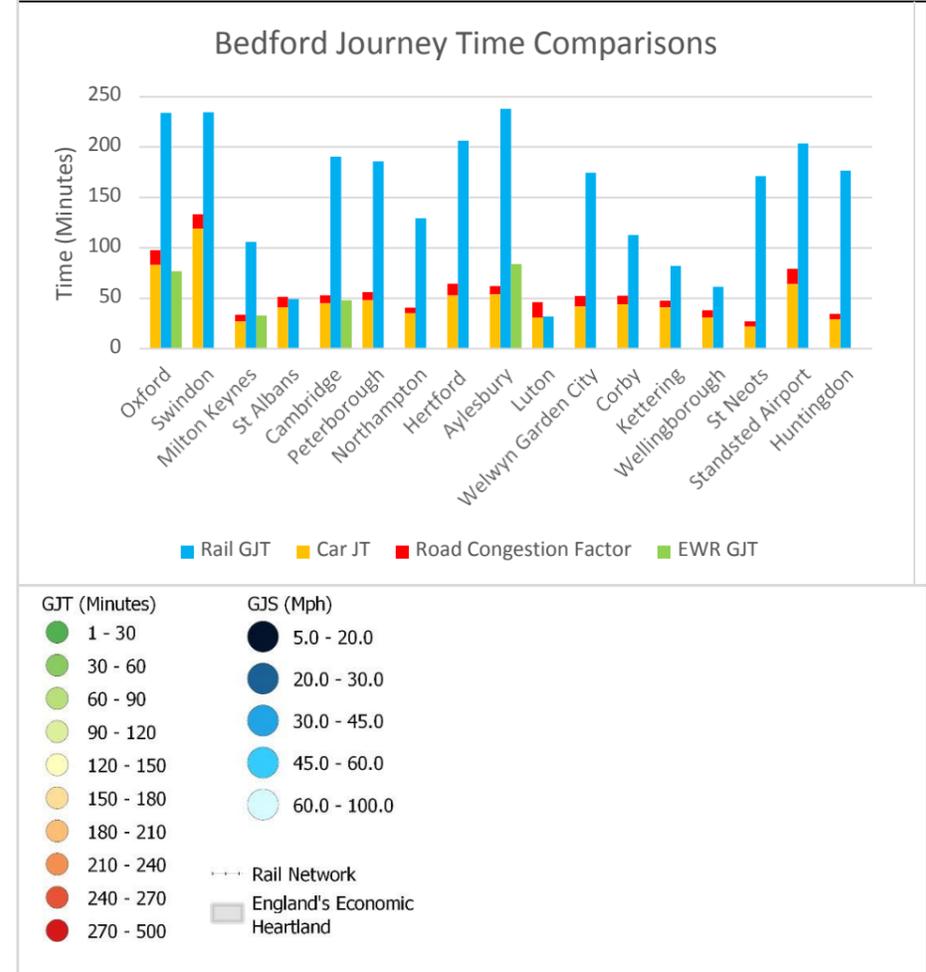
Bedford is an important stop on the Midland Main Line from London to the East Midlands. It is also the northern terminus for one of the Thameslink branches, this gives direct access to the South of England via London Bridge. Bedford is also the eastern terminus of the Marston Vale line from Bletchley. Services are provided by East Midlands Railway, Thameslink and London NorthWestern Railway.

Direct services run from Bedford to the following EEH nodes:

- London (6tph)
- St Albans (4tph)
- Luton (5tph)
- Wellingborough (2tph*)
- Kettering (2tph*)
- Corby (1tph*)
- Leicester (1tph)
- Bletchley (1tph)

* Will increase by 1tph on completion of Midland Main Line upgrade

In the future East West Rail will introduce direct services to Oxford and Cambridge with interchange opportunities via a new station on the ECML and higher frequencies on the route to Bletchley.



Midland Main Line

As would be expected, given Bedford's location on the Midland Main Line (MML) there is a good selection of direct services along the MML corridor. The locations south of Bedford are particularly well served, e.g. Luton and St Albans. In the off peak, there are typically five direct trains per hour that run from Bedford to Luton, with a GJT of 32 minutes. To St Albans, there are four direct trains per hour in the off peak from Bedford, with a GJT of 49 minutes. The GJS to both Luton and St Albans is 37mph. This GJS is reflective of the high service frequency and the limited number of stops between Bedford and the two locations, which allows the trains to reach higher average speeds. The GJT to London (1 hour 4 minutes) is reflective of the six trains per hour that run during the off peak directly from Bedford to London St Pancras.

However, the GJS tells a different story in relation to the services along the MML north of Bedford. For example, the GJS from Bedford to Wellingborough, Kettering and Corby are between 15mph- 16mph, yet the GJS of Bedford to Luton is 37mph. This discrepancy of GJS is due to the low frequency of services available from Bedford that serve the northern section of the MML (Wellingborough, Kettering and Corby). For example, there are typically only two trains per hour from Bedford to both Wellingborough and Kettering. In addition, the rail journey from Bedford to Wellingborough is presently replaced by a bus service after 16:28, which consequently reduces the average speed of the journey overall.

The forthcoming enhancements north of Bedford are expected to address these issues and will restore some of the connectivity and frequency between Bedford and the northern nodes along the MML, which will ultimately improve the GJT and GJS too. More specifically, this will involve the franchise commitment for two direct trains per hour to Corby, planned to call at Kettering, Wellingborough and Bedford, doubling the service frequency and improving the GJT significantly.

Journeys to the West Midlands are best achieved via Leicester, although the interchange and low frequencies means Birmingham has a GJT in excess of three hours.

West Coast Main Line

Bedford is connected to the West Coast Main Line (WCML) via the Marston Vale line to Bletchley. The GJT between Bedford and Bletchley stands at 1 hour 21 minutes giving a GJS of just 12mph. Consequently, all the key nodes along the WCML have a poor GJS and GJT from Bedford due to the poor connectivity and characteristics of the Marston Vale line. For example, all of the WCML nodes between Birmingham International and Watford have a GJS ranging from 11-23 mph from Bedford. When considering the geographical proximity and potential connectivity offered by the Marston Vale line, the GJTs from Bedford to the nodes along the WCML are poor. For example, the GJT from Bedford to Watford stands at 2 hours 15 minutes, yet the GJT to St Albans, which is only approximately 7 miles from Watford, stands at 49 minutes.

East Coast Main Line and West Anglia Main Line

In order to reach the East Coast Main Line (ECML) from Bedford, passengers must travel south, down the MML to London St Pancras. There are two options then available to passengers, one being a short walk across to London Kings Cross, where direct services are available, which take passengers up the ECML. Alternatively, passengers can remain at London St Pancras where there are also direct services available to locations on the ECML.

Journeys between Bedford and nodes located on the ECML and WAML are uncompetitive with GJTs between two and three hours long and are therefore unlikely to be undertaken by rail. This is caused by the indirect routing via St Pancras that is required to use rail between these locations.

Peterborough can in theory be accessed via Leicester as well as via London, although the low frequency of trains from Leicester to Peterborough (just one train per hour) and it being a quite an indirect route also means that road travel via the A1 is a better alternative. The road journey takes 48 minutes (56 minutes with congestion), much quicker than the rail GJT of just over 3 hours.

The X5 bus provides half-hourly connectivity to St Neots (GJT of about 55 minutes) and Cambridge (GJT of just shy of 2 hours) which provides a significantly faster connection than the rail offering.

Great Eastern Main Line

Colchester, Ipswich and Norwich are reached with a GJT of 3 hours 33 minutes, 4 hours, 1 minute and 4 hours 57 minutes respectively. The requirement to cross London to the GEML and the significant distance needed to be covered by the rail offering means rail journeys are not competitive with road to these locations.

Chiltern Main Line and Great Western Main Line

To the west of the MML, the lack of a direct connection makes a very significant impact with all nodes having a GJT in excess of three hours and some nearly four hours. The indirect routing is what is driving a large element of this GJT as the GJTs of the constituent parts of the journeys are themselves quite fast. The rail GJT to Oxford is nearly 4 hours, the X5 bus does the same journey with a GJT of around 2 and a half hours

In all these cases road provides a significantly faster journey than rail to the west of the region.

East West Impact

East West will make dramatic improvements to the rail offering for Bedford. High frequency services to both Oxford and Cambridge will bring many locations within one interchange where currently two or more are required. These are:

Change at Bletchley: Aylesbury, Milton Keynes, Northampton, Rugby, Birmingham stations, Leighton Buzzard, Hemel Hempstead and Watford

Change at Bicester: High Wycombe

Change at Oxford: Didcot, Reading, Banbury

Change at ECML Interchange station: Peterborough, St Neots, Huntingdon, Stevenage, Welwyn Garden City, Hatfield

Change at Cambridge: Ely, Norwich, Ipswich, Bishop's Stortford, Stansted Airport

Whilst to some of these locations, the journey via East West Rail may not be much quicker than the current rail offering (particularly in the case of High Wycombe via Bicester (instead of via London) or Birmingham via Bletchley (instead of via Leicester) it does show the potential that East West Rail has. Of all the nodes identified in this study, following the completion of East West to Cambridge, only Colchester, Reading and Hertford will lie more than a single interchange away from Bedford.

Summary

Under the December 2019 timetable, before the benefits the MML Upgrade are fully realised, rail is only competitive with other transport modes on the MML corridor itself. In the most part this is southwards towards London and northwards to the East Midlands. Connectivity is blunted to the WCML destinations by poor frequency on the Marston Vale route currently.

For the rest of EEH rail cannot compete with road until the delivery of East-West Rail at which point Bedford will have greatly enhanced connectivity to the nodes across the West Coast Main Line, East Coast Main Line and West Anglia Main Line and out towards Ipswich and Norwich.

Case Study 7: St Albans

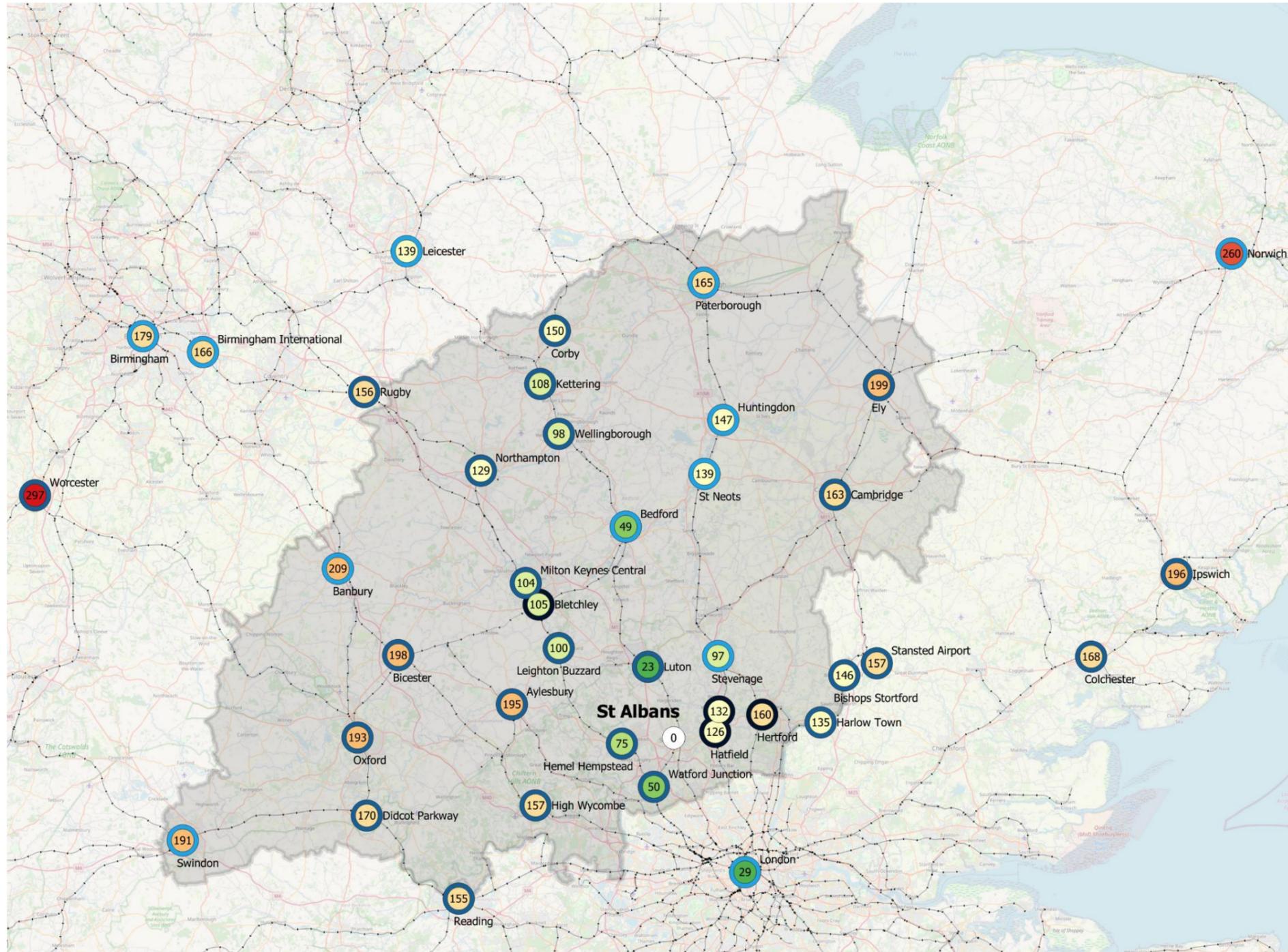


Figure 20: Generalised Journey Times and Speeds to EEH Key Nodes from St Albans

St Albans has two stations on the National Rail Network. St Albans City on the MML is served by Thameslink services station and has direct services to the following EEH nodes:

London (10tph)

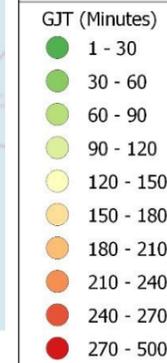
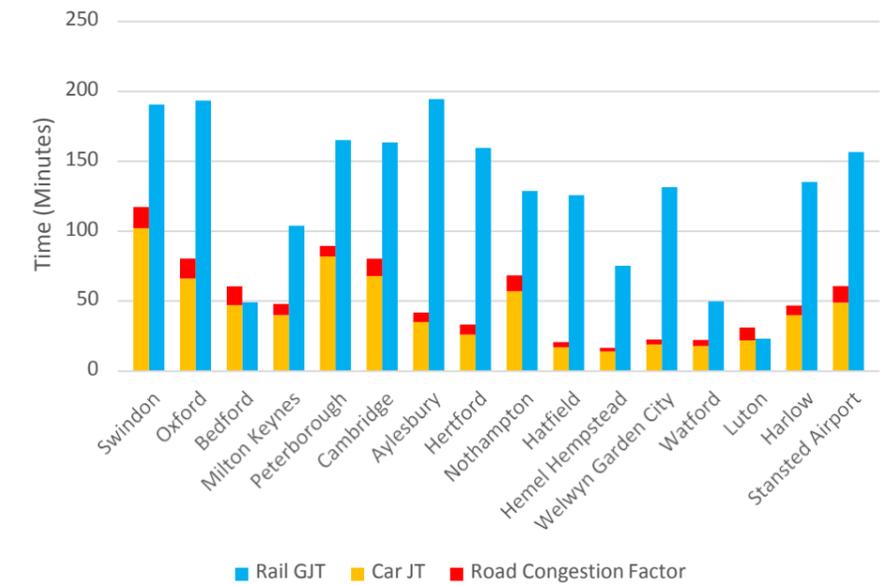
Luton (6tph)

Bedford (4tph)

Services by East Midlands Railway pass through the station but do not call at the station.

St Albans Abbey is served by London NorthWestern railway on a branch line to Watford Junction with a train every 45 minutes.

St Albans Journey Time Comparisons



Midland Main Line

St Albans is an extremely well served location for rail travel into London via the MML with ten trains timetabled in the off peak that run directly into London St Pancras. These ten services have different calling patterns as four of the services run slow, with frequent commuter-based stopping patterns, another four of the services run fast/direct into London and two of the remaining services have some stops in between St Albans and St Pancras. The high frequency of direct services means that the GJT is equivalent to the average journey time of the ten trains.

To the north of St Albans, there are six direct trains available per hour in the off peak that call at Luton. The GJT to Luton stands at just 23 minutes, which is due to a couple of factors. Firstly, the connectivity is very good, i.e. a high frequency of six trains per hour between two locations that are roughly only 10 miles apart. In addition, each one of the six trains per hour only has two stops (Harpenden and Luton Airport Parkway) between St Albans and Luton. This lack of stops helps to maintain speed throughout the short journey, and this is reflected by the GJS of 28mph.

There are four direct trains per hour available in the off peak from St Albans directly to Bedford and the GJT is 49 minutes, which is reasonable when it is considered that the actual station to station (St Albans City to Bedford) average journey time is 40 minutes. The GJS to Bedford is 37 mph, which is the fastest GJS to any key node from St Albans. This is primarily as a result of the limited stops along the way and high frequency of service. The GJTs start to increase significantly further north of Bedford, e.g. the GJT from St Albans to Wellingborough stands at 1 hour 38 minutes and the GJT of St Albans to Kettering is 1 hour 48 minutes. These long GJTs are a result of there being no direct services available from St Albans to either of the locations. Passengers from St Albans are required to interchange at Luton or Luton Airport Parkway, where there are direct services available to both Wellingborough and Kettering. This journey pattern consists of a large interchange penalty, i.e. the associated inconvenience and waiting times for rail passengers having to interchange at both Luton stations. The same scenario applies to journeys from St Albans to Corby, which has a GJT of 2 hours 30 minutes. The typical journey involves an interchange again at Luton but as there is a lower service frequency to Corby along the MML, some journeys from St Albans to Corby require two interchanges (one at Luton and another at Kettering). This highlights the poor level of service and connectivity from St Albans to the northern section of the MML. The forthcoming electrification of the MML will address some of these issues and will restore some of the connectivity and frequency between St Albans and the northern nodes along the MML, which will ultimately improve the GJT and GJS too. However, it is not envisioned that the improved service to Corby will call at St Albans meaning that an interchange will still be required to link the two locations.

West Coast Main Line

There is a variety of options available to St Albans based rail passengers who wish to connect to the locations that are on the WCML.

Firstly, and the most logical route is for passengers to use St Albans Abbey station, which has a train every 45 minutes via the Abbey Line to Watford Junction. The GJT from St Albans to Watford Junction via the Abbey Line stands at 50 minutes and the GJS is slow at just 23 mph. The slow GJS is a direct result of the 50-mph maximum line speed and the frequent stopping pattern of the services along the way. However, this does provide a quicker route to the WCML as opposed to travelling into London via the MML and then back out via the WCML, especially for locations south of Northampton.

There are two alternative methods to travel between St Albans and WCML although neither are as quick as using the St Albans Abbey to Watford Junction link (the GJT displayed on the map is from St

Albans Abbey). The first is to travel from St Albans City station and go via the Marston Vale line from Bedford to Bletchley although this requires two changes and has a low frequency of service.

The second option is to travel from St Albans City via London using the 10 direct trains per hour that run into London St Pancras via the MML. Passengers can then connect to nearby London Euston. From Euston, passengers then have access to a wide variety of frequent services to the WCML locations, especially those North of Birmingham as Watford or Bletchley do not have direct connectivity to several locations without an interchange.

Chiltern and Great Western Main Lines

There are no other realistic options available for St Albans based passengers to get to the Chilterns or GWML based locations other than to travel to London St Pancras and to then interchange at London Marylebone or London Paddington respectively. There is an average 15- 20-minute journey via the underground network, which instantly increases the overall GJT.

High Wycombe is only around 20 miles away from St Albans, yet the GJT via rail stands at 2 hours 37 minutes, which is slightly better when compared to the GJT for Aylesbury. This difference is due to the higher frequency of services provided to High Wycombe in addition to Aylesbury being slightly further from London. Car journeys take just 35 minutes (42 minutes with congestion) to Aylesbury.

For this section of the Heartland, the GJTs are just not competitive with other transport modes especially when considering the good links on the road network via the M25, M40 and M4 that St Albans enjoys.

East Coast Main Line

Passengers from St Albans must make use of the ten direct trains per hour into London St Pancras if they wish to travel to ECML based locations. Some of the locations on the ECML are served by both London St Pancras and London Kings Cross. Therefore, passengers can simply change platforms within the St Pancras complex, or they can walk across to Kings Cross station for services from that station.

Both Hatfield and Welwyn Garden City have GJTs from St Albans of over 2 hours which is very high, especially when it is considered that Hatfield is just 5 miles away from St Albans and Welwyn is 7 miles. It will be quicker for a person to walk from the centre of St Albans to the centre of Hatfield, as opposed to making the journey via rail because of the need to go via London. This illustrates how the rail offering from St Albans to both Hatfield and Welwyn is simply not a viable journey. Hertford is similarly affected but an extra interchange is required at Finsbury Park to reach Hertford North which contributes to the GJT being around 30 minutes longer than Hatfield.

In contrast, the high service frequency to Stevenage from London results in a GJT of 1 hour 37 minutes. While a significant improvement over the much closer locations of Hatfield and Welwyn Garden City, it is still long.

The GJT of St Albans to Peterborough stands at 2 hours 45 minutes. The same journey by car takes 1 hour 12 minutes (extend to an hour and a half with congestion).

West Anglia Main Line and Great Eastern Main Line

There are two direct services that run to Cambridge from St Pancras and four direct trains that run to Cambridge from Kings Cross. Just two of the six direct services to Cambridge run fast with no stops, whilst the remaining four services have frequent stops along the way to Cambridge. The result is that the GJT of St Albans to Cambridge stands at 2 hours 43 minutes.

St Albans based passengers who intend to travel to locations on the WAML and GEML must travel to Liverpool Street, which involves a lengthy transfer via the Underground, i.e. St Pancras to Liverpool Street. Therefore, despite the good GJT to London, the overall GJT to destinations in East Anglia is long and uncompetitive due to the double interchange.

East West Rail Impact

With the good GJT to Bedford, there is an opportunity for St Albans to have an improved journey time towards Oxford and Cambridge. However, there will still be a need for passengers to interchange twice and sometimes more for some locations. For example, St Albans to Didcot will require an interchange at Bedford, followed by another at Oxford. Similarly, St Albans to Swindon will require three interchanges, first at Bedford, secondly at Oxford and finally at Didcot. This is likely to blunt the GJTs, especially towards the north and west of the region, with other examples including Milton Keynes (two changes), Northampton (two changes) and Reading (three changes). For destinations south of the East West route, the new railway will provide little benefit as two interchanges and an equally circuitous route will be required. An example of this is St Albans to Hemel Hempstead, passengers will be torn between similar journey patterns, i.e. whether to use East West Rail or to travel via a London interchange. Therefore, the GJTs offered by East West Rail for London peripheral locations are likely to struggle to better those offered via a London interchange.

Access to HS2

Passengers from St Albans will have the opportunity to access HS2 from Euston for the full High-Speed Network. The alternative access is potentially via the East Midlands Hub station for destinations in the North-East of England and Scotland, although the latter will be dependent on any post HS2 timetable for the MML to make the journey from St Albans northwards for interchange worthwhile from a GJT perspective.

Summary

Despite having a very limited range of direct service options to the Heartland, the high frequency and fast journeys to London means that St Albans is arguably better served than other locations that are similarly limited in destination terms. This close relationship with London reduces the impact of having to travel in to the capital to reach more far flung destinations in the Heartland, however, rail journeys to locations nearby on the southern fringes of the Heartland are particularly poor in comparison. These locations lend themselves more favourably to a car based journey, which is due to the poor connectivity offered by rail to and from such southerly based locations.

Case Study 8: Peterborough

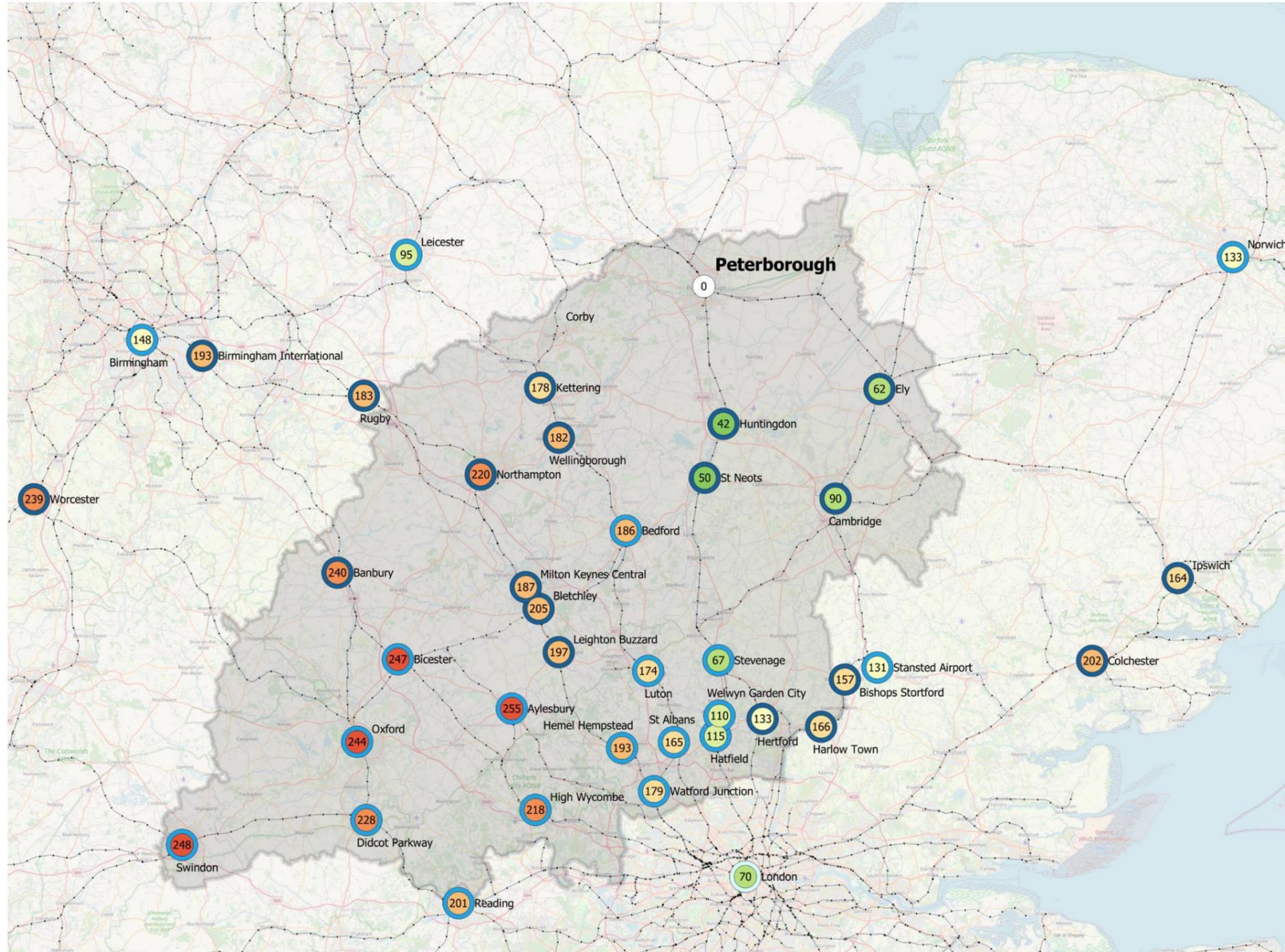


Figure 21: Generalised Journey Times and Speeds to EEH Key Nodes from Peterborough

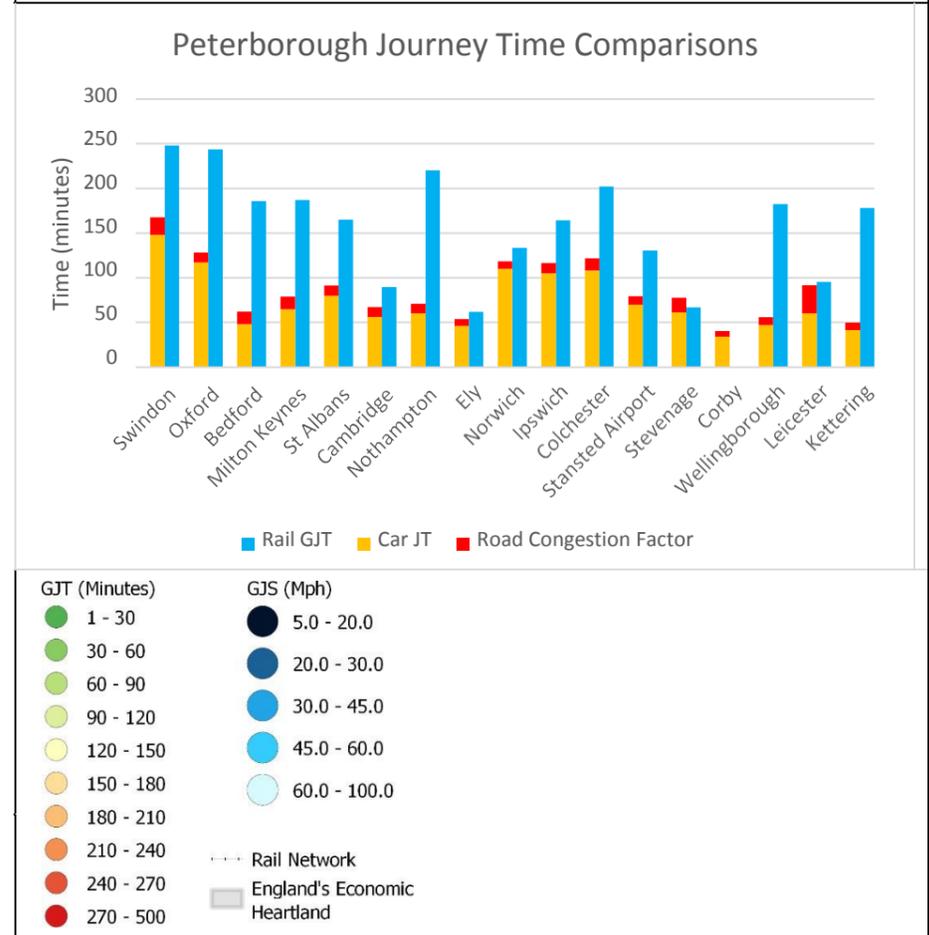
Peterborough lies on the East Coast Main Line and is a principal station for services to the North of England, the East Midlands and East Anglia. The presence of Thameslink services gives direct services to the south of England via London Bridge.

Services are provided by LNER, Thameslink/Great Northern, East Midlands Railway, CrossCountry Trains and Greater Anglia

There are direct services to the following EEH nodes:

- London (5tph)
 - Stevenage (3tph)
 - St Neots (2tph)
 - Huntingdon (2tph)
 - Ely (3tph)
 - Cambridge (1tph)
 - Norwich (1tph)
 - Ipswich (1tp2h*)
 - Stansted Airport (1tph)
 - Leicester (1tph)
 - Birmingham (1tph)
- *increases to 1tph from May 2020*

In the future, HS2 Phase 2B presents the opportunity for a recasting of the ECML timetable that could transform the connectivity for Peterborough along the ECML and increase its importance as a gateway and interchange for the region.



East Coast Main Line

Towards London there is a high number and mixture of rail services to Kings Cross or St Pancras. There are five direct trains per hour to London, three of which call at London Kings Cross non-stop, and two of which call at London St Pancras, with the GJT from Peterborough to London standing at 1 hour 10 minutes. The fast services complete the journey in 49 minutes, contributing a lot to the relatively low GJTs. However, the twice an hour Peterborough to St Pancras trains with their more frequent stopping pattern, as they serve as commuter services, take trains 1 hour 33 minutes to reach London. These services off-set the fastest trains resulting in the overall GJT. These slower services play a useful role in providing connectivity to locations such as Stevenage and Huntingdon. The GJS to London stands at 66 mph, which is reflected by the three very fast Kings Cross services being balanced out by the two slower St Pancras trains.

To other locations on the ECML, Peterborough has two direct services per hour to both St Neots and Huntingdon. The GJT of Peterborough to Stevenage stands at 1 hour 7 minutes, which is served by three trains per hour direct.

The GJT increases considerably for Peterborough to Welwyn Garden City and Hatfield, as there are no direct services to either of the locations by rail. Passengers from Peterborough must interchange at Stevenage in order to connect to the two direct trains per hour that call at both Welwyn and Hatfield. The lack of direct services, the interchange penalty and added time to each journey is why the GJT of Peterborough to Welwyn stands at 1 hour 50 minutes and Peterborough to Hatfield stands at 1 hour 55 minutes. This makes both locations quite significant outliers on this route.

The absence of direct services from Peterborough to Hertford North is another example of why the GJT between the two locations is so high. As stated, with no direct services available, Stevenage acts as the interchange hub for such journeys. There are two direct trains per hour that run from Stevenage to Hertford North, but the required interchange adds to the overall GJT of 2 hours 13 minutes.

Completion of the additional platform at Stevenage will allow more services to run between Hertford North and Stevenage in the future which will help a little with the GJT although the interchange and the slow speed will remain as significant detriments to the GJT.

West Anglia Main Line

Peterborough has a connection to the WAML via the Peterborough to Ely line, which is the route used by the two to three-trains per hour that run direct to Ely. The GJT of Peterborough to Ely stands at 1 hour 2 minutes, despite the two locations being roughly 24 miles apart. The Peterborough to Ely line has a maximum line speed of 75 mph, so the services that run along the route cannot pick up significant speed throughout the journey. Car journeys on the same route take 46 minutes (extended to 54 minutes with congestion). As part of the Greater Anglia franchise, there is a commitment to run an hourly Peterborough to Ipswich service. This will mean that Peterborough to Ely will get three trains an hour, every hour which will contribute to an improved GJT on this corridor, although this commitment requires extra infrastructure to be provided in the Ely area to deliver it.

One of the direct services to Ely continues on to Cambridge and then subsequently to Stansted Airport. The low frequency of one train per hour means that the GJT suffers from Peterborough to Cambridge, which stands at 1 hour 30 minutes. The same can be said for journeys to Stansted Airport, with a GJT of 2 hours 11 minutes.

With only one train per hour available from Peterborough to both Cambridge and Stansted Airport, passengers can use Ely as an interchange hub in order to access additional services.

Once at Ely, passengers then have access to a wider selection of trains, for example there are four trains per hour from Ely to Cambridge, two trains per hour to Stansted Airport and two trains per hour from Ely to Norwich. However, as there is an interchange required, this does not help to improve the poor overall GJT offered from Peterborough to such locations.

Two GJTs that also stand out are those of Peterborough to Bishop's Stortford (2 hours 37 minutes) and Peterborough to Harlow Town (2 hours 46 minutes). Passengers from Peterborough are restricted by the connectivity on offer to both locations by rail. Typically, an interchange at Cambridge is required, where two direct trains are available per hour to both Bishop's Stortford and Harlow Town. However, the low frequency from Peterborough to Cambridge (one direct train per hour) and the subsequent interchange penalty are all reasons as to why the GJTs stand so high.

Great Eastern Main Line

The GJT of Peterborough to Norwich is 2 hours 13 minutes, which is not particularly fast, however compared to the road journey, it is not particularly uncompetitive with the car journey taking similar time dependent upon traffic conditions. The low frequency of services on offer between the two locations is the reason for the high GJT, i.e. only one direct service per hour to Norwich. As previously mentioned, passengers from Peterborough can interchange at Ely to access an additional train per hour to Norwich but this creates inconvenience and interchange penalty for the journey.

The GJT is even higher for Peterborough to Ipswich (2 hours 44 minutes) which is a result of the one direct train every two hours that runs from Peterborough to Ipswich. The commitment to increase this to hourly from May 2020 will improve the GJT by around 30 minutes on this corridor. Some of these services will continue to Colchester too which will improve upon the GJT between Peterborough and Colchester by providing direct services; however this requires additional infrastructure to be developed in the Ely area. In the December 2019 timetable (used in this analysis), the fastest way to complete the Peterborough to Colchester journey is for passengers to travel into London (typically Kings Cross) where they can use the underground to reach London Liverpool Street. From Liverpool Street, passengers can then access the five direct trains per hour that run to Colchester. It can be gathered from the circuitous journey that the GJT from Peterborough suffers, i.e. two interchanges and added waiting times. Thus, the GJT of Peterborough to Colchester is a lengthy 3 hours 22 minutes.

Midland Main Line

Peterborough is currently connected to the MML via the hourly service to Leicester that skirts across the northern edge of the EEH region. Services on this route link Birmingham with Stansted Airport. The GJT to Leicester is 1 hour 35 minutes despite the two locations being 38 miles apart. The same journey by road takes 60 minutes, however the journey length is very volatile due to congestion and can be extended to 1 hour 32 minutes by congestion. The GJT of Peterborough to Birmingham (2 hours 28 minutes) is caused primarily by the hourly frequency of the service but also due to these trains acting as the local stopping service as well as an intercity train.

Leicester acts as the interchange gateway for Peterborough based passengers who wish to access the MML (Corby, Kettering and Wellingborough) and destinations further north in the East Midlands. Once at Leicester, passengers have access to a direct hourly service southbound that calls at both Kettering and Wellingborough. The combination of the hourly service between Peterborough and Leicester, the interchange penalty and the hourly frequency southwards leads to the long GJTs from Peterborough to the MML. The rail service for Peterborough to Corby is even more problematic, as there are no direct services available from Leicester to Corby. Thus, passengers must interchange at Leicester and then interchange again at Kettering where the hourly services to Corby are available. This represents a rail journey that people just simply wouldn't make and is likely to be the reason as to why the GJT

data was not available for Peterborough to Corby, as people just do not make the trip by rail. This is a clear example of where rail fails, especially when it is considered that Peterborough and Corby are only approximately 19 miles apart and a car can do the same journey in 34 minutes (40 minutes with congestion).

For destinations further south than Wellingborough, Leicester becomes impractical as an interchange hub for Peterborough passengers. For example, there is only one direct train per hour from Leicester to Bedford and then no direct services are available to either Luton or St Albans. Thus, passengers from Peterborough are better off travelling into London Kings Cross and walking to London St Pancras where there is a high frequency of direct trains available to St Albans, Luton and Bedford. However, as this requires an interchange in London, passengers from Peterborough will expect GJTs to St Albans of 2 hours 45 minutes and 2 hours 54 minutes to Luton.

West Coast Main Line

For all WCML locations the journey from Peterborough is not competitive via rail as the journey involves travelling in to London and back out again via Euston. The alternative is for passengers to interchange via Nuneaton, however, the hourly frequency of the Peterborough to Birmingham service makes travelling to Nuneaton less appealing. In addition, the only regular service on the WCML that calls at Nuneaton runs hourly and calls only at Rugby and Milton Keynes. Therefore, passengers face an additional interchange should they wish to travel to other WCML locations (other than Milton Keynes or Rugby).

The starkest example of poor rail connectivity to the WCML is Northampton; despite being just 36 miles apart, the GJT of Peterborough to Northampton is the lengthiest of all GJTs to WCML locations, standing at 3 hours 40 minutes. A car can do the same journey in an hour (1 hour 11 minutes with congestion).

Chilterns and Great Western Main Line

Locations on the Chiltern and Great Western Main Line are a significant distance away from Peterborough, therefore higher GJTs are to be expected. Again, the journey via London means that rail cannot provide a competitive journey, largely due to the difficult interchange between Kings Cross/St Pancras and Marylebone or Paddington. This slow element of the journey wipes out the fast journey to London meaning that even to somewhere like Reading, where the component GJTs are quite low, the overall GJT is high at 3 hours 21 minutes.

East West Rail Impact

Peterborough is not proposed to be a part of the East West Rail network. An interchange station is proposed between St Neots and Sandy on the ECML meaning that at least one interchange will be required to access destinations on the East West Rail route. The result is that only a small number of EEH nodes will be accessible via one interchange; these will be Bedford, Bletchley, Bicester and Oxford. To make significant improvements on the GJTs, a high frequency of service between Peterborough and the proposed East West interchange station will be required to minimise the interchange penalty. For destinations off the East West Rail route, there will be a requirement to interchange at least twice, despite a more direct route being available. This will mean that it is likely that while there will be a GJT improvement over the December 2019 GJT, it is still unlikely to be competitive with road on most journeys.

Access to HS2

Peterborough will not be located near to any HS2 stations, for travel to the north-east there will be the opportunity to travel to the East Midlands Hub or Leeds for onward connectivity. To the north-

west an interchange via Birmingham may be quicker than the direct service via Nottingham, but the low frequency in to Birmingham may result in little difference in the GJTs compared to the direct service.

Summary

Peterborough acts as a gateway for the eastern part of the region to reach the Midlands and north of the country but is hampered by low frequency on the cross-country routes that complete these journeys. The connectivity to London is good but the lack of direct connectivity to the centre and west of the Heartland means that rail cannot compete with roads in this area and East West Rail will do little to change the rail connectivity in this regard, particularly for destinations beyond the core East West route.

Case Study 9: Hertford

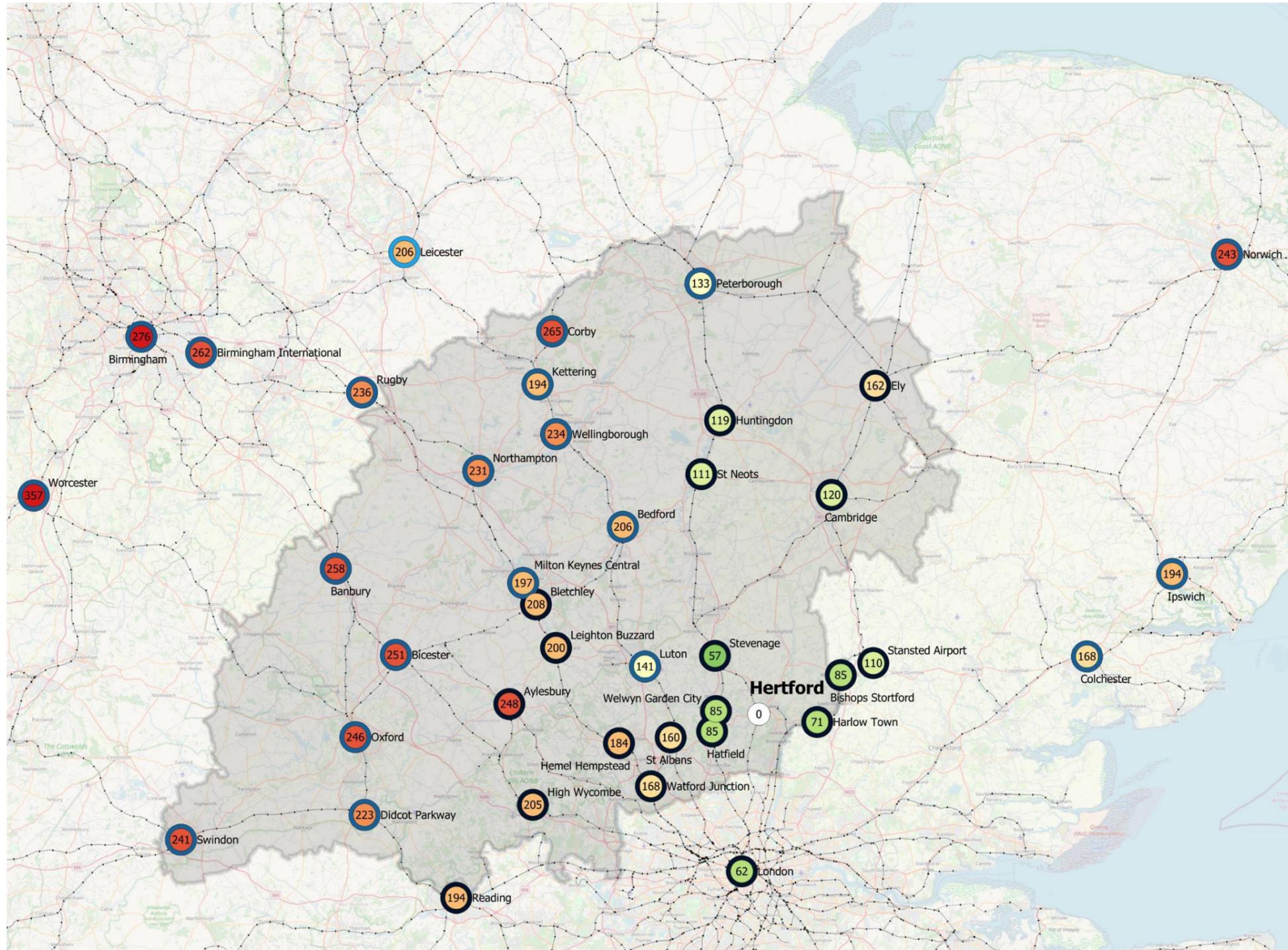


Figure 22: Generalised Journey Times and Speeds to EEH Key Nodes from Hertford

Hertford has two stations, Hertford North with services north to Stevenage and south to London Moorgate. Services from Hertford East head south to London Liverpool Street.

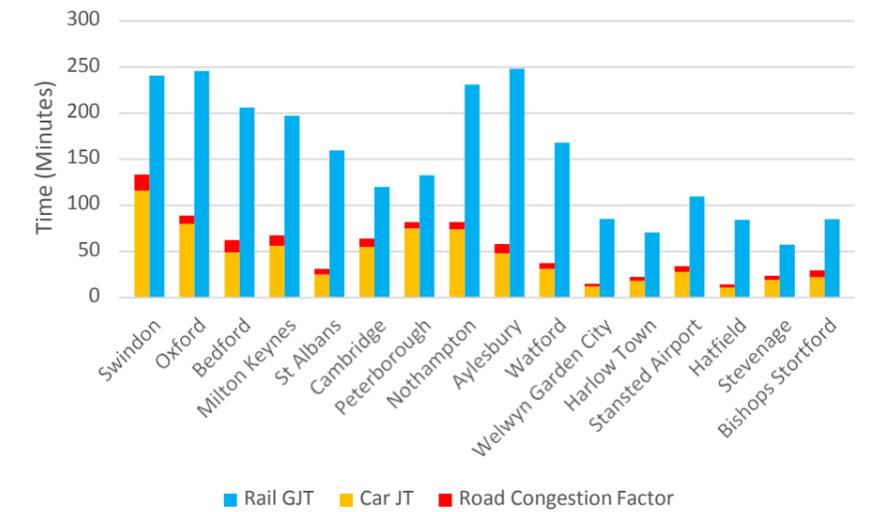
The EEH nodes that can be reached directly from either Hertford station are limited to:

- London (2tph from Hertford East, 4tph from Hertford North)
- Stevenage (2tph)

Services are provided by Great Northern at Hertford North and Greater Anglia at Hertford East.

In the near future, the service frequency to Stevenage will increase to 4tph following the construction of an additional platform at Stevenage, which will enable this.

Hertford Journey Time Comparisons



GJT (Minutes)	GJS (Mph)
● 1 - 30	● 5.0 - 20.0
● 30 - 60	● 20.0 - 30.0
● 60 - 90	● 30.0 - 45.0
● 90 - 120	● 45.0 - 60.0
● 120 - 150	● 60.0 - 100.0
● 150 - 180	
● 180 - 210	
● 210 - 240	
● 240 - 270	
● 270 - 500	

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East Coast Main Line

Hertford North is located on the Hertford Loop line which branches off from the ECML just after Alexandra Palace and re-joins the ECML just before Stevenage. The Hertford Loop line consists of a number of commuter stops and the line runs at a maximum speed of just 75 mph.

None of Hertford North's services call at London Kings Cross, instead, four trains per hour run from Hertford North directly to Moorgate, which is the direct London terminus station for these trains and therefore the GJT of 1 hour 2 minutes into London is reflective of this journey pattern. The GJS from Hertford into London stands at just 19mph, which is also reflective of the frequent stopping pattern along the Hertford Loop line and of the 75ph maximum line speed. As Hertford North is based on a loop off the East Coast Main Line, even local journeys to Welwyn Garden City and Hatfield require travelling north to Stevenage for interchange or south to Alexandra Palace to return north. Consequently, GJTs even to some of the nearest locations are poor and uncompetitive with the road alternative. Hatfield and Welwyn Garden City are both reachable with a GJT of 1 hour 25 minutes whereas the road journeys take a mere 11 minutes and 12 minutes respectively, both extended by up to 3 minutes with congestion.

Stevenage acts as a key interchange hub for Hertford based passengers, as it provides direct services to many other ECML and WAML locations, e.g. Cambridge, Peterborough, St Neots and Welwyn Garden City. There are two direct trains per hour in the off-peak that run from Hertford North to Stevenage, with a GJT of 57 minutes. The two locations are only roughly 9 miles apart, yet the GJT suffers due to the restrictions on speed for the two hourly services, i.e. maximum of 75 mph. The restrictions of speed are apparent with the extremely low 10 mph GJS between Hertford and Stevenage. The poor GJT is also a product of only two trains per hour running to Stevenage, although this will improve when the frequency increases to 4tph from May 2020. As of December 2019, the generalised journey speed on this journey is just 10mph

The GJTs to other locations along the ECML suffer due to the reliance on interchanging at Stevenage. There are no direct services available to any other ECML location, other than Stevenage, which is why there is such a significant spike in GJTs to Peterborough, Huntingdon, St Neots, Hatfield and Welwyn.

Finsbury Park can be used as interchange for access by Underground to the other main line terminals in London, providing a slightly more direct route than going to Old Street or Moorgate, especially for St Pancras and Euston stations.

West Anglia Main Line and Great Eastern Main Line

Hertford East has better access to WAML and GEML based locations as opposed to Hertford North as it is located on the Hertford East branch line. The line branches off from the WAML just north of Broxbourne, where it serves a small number of locations before terminating at Hertford East. There are two direct trains per hour that run from Hertford East to London Liverpool Street, with stops at useful interchange stations such as Broxbourne, Cheshunt and Tottenham Hale along the way.

An interchange at Broxbourne (located on the WAML) provides Hertford based passengers with access to four direct trains per hour that call at Harlow Town and Bishop's Stortford. Two of the four direct trains per hour from Broxbourne also go on to call at Cambridge, which makes it a useful interchange hub for such journeys. However, the Stansted Airport services pass through and do not call at Broxbourne, therefore Hertford based passengers must use Tottenham Hale as the interchange point in order to access the four hourly direct services that run to Stansted Airport, the result is a GJT to Stansted of nearly 2 hours. Road can do the same journey in 28 minutes (34 minutes with congestion).

Despite direct access to Liverpool Street from Hertford East, which provides a single interchange, the GJT to Colchester is a staggering 2 hours 48 minutes, compared to a road journey time of between an hour and 90 minutes. Norwich has a GJT of over 4 hours by rail, which perfectly illustrates the poor rail connectivity on offer from Hertford to further afield destinations.

Midland Main Line, West Coast Main Line, Chiltern Main Line and Great Western Main Line

The service offering from the two Hertford stations to London is 6 trains per hour, however, to access destinations to the west of the ECML, the best route is from Hertford North. The tube transfer is lengthy, with passengers having to travel all the way to Moorgate to access the Circle, Hammersmith & City or the Metropolitan lines should they wish to reach Marylebone (Chiltern) or Paddington (GWML). To get to St Pancras (MML) or Euston (WCML), passengers from Hertford must travel to Finsbury Park and then travel via the Victoria line to access both London termini. Either way, the journey from Hertford to the relevant London termini is lengthy and it means that rail cannot compete with any journey to the western area of EEH, with most GJTs in excess of three hours.

East West Rail Impact

East West Rail will have a very limited impact on the connectivity for Hertford as there will be two changes required to simply access the route. There will be an interchange required at Stevenage and then again at the ECML interchange station between Sandy and St Neots. A lot will depend on the service frequency that will call at the new station on the ECML, as it will influence the GJT between it and Hertford.

The result is that it is likely that all rail journeys to EEH locations will continue to be best served via London.

Access to HS2

Hertford's access to HS2 will be from Euston where access to the full range of High-Speed Destinations will be possible. All other HS2 stations will require such a lengthy journey that any saving provided by the High-Speed services is written off by trying to access them.

Summary

Despite having two stations on different routes, both Hertford North and East are at the end of commuter lines in to London. The lack of direct connections northwards means that almost all journeys are heavily dependent upon long transfers via the TfL network to reach the other main lines. The long journeys in to London by either route combined with the long transfers to other stations means that rail just cannot compete with road for access to the rest of EEH and this will continue to be the case even with East West Rail.

Case Study 10: Cambridge

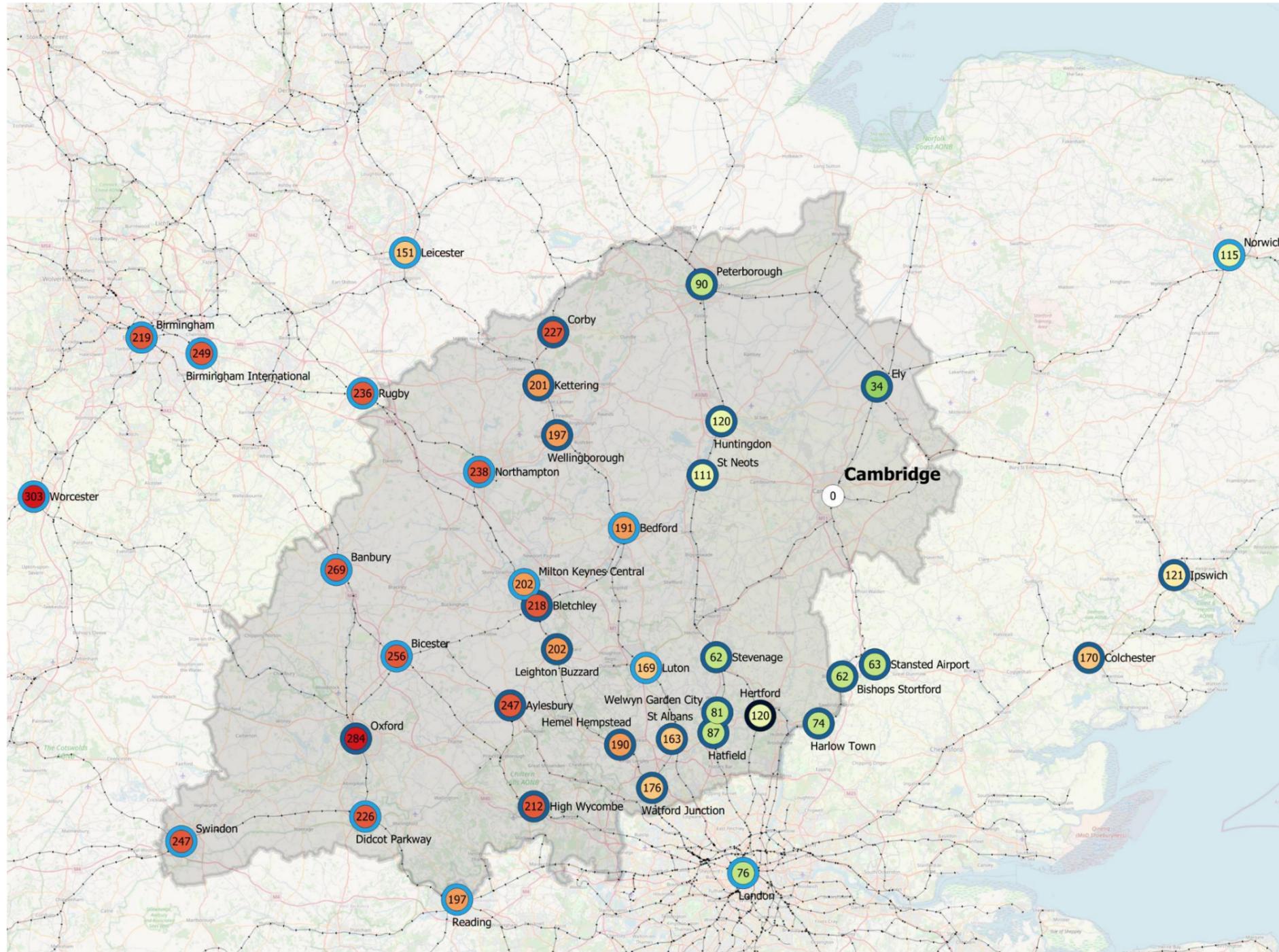


Figure 23: Generalised Journey Times and Speeds to EEH Key Nodes from Cambridge

Cambridge lies on two main routes to London, the WAML and a branch of the ECML. It also has cross country links towards the Midlands and East Anglia. Train services are provided by Thameslink, Great Northern, Greater Anglia and CrossCountry Trains.

EEH nodes that can be accessed directly from Cambridge are: London (8tph)

Norwich (1tph)

Ipswich (1tph)

Ely (4tph)

Stansted Airport (2tph)

Bishop's Stortford (2tph)

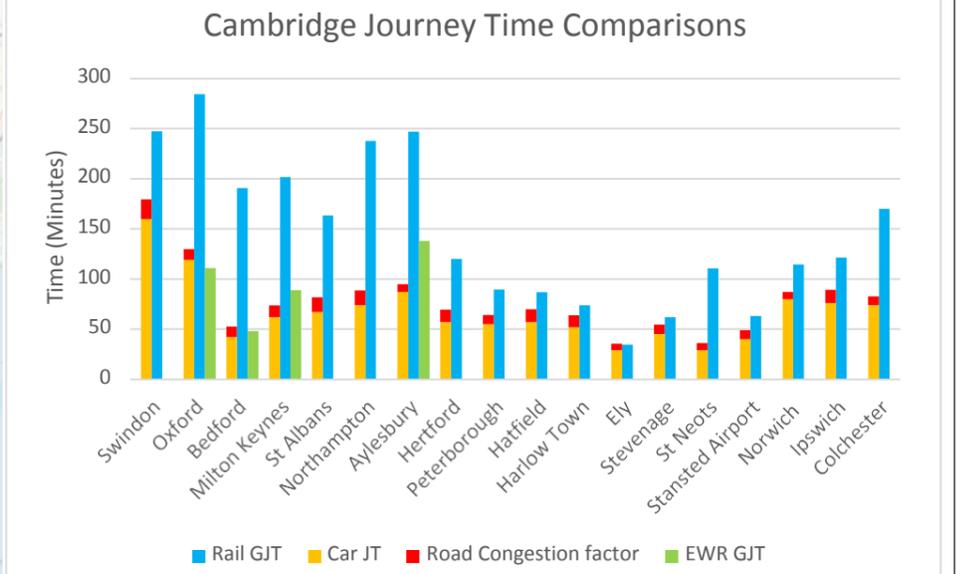
Harlow Town (2tph)

Stevenage (4tph)

Hatfield (2tph)

Welwyn Garden City (2tph)

In the future Cambridge will act as the Eastern terminus of East West rail with direct services to Oxford.



GJT (Minutes)

1 - 30

30 - 60

60 - 90

90 - 120

120 - 150

150 - 180

180 - 210

210 - 240

240 - 270

270 - 500

GJS (Mph)

5.0 - 20.0

20.0 - 30.0

30.0 - 45.0

45.0 - 60.0

60.0 - 100.0

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West Anglia Main Line and Great Eastern Main Line

Cambridge is situated on the WAML, where it has direct connectivity available to the locations along the WAML corridor. There are two trains that run per hour in the off peak directly to London Liverpool Street (although most services to London from Cambridge run to Kings Cross and St Pancras). The same two trains per hour also call at both Harlow Town and Bishop's Stortford. There are also two direct trains per hour that run from Cambridge directly to Stansted Airport. Although the locations stated have a good level of direct connectivity, the frequency of service on offer is not particularly high, which is why the GJTs take more than one hour. Harlow is located roughly half way between Cambridge and London, yet it has a GJT that is nearly the same as the GJT to the capital.

To the north, there are four trains per hour in the off peak that run from Cambridge directly to Ely, with a GJT of 34 minutes. Services beyond Ely then branch off on to three different routes. There is only one direct train per hour that runs from Cambridge to Norwich, this low frequency is a key reason why the GJT stands at 1 hour 55 minutes. There is an additional option for Cambridge based passengers to interchange at Ely, where an additional hourly direct train to Norwich runs. Cambridge and Norwich are approximately 57 miles apart, yet the GJT is not reflective of this distance. Cambridge has a direct connection to Ipswich which acts as a good link to the GEML however it is served by just one train per hour, which results in a GJT of 2 hours 1 minute.

East Coast Main Line

Cambridge has direct services to large parts of the ECML. There are four direct trains per hour in the off peak that run to London Kings Cross and two to St Pancras (that run beyond to destinations south of the Thames). The high frequency on this route and the additional two trains to Liverpool Street gives a GJT to London of 1 hour 16 minutes.

The GJT of Cambridge to Stevenage is 1 hour 2 minutes, with four direct trains in the off peak. Further south on the ECML, both Welwyn Garden City and Hatfield are served by just two direct trains per hour from Cambridge. The lower frequency of service (two trains per hour) and large number of stops along the route to both locations from Cambridge is why the GJT stands at between 1 hour 20 and 1 hour 30 minutes.

Stevenage acts as an interchange hub for stations between Hitchin and Peterborough for Cambridge based passengers as there are no direct rail connections for these journeys. This is an indirect route especially when it is considered how close both St Neots and Huntingdon are to Cambridge. St Neots is only 16 miles away from Cambridge and the A428 provides good connectivity between the two locations with car journeys of 29 minutes (36 minutes with congestion), yet the rail GJT takes 1 hour 51 minutes. Likewise, Huntingdon is 16 miles from Cambridge but for the same reasons as St Neots, the rail GJT is 2 hours while the A14 gives a direct route between the two. Therefore, the use of rail as a mode of transport from Cambridge to both St Neots and Huntingdon is not appealing for passengers.

To the north west, there is a direct hourly service that runs from Cambridge to Peterborough via Ely. As with other journeys via Ely, passengers from Cambridge also have the option available to interchange there, where an additional one train per hour runs directly to Peterborough. The low frequency of direct services and the interchange penalty associated with journeys via Ely mean that the GJT from Cambridge to Peterborough is 1 hour 30 minutes.

There are no direct rail services available for Cambridge to stations on the Hertford Loop therefore Stevenage again acts as an interchange hub for such journeys. There are two direct trains per hour from Stevenage to Hertford North but the required interchange (when making the journey from Cambridge) adds to the overall GJT of 2 hours.

Midland Main Line

As there is no direct connectivity available from Cambridge to MML based locations, passengers must consequently travel to London where they can then interchange at St Pancras. This adds a significant interchange penalty on to all journeys from Cambridge to the locations based on the MML, which is reflected by the GJTs in excess of three hours.

West Coast Main Line

Like the MML, Cambridge has no direct connectivity available to the WCML, meaning the GJTs to all locations along the route are lengthy. Passengers from Cambridge must travel to the three London stations that they have access to (Liverpool Street, Kings Cross and St Pancras), where they can then travel via the underground to London Euston for an interchange. As journeys move further north along the WCML, the GJT increases, with Cambridge to Milton Keynes taking 3 hours 22 minutes. The same journey by the X5 bus has a GJT of 2 hours 55 minutes and, in the car, it takes just 1 hour 2 minutes (extended to 1 hour 14 minutes with congestion). This paints the picture of how poor the rail offerings are between such locations.

Chilterns and Great Western Main Line

There is a significant distance from Cambridge to both the Chilterns and GWML, which is reflected by the high GJTs to such locations. This high GJT is also due to the requirement for rail passengers from Cambridge to travel into one of the three London stations (Liverpool Street, Kings Cross or St Pancras) where they then must travel west, across London, to Marylebone or Paddington station. This journey across London via the underground adds to the overall GJT, as there is an average 20-minute journey via the Circle Hammersmith and City line from St Pancras or Kings Cross to either Paddington or Marylebone station. The journey from Liverpool Street is even more lengthy, where it typically takes up to 30 minutes via the Hammersmith and City line to get to either Paddington or Marylebone station.

As would be expected, most of the GJTs increase proportionately to the greater distance covered along either the Chilterns or GWML, however Oxford is an anomaly, with a GJT of 4 hours 44 minutes from Cambridge. A car journey between the university cities takes 1 hour 59 minutes (2 hours 10 minutes with congestion).

East West Rail Impact

East West Rail will bring many EEH nodes to within one interchange of Cambridge which will transform the rail offering. The following locations will be brought to just one interchange from Cambridge;

Change at ECML Interchange station: Huntingdon and St Neots.

Change at Oxford: Didcot and Banbury.

Change at Bicester: High Wycombe.

Change at Bletchley: Rugby, Northampton, Milton Keynes, Leighton Buzzard, Hemel Hempstead, Watford and Aylesbury.

Change at Bedford: Corby, Kettering, Wellingborough, Luton and St Albans.

This will mean that the GJTs will be improved for almost all EEH nodes, although the need to interchange twice to reach Great Western Main Line locations will remain. This may result in interchanging via London as still being the fastest route to reach this area of the Heartland and the South-West of England.

Access to HS2

Cambridge is well placed to access HS2 from London Euston. The GJT to London makes this a viable journey for destinations on the High-Speed Network. The low frequency of the cross-country links and

their extended journey times means that journeys to Birmingham Interchange and East Midlands Hub won't be viable for destinations on HS2.

Summary

Cambridge has good connectivity to the south-eastern quadrant of the Heartland and while direct links do exist to the Midlands that do not necessitate a journey via London, these links do not provide an option for journeys to the rest of the Heartland. The connectivity to the rest of the region relies heavily on the fast journeys to London but even so they remain uncompetitive when compared to road transport. That will change once East West Rail reaches Cambridge, as the journey offerings will mean that rail connectivity will no longer rely on London to reach the rest of Heartland except for those in the most western reaches of the region.

Case Study 11: East West Rail

A whole new set of Generalised Journey Times as a result of the introduction of East West Rail are not possible to be calculated for this analysis, this is because there is still a lot of development work to be done on East West Rail. Exactly how the timetable will look will depend on a multitude of factors and therefore the number of assumptions would mean it has little value. However, the GJT on the East West Rail network can be assumed.

The current GJTs for the key nodes that are also East West Rail destinations are shown in Figure 24.

	Oxford	Bicester	Bletchley	Bedford	Cambridge	Aylesbury	Milton Keynes
Oxford		40	190	234	287	187	161
Bicester	40		212	235	259	128	215
Bletchley	190	212		82	217		22
Bedford	234	235	82		191	245	106
Cambridge	287	259	217	191		247	203
Aylesbury	187	128		245	247		224
Milton Keynes	161	215	22	106	203	224	

GJT in Minutes	
0 - 30	
30 - 60	
60 - 90	
90 - 120	
120 - 150	
150 - 180	
180 - 210	
210 - 240	
240 - 270	
>270	

Figure 24: Current GJTs between Key Nodes that will lie on the East West Rail route

As has been established in the previous case studies, the GJTs between these locations on the most part is poor and relies on two interchanges via London. Once the Central and Western sections are delivered, the GJTs will improve dramatically.

When showing the indicative GJT for East West Rail as a percentage of the current GJT, the transformational nature of East West Rail is clear. All GJTs improve by at least a third (with the exception of Milton Keynes to Bletchley). There is a nearly 75% reduction in GJT on the Oxford – Bicester – Bletchley section.

The sections that see the smallest improvements are sections of route where there are already direct services operating or East West Rail won't provide direct connectivity.

	Oxford	Bicester	Bletchley	Bedford	Cambridge	Aylesbury	Milton Keynes
Oxford		65%	24%	33%	39%	46%	38%
Bicester	65%		16%	28%	38%	57%	23%
Bletchley	24%	16%		45%	33%		68%
Bedford	33%	28%	45%		25%	34%	31%
Cambridge	39%	38%	33%	25%		56%	44%
Aylesbury	46%	57%		34%	56%		31%
Milton Keynes	38%	23%	68%	31%	44%	31%	

Indicative EWR GJT as % of current GJT	
0 - 10%	
10% - 20%	
20% - 30%	
30% - 40%	
40% - 50%	
50% - 60%	
60% - 70%	
70% - 80%	
80% - 90%	
90% - 100%	

Figure 25: Indicative EWR GJTs as a percentage of the current GJT between EWR Key Nodes

When looking at what the indicative GJTs for East West Rail will be, in minutes, some interesting themes emerge. Firstly, the vast majority of the East West destinations have GJTs in the 60 – 90-minute bracket, with the end to end Oxford to Cambridge journey having a GJT of under two hours. Given the road journey between the two is similar at 2 hours without congestion, this means that rail

will provide a competitive option to car transit on this corridor as result of providing a direct service, with relatively few stops.

	Oxford	Bicester	Bletchley	Bedford	Cambridge	Aylesbury	Milton Keynes	ECML Station	GJT in Minutes	
		0 - 30								
		30 - 60								
		60 - 90								
		90 - 120								
		120 - 150								
		150 - 180								
		180 - 210								
		210 - 240								
		240 - 270								
		>270								
Oxford		26	45	77	111	86	61	87		
Bicester	26		33	65	99	73	49	75		
Bletchley	45	33		37	71	62	15	47		
Bedford	77	65	37		48	84	33	24		
Cambridge	111	99	71	48		138	89	38		
Aylesbury	86	73	62	84	138		69	110		
Milton Keynes	61	49	15	33	89	69		61		
ECML Station	87	75	47	24	38	110	61			

Figure 26: Indicative GJTs between Key Nodes on East West Rail route following delivery of East West Rail Western and Central Sections.

The slightly longer route corridor option that East West proposes to take between Bedford and Cambridge and the number of stations calls, accounts for the longer journey times for Bletchley – Cambridge (71 minutes) compared to Bletchley – Oxford (45 minutes).

Milton Keynes lies approximately halfway between Oxford (29 miles to Milton Keynes) and Cambridge (38 miles to Milton Keynes), however the indicative GJT of 89 minutes show that the journey to Cambridge is around 50% longer than the journey to Oxford. This can be attributed to some of the reasons outlined above but is also a factor of the lack of direct services to Cambridge, resulting in an interchange at Bletchley.

Aylesbury has a much-improved offering from today but the single train per hour service provided to Milton Keynes clearly set its out as an outlier. The GJT to Milton Keynes being over an hour compared to the road journey that takes around 34 minutes (39 minutes with congestion) meaning that the Rail GJT, whilst improved will still be around double that of the car journey. Although the GJT is nearly halved to Oxford, the need to change at Winslow results in a GJT of nearly an hour and a half while road journeys take 41 minutes (47 minutes with congestion), again representing a road offering that is half that of the proposed rail offer. The low frequency of service and indirect routing means that Cambridge is reached in 2 hours and 18 minutes.

A key point highlighted in the other cases studies is how East West Rail fits in to the wider rail network. While there will be a very strong core linking Oxford and Cambridge, the interchange penalty to reach destinations beyond this core will negatively affect the GJT. Swindon to Peterborough is a particularly stark example of this but not the only example. A prospective passenger wanting to undertake this journey would need to interchange at Didcot Parkway, Oxford and the ECML interchange to get to Peterborough, no matter how good the core section is, this will have a big impact on the GJT. Less extreme, but similar examples, needing two interchanges exist for nearly all journey pairs that don't start and end on the core East-West Rail route.

Gaps in the rail offering throughout the Heartland

Following on from the Service Levels analysis, it is apparent that there are several consistent themes with regards to the associated rail connectivity gaps and the patterns of rail travel across the Heartland. Therefore, a summary of gaps within the EEH region has been made.

Common themes across the EEH network

It is clear to see, following on from the Service Level analysis, that EEH has some positives and negatives when it comes to the rail offering that is currently available to passengers across the Heartland. The distinction between good and bad levels of connectivity is very much associated with the direction and pattern of travel each passenger makes by rail.

Starting with the positives, EEH rail passengers generally experience good levels of rail connectivity when they make journeys along a single main line. For example, a passenger who is based in Milton Keynes can travel to many destinations along the WCML easily, as they will have access to a number of frequent and direct services. The same theme is noticeable for other Main Line rail journeys, e.g. Swindon based journeys to locations along the GWML (including London) are well served, with GJS recordings ranging from 40-68 mph. This is something that EEH does very well, as each Main Line is typically served by fast and frequent services that run directly into London, which enables passengers to travel easily to and from destinations along each arterial route.

The negatives start to emerge when EEH based passengers must make changes across the region from one main line to another, regardless of overall distance. For example, when passengers need to travel from Milton Keynes to Reading, a significant interchange penalty increases the GJT as a result of the interchange between Euston and Paddington. This journey pattern is a common theme that is typical, i.e. passengers travelling into London, interchanging and then travelling back out of London via a different main line in order to reach the ultimate destination. This common journey pattern highlights the key problem that the rail network within EEH lacks cross connectivity that avoids London. Passengers can easily travel up and down the Heartland, but they have a limited number of options available for journeys that go across the region, i.e. east and west. In addition, London terminus stations are already extremely busy, and this journey pattern only adds to the number of people who use them, putting unnecessary pressure on already busy routes in to the capital.

Cross connectivity: The Arc Concept

The Oxford-Cambridge Arc is now a well-established concept of an area of concentrated development of employment and homes and a need for transport infrastructure to support it. East West Rail sets out to support that development however, as has been demonstrated in the Service Levels chapters, its influence is limited to quite a narrow corridor in the Heartland and while locations off the route will undoubtedly benefit for places in the North and South of the region, the benefits of East West Rail are diluted. This is especially prevalent where journey pairs don't cross the East West Rail route, for example Northampton to Peterborough, as opposed to a Northampton to Aylesbury journey. A journey via East West Rail will still require a large amount of doubling back to complete the journey and often, two interchanges to complete. An identical situation exists in the south of the region where East West doesn't provide a faster alternative to travelling via London, especially when considering that the service offering tends to reduce when heading away further from the capital.

Some of these corridors either extend into other Sub-national Transport Body areas or will have an impact on services and aspirations in other regions and will require working collaboratively to maximise the benefits for all parties.

The Three Arcs

With the above in mind, a three-arc concept has been proposed; East West Rail forms the central arc linking the GWML with GEML via Oxford, Milton Keynes, Bedford and Cambridge. This is flanked by a northern arc that provides connectivity in a corridor that links North Oxfordshire Banbury with Northampton, North Northamptonshire and Peterborough and a Southern arc that parallels the southern border of the region providing an orbital route of London between the Chiltern Route and West Anglia Main Line.

In the most part, the three 'Arcs' do not currently have a rail corridor operating along them, although the Central arc will have East West Rail, once built at its core.

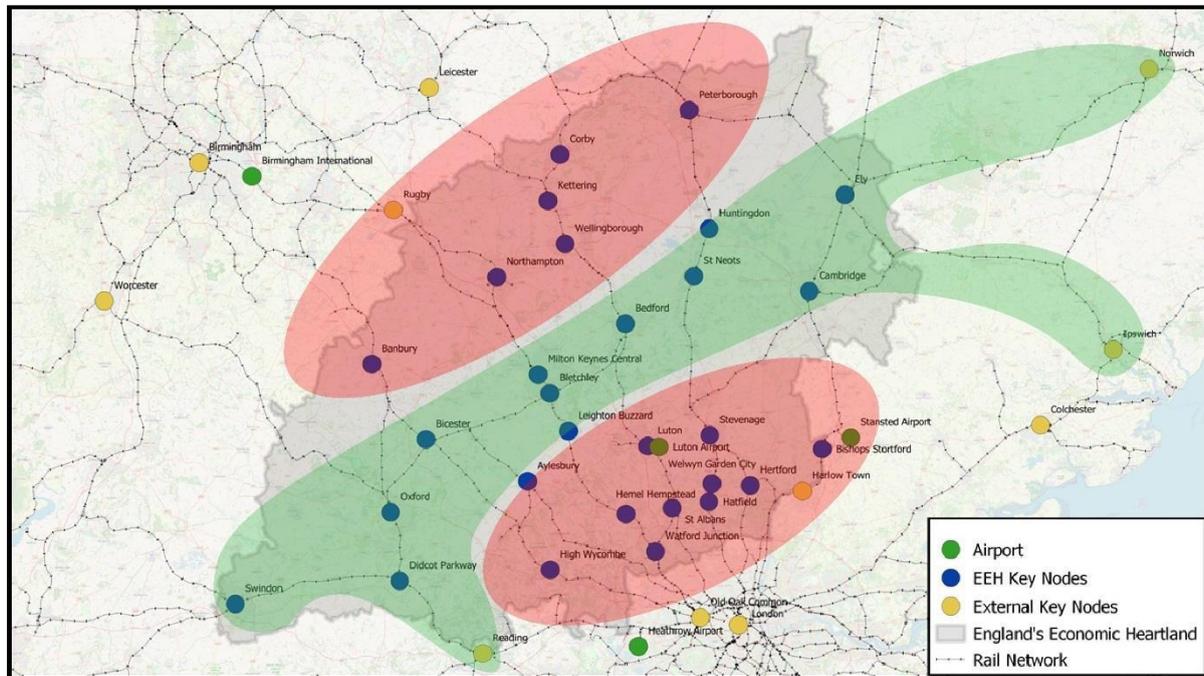


Figure 27: Three Arcs of Connectivity, The North, Central and Southern Arcs

The Central Arc

The Central Arc is the concept of extending the Oxford – Cambridge Arc to a wider east to west geography to include Swindon at the west and Ely and Newmarket in the East. Pushing the Central Arc beyond just Oxford to Cambridge will bring much more of the Heartland within one interchange of the rest of the region and tie the region in to the central hubs of Milton Keynes and Bedford with direct connectivity with the West and East Midlands. This will dramatically reduce, not just journey times in EEH but across wider portions of southern England and relieve pressure on the Main Lines in London and the TfL network.

By extending out to East Anglia it connects the key regional centres of Norwich and Ipswich together, improving on the hourly links that currently link the East Anglian centres to Cambridge.

East West Rail could form a main line railway with a variety of services, linking some of the biggest centres in the region together will go a long way to providing single-interchange opportunities to a large portion of the region and also the wider country, especially if services were to be extended on to the main lines that it intersects with, particularly at the western end of the corridor.

The Northern Arc

A rail corridor in the north of the region would make significant connectivity improvements to communities in the north of the region.

Potential benefits of such a northern arc:

- More direct connectivity across the northern Heartland reducing reliance on travel via the West and East Midlands
- Provide a rail alternative to the A43 corridor
- Ability to provide services to high growth sites that are currently not on the rail network such as Daventry.
- Provide options for services other than southwards from Corby.

There is potential for an additional route into the West Midlands via Leamington Spa by avoiding the Leicester area.

This could be provided by additional services to locations off the core East West Main line or by extending the proposed Oxford-Cambridge services to destinations further afield. In whichever way the output is achieved, increasing the range of destinations that can be reached directly by trains using the new infrastructure will improve the ability to reduce GJTs across the region.

The Southern Arc

The concept of the Southern Arc is similar to that of the Northern Arc, but with the benefits of potentially relieving pressure on the orbital road network in this area, most notably the M25 and A414, promoting modal shift and decarbonisation. It would enable an increase of rail usage and create journey opportunities where rail doesn't currently offer a viable alternative to other transport means. By linking the radial main lines at this point creates the potential for a London orbital route.

Other corridors of poor connectivity

Away from the Three Arcs there are seven other corridors that have been identified in this analysis as being noticeably poorer than elsewhere in the region.

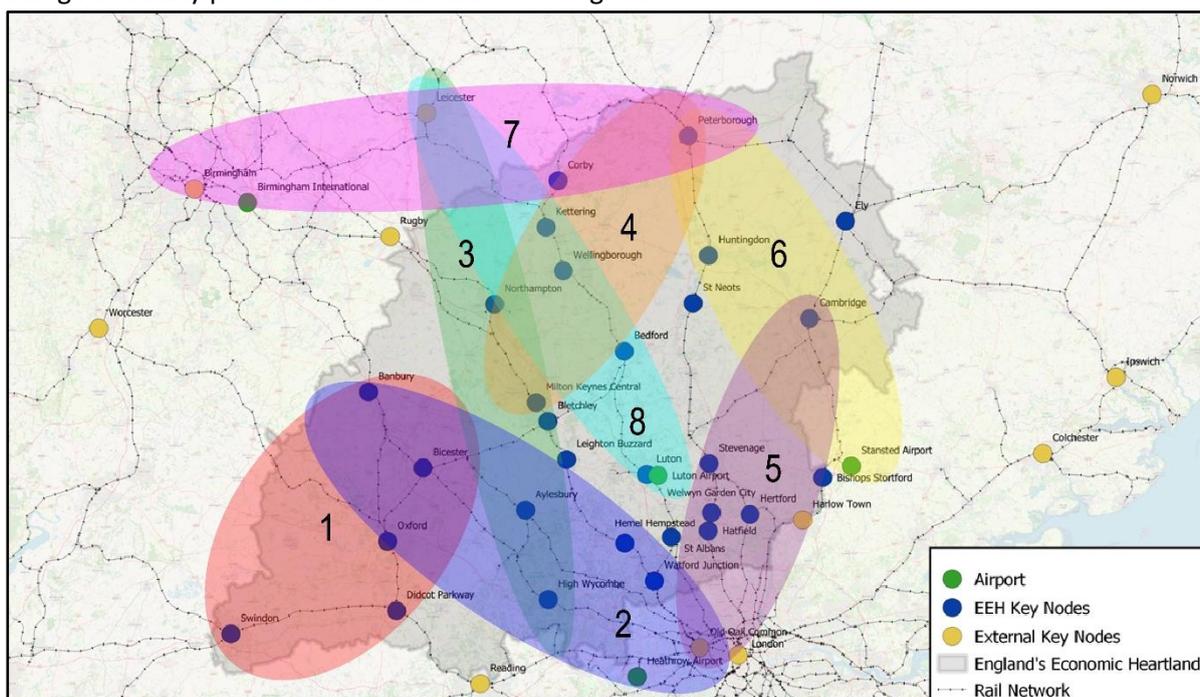


Figure 28: Seven other corridors that have been identified to have poor rail connectivity

1: Oxfordshire and Swindon: In line with the Oxfordshire Rail Corridor Study (ORCS) the lack of connectivity between, particularly Oxford and Swindon but more generally the wider Oxfordshire area is a significant barrier to travel across the whole region. Improvements in service are intrinsically linked with the service that East West Rail offers. The connectivity issues also extend towards the West Midlands with a lack of connectivity for Swindon and Oxfordshire to Coventry and Birmingham Airport and towards Worcester.

2: Chiltern Main Line: The Chiltern route does a very good job of connecting Buckinghamshire and Oxfordshire with London, however inter-connectivity could be significantly improved as currently there are low frequencies between intermediate stations. Aylesbury compares badly with towns of a similar size and distance from London in terms of journey times. The lack of direct connectivity to Oxford and the West Midlands also sets it apart from other places in the same region. As this corridor provides direct links to the West Midlands, the lack of good northwards connectivity (often only hourly connections, if it exists at all) means very long GJTs. To maximise the benefits of the Western section of East West Rail, good connectivity in this corridor will be essential.

3: East Midlands to Thames Valley: This corridor is currently poorly served by both road and rail. Whilst East West Rail proposes to address some of these issues, and HS2 will provide end to end connectivity between East Midlands Hub and Old Oak Common, the important settlements of Northampton, Milton Keynes, Aylesbury and High Wycombe will remain poorly served in this corridor.

The East West Rail hourly frequency will do little to transform GJTs and only cover a small sub-section of this corridor. Heathrow airport can be appended to this corridor to improve access from areas directly north of the airport that are untouched by the benefits of Western Rail Link to Heathrow and the introduction of Elizabeth line services.

4: Peterborough - Milton Keynes: Milton Keynes will form a major hub for the east of the region to reach the west once East West Rail is complete. Similarly, Peterborough acts as a gateway to the north and east of the country. East West Rail not providing services to the east from Milton Keynes and no East West Rail services to Peterborough means that two of the biggest population centres in the Heartland will have no direct connectivity.

5: Cambridgeshire – Eastern Hertfordshire: Hertford itself has been picked out as an area with poor connectivity with a lack of service northwards to Stevenage and an interchange required there to travel to Cambridge and long journeys to London. While Hertford is the starkest example of this, Hatfield and Welwyn Garden City are also identified as having poor connectivity to Cambridge.

This also applies to services from Cambridge along the WAML. The hourly semi-fast service means that connectivity to western Essex is poor and some significant savings could be made to GJT by improving this frequency.

6: Peterborough – Cambridge and Stansted Airport: The hourly service linking the biggest population centres in the north-east of the region that are only 30 miles apart, severely limits the ability for travel northwards from Cambridge. It is notably worse than the connectivity between other cities of a similar distance in the country, e.g. Leicester and Nottingham are linked by four trains per hour and around 20 miles apart. Low frequency of services to airports is also significant deterrent to rail travel to airports.

7: Peterborough – East Midlands and West Midlands: This is an extension of corridor 6. This section of route between Peterborough and Leicester has just one train per hour. Strengthening of links on this corridor will reduce the need for reliance on the A47 corridor and will improve connections from

Norfolk, Suffolk and Lincolnshire as well Cambridgeshire to the East & West Midlands as well via interchange at Peterborough.

8: Bedfordshire & Northamptonshire to the East Midlands: Following the route of the Midland Main Line (MML), this corridor will explore benefits of improving the connections between EEH and to Leicester, Nottingham and Derby, and therefore links to High Speed 2 at East Midlands Hub. The MML provides strong north south connections, though some journeys are constrained by the need to change train.

These corridors demonstrate some of the worst areas of connectivity and if steps were taken to resolve the issues, the improvements to GJTs could be transformative. Further study work as part of Phase 2 of this project will need to be taken to identify the potential value of improving connections in these corridors.

Some of the corridors identified overlap with others and it may be that delivery of improvements on one corridor will enable improvements on another corridor. For instance, a direct Milton Keynes to Peterborough connection could be facilitated by running a service via East West rail rather than needing a completely new railway.

Connectivity to Airports

Connectivity to airports is also notably lacking. Some focus has been given in the corridors identified above, but for most of the region, access to the airports relies on awkward interchanges via London. Not only does this affect the GJT, but is a major deterrent if travelling with luggage and adds unwelcome uncertainty to a very time critical journey

Heathrow Airport

As things currently stand, London Paddington is best placed to provide direct connectivity to Heathrow via rail, which means that passengers of the wider EEH network typically travel into London and interchange at Paddington to reach Heathrow.

The advent of Elizabeth Line services starting will improve the access to Heathrow from the west, especially for destinations on the WAML and GEML as a direct service will be available to the airport from Liverpool Street station, eliminating the need for an interchange at Paddington.

The Western Rail Link to Heathrow project will provide four additional direct trains per hour between Reading and Heathrow. This will improve rail connectivity to Heathrow as passengers from the EEH region will be able to interchange at Reading to access these new Heathrow services.

However there remains a gap as EEH's rail network does not provide full connectivity to Reading and this remains the case even with East West Rail being completed. For example, passengers from East West Rail connected locations (Bedford, Bletchley, Milton Keynes and Cambridge) will still have to interchange at Oxford should they wish to travel to Reading. This will then be followed by another interchange at Reading to access the new Heathrow services. The alternative is that passengers will continue to interchange in London to reach Heathrow, which is something that the EEH rail network should strive to improve on. This strengthens the case for East West Rail to run beyond Oxford and in this case, linking to Reading would ultimately provide passengers with better connectivity to Heathrow Airport.

Stansted Airport

Stansted has a reasonable service frequency from London Liverpool Street, with four direct trains per hour available. However, the frequency of direct rail services between Stansted and other locations within EEH is extremely poor. Both Cambridge and Ely are two of the major calling points on the WAML, yet they both only have two trains per hour available to Stansted. As things stand, passengers

from the wider EEH network who use East West Rail will have to interchange at Cambridge should they wish to travel to Stansted. With only two trains per hour available, the interchange at Cambridge will significantly increase the overall GJT to the airport. This adds to the argument that Cambridge needs more direct services to Stansted Airport.

There are other examples of Stansted's poor connectivity, as even Hertford East, (as seen in the Service Levels chapter) which is based on a branch line from the WAML has no direct services to Stansted, therefore passengers have to interchange at Broxbourne, which adds to the GJT. In addition, both Peterborough and Norwich also have only one train per hour available to Stansted, which again highlights the poor rail connectivity on offer to the airport from wider situated locations.

Luton Airport

Luton Airport already has a relatively good service offering on the MML. If connectivity to the MML, avoiding London can be improved via the three arc concepts, then the ability to reach Luton Airport Parkway will be drastically improved for a large proportion of the Heartland.

Birmingham International Airport

Birmingham International is arguably set to become far better connected by rail to the rest of the EEH network in the near future.

Firstly, East West Rail will make the first step in opening up the access to the WCML for a large proportion of the EEH region. Both Bletchley and Milton Keynes (Bletchley in particular) will act as interchange hubs, allowing passengers from other main lines to access the WCML and ultimately travel to the airport. Birmingham Airport Connectivity enhancement represents another scheme associated with the airport by providing improved services to Oxford.

Second, HS2 Released Capacity is set to increase the number of direct services and stops along the WCML, which will mean that Birmingham International will have more connectivity available via rail. The combination of these two major projects will greatly improve the access to the airport from EEH.

Finally, HS2 is set to create the new 'Interchange' station, which will serve Birmingham International Airport. This will provide further rail connectivity in relation to the EEH region, as passengers will be able to travel from Euston or Old Oak Common directly to the airport.

As things currently stand, based on the current rail network, Birmingham International is not well served by rail in the context of the entire EEH region. However, the planned interventions show how rail connectivity can be ultimately improved going forward and this demonstrates as to why these schemes are so important. In the future these improvements will make rail to Birmingham International a more viable journey option for all passengers throughout the EEH region which will then help to make rail a competitive option for transport as opposed to the car.

Next Steps for Corridor Analysis

Having established areas that are poorly connected through this analysis, it is important to reinforce that this is not a set of conditional outputs or a wish list for infrastructure investment. Rather it is evidence of where to focus the next stage of analysis to determine where benefits exist. It is also not an exhaustive list and other corridors can be considered in the next stage if appropriate.

Upcoming Rail Enhancements in the Heartland

It is not always possible to improve connectivity within the limitations of the current network and attempts to remedy one situation can have knock-on effects elsewhere. Often an infrastructure intervention will be required to make significant improvements in capacity and connectivity. The following section identifies areas where infrastructure interventions are being developed and delivered across the EEH region to enhance the rail offering.

The Rail Network Enhancement Pipeline

The Rail Network Enhancement Pipeline (RNEP) is the process applied to all rail enhancements within England and Wales which are in the receipt of funding from the Department for Transport (DfT). Rail enhancement schemes which are seeking funding from the DfT need to follow and adhere to the RNEP decision gateway stages before they eventually move into the delivery process. The RNEP approach does not apply to High Speed 1 or to the core of the new High Speed 2 network¹⁵.

The RNEP schemes that will have either a direct or indirect impact on the EEH rail infrastructure have been captured and listed in relation to the main line route they will interact with. For this study, all RNEP schemes that are within the starting process from 'Pre-Initiate', 'Decision to Initiate' to the final stage of 'Decision to Deliver' will be categorised as 'in development'. Rail enhancement schemes that have been accepted by the DfT and which are then being deployed, will be represented by the 'in delivery' category. This simplifies the grouping of the schemes in the report.

It's important to note that just because a rail network enhancement is in the pipeline it does not mean that it will be ultimately delivered. Some enhancements will go through RNEP process (Figure 29) and will be stopped at certain stages due to various factors and complications.



Figure 29: Rail Network Enhancement Pipeline stage gates to delivery

The tables over the next pages show infrastructure enhancement schemes, organised by each main line, that are either in development or delivery. Unless otherwise stated, these schemes are all funded through the RNEP process. 3rd party schemes have the opportunity to enter the RNEP process at a later stage.

¹⁵ Rail Network Enhancements Pipeline-

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/877989/rail-network-enhancements-pipeline-document.pdf

Great Western Main Line: Associated enhancements and schemes

Name of Scheme	Output of Scheme	Stage of Scheme
London Paddington Station Congestion Relief	To increase passenger capacity within London Paddington station.	In Development
Crossrail	Introduction of full Elizabeth Line services will see additional services to Heathrow Airport and Maidenhead (peak only), and extension of all services through Crossrail central section.	In Delivery
Oxford Corridor Capacity Phase 2	Delivery of new infrastructure in and around Oxford station area and level crossing upgrades to accommodate additional passenger and freight services from 2024.	In Development
Western Rail Link to Heathrow	Will deliver 4tph direct services between Reading station and Heathrow via a new partially tunnelled rail link between Langley and Heathrow.	In Development
High Speed 2 – Old Oak Common interchange station	High Speed 2 will deliver a new station on the GWML offering interchange between GMWL fast, Elizabeth Line, and HS2 services and potentially Chiltern line services	In Development
Thames Valley Corridor Capacity Programme	Interventions required to support growth in Thames Valley (by accommodating forecast demand growth and improving connectivity.	In Development
Reading Independent Feeder (Power Supply)	As part of the electrification of the Great Western Main Line, this will provide an additional National Grid connection to provide resilience and additional capacity to the power system.	In Development
Oxfordshire Rail Investment Programme	Developing rail infrastructure in Oxfordshire to support the findings of the Oxfordshire Rail Corridor Study	In Development
North Cotswold Task Force	Enhancement of services on the North Cotswold Line between Oxford and Worcester	In Development (Third Party funded scheme).

Chiltern Main Line: Associated enhancements and schemes

Name of Scheme	Output of Scheme	Stage of Scheme
Chiltern Train Lengthening	To relieve passenger overcrowding on trains in to London Marylebone to meet forecast demand by the end of 2023.	In Development
Solihull Corridor	To deliver higher frequency services on the Solihull Corridor in Birmingham and additional services to Banbury and Oxford	In Development
Birmingham Airport Connectivity	An infrastructure scheme to deliver two trains an hour between Birmingham International, Coventry, Leamington Spa, Banbury and Oxford as well as an additional train between London Marylebone and Birmingham Moor Street.	In Development
East-West Rail Western Section	A programme linking Oxford and Aylesbury with Milton Keynes. This will introduce additional services to the Bicester –Oxford corridor and in the Aylesbury area.	In Delivery
London Underground 4LM upgrade	Programme of resignalling to introduce Automatic Train Operation on the London Underground Metropolitan Line that is used by Chiltern services between Harrow-on-the-Hill and Amersham. This may allow increased speed for Chiltern services and potentially longer services.	In Development (Not RNEP funded).

West Coast Main Line: Associated enhancements and schemes

Name of Scheme	Output of Scheme	Stage of Scheme
HS2	HS2 will be a new line, starting at Euston, introducing additional Long-Distance High-Speed services linking London to the Midlands, North West, North East and Scotland. These services will replace the need for most of the long-distance services currently using the WCML, releasing capacity for new additional freight and passenger services.	In Delivery (Not RNEP funded)
Redevelopment of Euston Conventional Station (RECS)	RECS is a workstream looking at improving the conventional station at Euston to make the station fit for the long-term growth of the West Coast Main Line post HS2.	In Development
Rugby Parkway	Rugby Parkway is a proposed new station south of Rugby on the Northampton line, this will enable a growth in the service offering to the Rugby area.	In Development (3 rd party scheme)
East- West Rail Western Section	EWR is a programme linking Oxford and Aylesbury with Milton Keynes and Bedford. This will introduce new service on this corridor between Bletchley and Milton Keynes, enhancing the connectivity of the area.	In Delivery
Watford Junction	A proposed new footbridge and gate line at Watford Junction will facilitate better passenger circulation through the station.	In Development

Midland Main Line: Associated enhancements and schemes

Name of Scheme	Output of Scheme	Stage of Scheme
Brent Cross West	A new station is planned to be built at Brent Cross West, with London Borough of Barnet working closely with Network Rail. This station is planned to be served by Thameslink services on the Midland Main Line.	In Development
St Albans Capacity & Footbridge	Improvement work is being carried out at St Albans station to increase capacity, and ease passenger congestion at the station. Further work is proposed to build a second footbridge at the station.	In Development
Midland Main Line Upgrade Programme	<p>Full electrification programme between Bedford and Kettering, this includes implementation of an additional fourth track between these locations. Doubling of tracks between Kettering and Corby is also taking place.</p> <p>Electrification to extend to Market Harborough is also planned, which provides sufficient power to allow the new bi-mode trains to run in electric mode.</p>	<p>In Delivery (Key Output 1)</p> <p>In Development (Key Output 1a)</p>
Wixams Station	New station proposed to be built on the MML, promoted by Bedford Borough Council.	In Development
East West Rail Central Section	Providing direct services between Bedford and the newly proposed stations, one station on the East Coast Main Line (between St Neots and Sandy) and the other in Cambourne.	In Development (Not RNEP funded)

East Coast Main Line: Associated enhancements and schemes

Name of Scheme	Output of Scheme	Stage of Scheme
Kings Cross Re-Modelling	A major, multimillion-pound investment into the infrastructure at King's Cross railway station that will transform train travel to and from London on the East Coast Main Line by replacing track, signalling and overhead line equipment outside the station.	In Delivery
Stevenage Turnback Platform	A new platform and track at Stevenage station so trains from the Hertford North line (known as the Hertford Loop) can terminate and go back towards London without using up capacity on the existing tracks. This will enable more services to run in future while improving resilience and reliability.	In Delivery
Power Supply Upgrade (Phase 1)	Upgrading the power supply from Wood Green to Bawtry. This work will allow both the existing timetabled services to run in electric traction rather than a mix of traction, but also provides the power upgrade to run the quantum of electric services identified for the December 2021 Timetable.	In Delivery
East Coast Digital	Digital signalling on the ECML to increase capacity and improve performance.	In Development
East West Rail Central Section	Providing direct services between Bedford and the newly proposed stations, one station on the East Coast Main Line (between St Neots and Sandy) and the other in Cambourne.	In Development (Not RNEP funded)

West Anglia Main Line and Great Eastern Main Line: associated enhancements and schemes

Name of Scheme	Output of Scheme	Stage of Scheme
Crossrail	Services between Liverpool Street and Shenfield are currently being run as 'TfL Rail'. Once the central section of Crossrail opens these services will become part of the Elizabeth line, providing a direct connection to central London, interchange via Whitechapel to south-east Elizabeth Line branch to Abbey Wood and the Great Western Main Line at London Paddington. A peak hour service will also operate between Gidea Park and Liverpool Street high level, with the core Elizabeth Line services using new low-level platforms at London Liverpool Street.	In Delivery
London Liverpool Street Pedestrian Capacity	Targeted capacity interventions to mitigate existing safety and congestion issues at the station, cater for anticipated growth from rolling stock upgrades and improve existing journey times. This intervention caters for growth up to 2029 and accommodates GEML Tranche 1.	In Development
London Liverpool Street Integrated Improvement Programme	Wholesale redevelopment of station, including opportunities from adjacent third-party developments. Outcomes includes improved passenger circulation, retail facilities and platform capacity up to 2043.	In Development
Cambridge South Station	To deliver a new station and associated infrastructure in the Cambridge South area.	In Development
Ely Area Capacity Enhancement	To increase capacity through the Ely area for freight and passenger services, including level crossings on Ely-Peterborough, Kings Lynn-Ely and Cambridge-Ely routes.	In Development

	This scheme is needed to deliver the franchise commitment of an hourly Peterborough to Ipswich service	
Soham Station	Re-introduction of Soham Station on the Ipswich-Ely line.	In Development
Soham Area Capacity Enhancement	To increase capacity through the single line section of the Ely-Ipswich line for freight and passenger service increases.	In Development
Haughley Junction	Double tracking Haughley Junction to improve resilience between GEML and cross-country services.	In Development
East West Rail Central Section	Providing direct services between Bedford and Cambridge as part of the wider East West Rail programme	In Development (Not RNEP funded)
Great Eastern Main Line Programme	<p>Tranche 1 Strategic Outline Business Case(SOBC) being developed by New Anglia LEP, GEML Taskforce in partnership with Network Rail. Tranche 1 outputs include 24tph peak into London Liverpool Street. Indicative scope presumed to include Bow Junction remodelling, headway reduction in the Chelmsford area, level-crossings, power supply and stabling.</p> <p>Note – the Great Eastern Main Line study (2019) further recommended that Tranche 2 and 3 are progressed at a relevant juncture to enable 27tph in the high peak and develop opportunities for improved journey times.</p>	In Development
Stratford Station Pedestrian Capacity	Targeted medium-term capacity interventions to stabilise existing station operating baseline, cater for anticipated growth from rolling stock upgrades, improve existing journey times and explore new passenger movement opportunities. This intervention caters for growth up to 2031 and accommodates GEML Tranche 1.	In Development

	An interim CP6 Congestion Relief project is also being progressed through the RNEP pipeline as a change control. This is required as a first phase output to mitigate critical congestion bottlenecks.	
Stratford Station Capacity Enhancement	<p>A longer-term requirement post 2031 to improve station to accommodate passenger throughput, optimise efficient movement of passengers, and meet future local and rail industry demand.</p> <p>This scheme may be progressed as part of a larger local masterplan initiative incorporating wider social and economic development outputs. Network Rail is discussing pre-SOBC roles and responsibilities with TfL, TOCs and local authority partners.</p>	In Development

Summary of Rail Enhancement Schemes from the Heartland’s Perspective

Overall it is clear that there are a number of rail enhancements schemes across the Heartland that have the potential to interact with and improve the region’s rail network. These are mapped out in Figure 30, overleaf.

It is important to note that all of these schemes that are listed as ‘In Development’ are not guaranteed delivery and will be subjected to scrutiny at each stage of development in the RNEP process that will make a decision about whether to continue to invest in the development or to deliver at all.

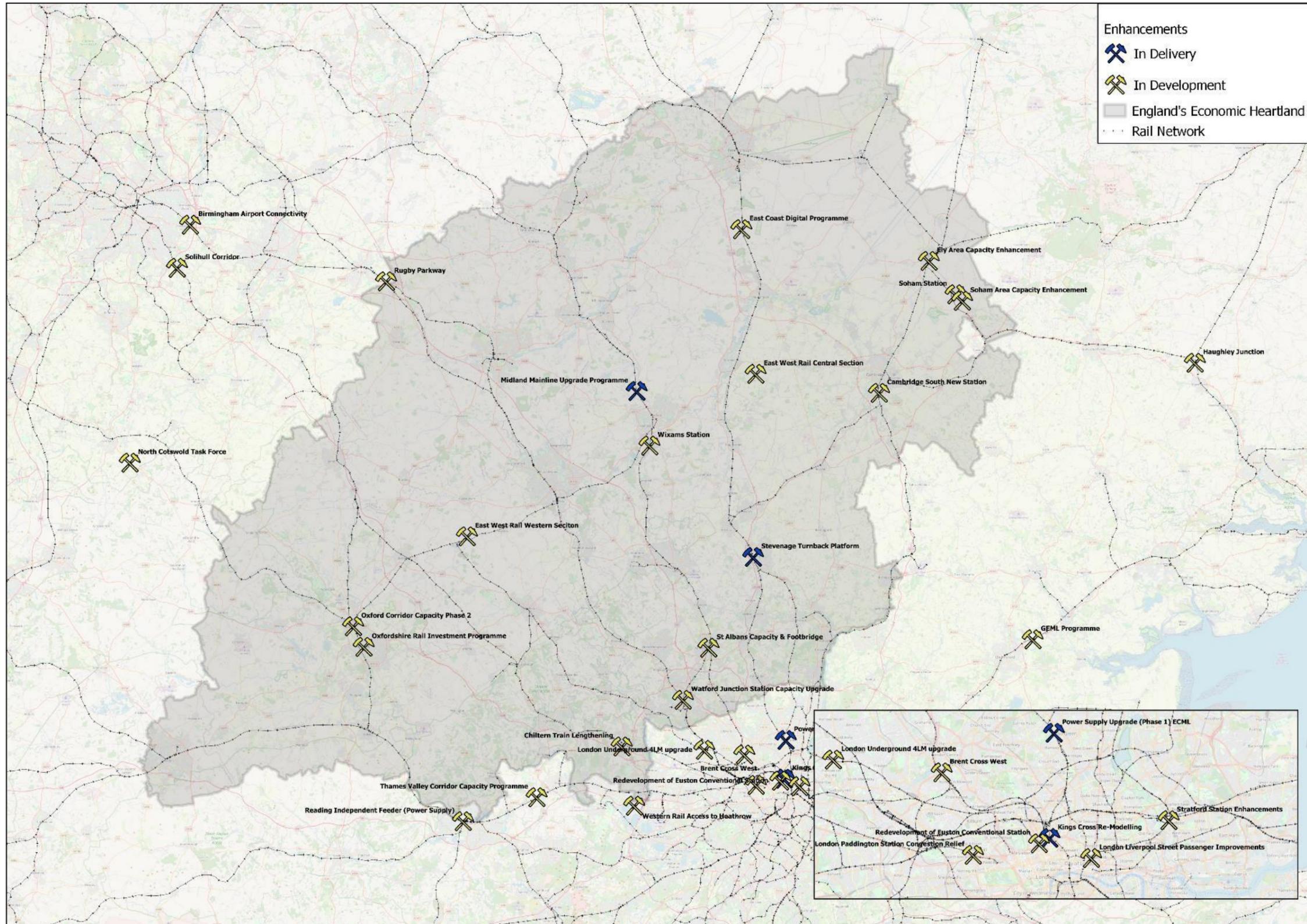


Figure 30: Locations of Enhancement Schemes in Delivery and Development that will have an impact on the EEH Rail Network

High Speed Two: Released Capacity

Although High Speed Two (HS2) does not directly serve any stations in the EEH area, it presents a significant opportunity to improve Generalised Journey Times across the region. A map of the HS2 network is shown in Figure 31.

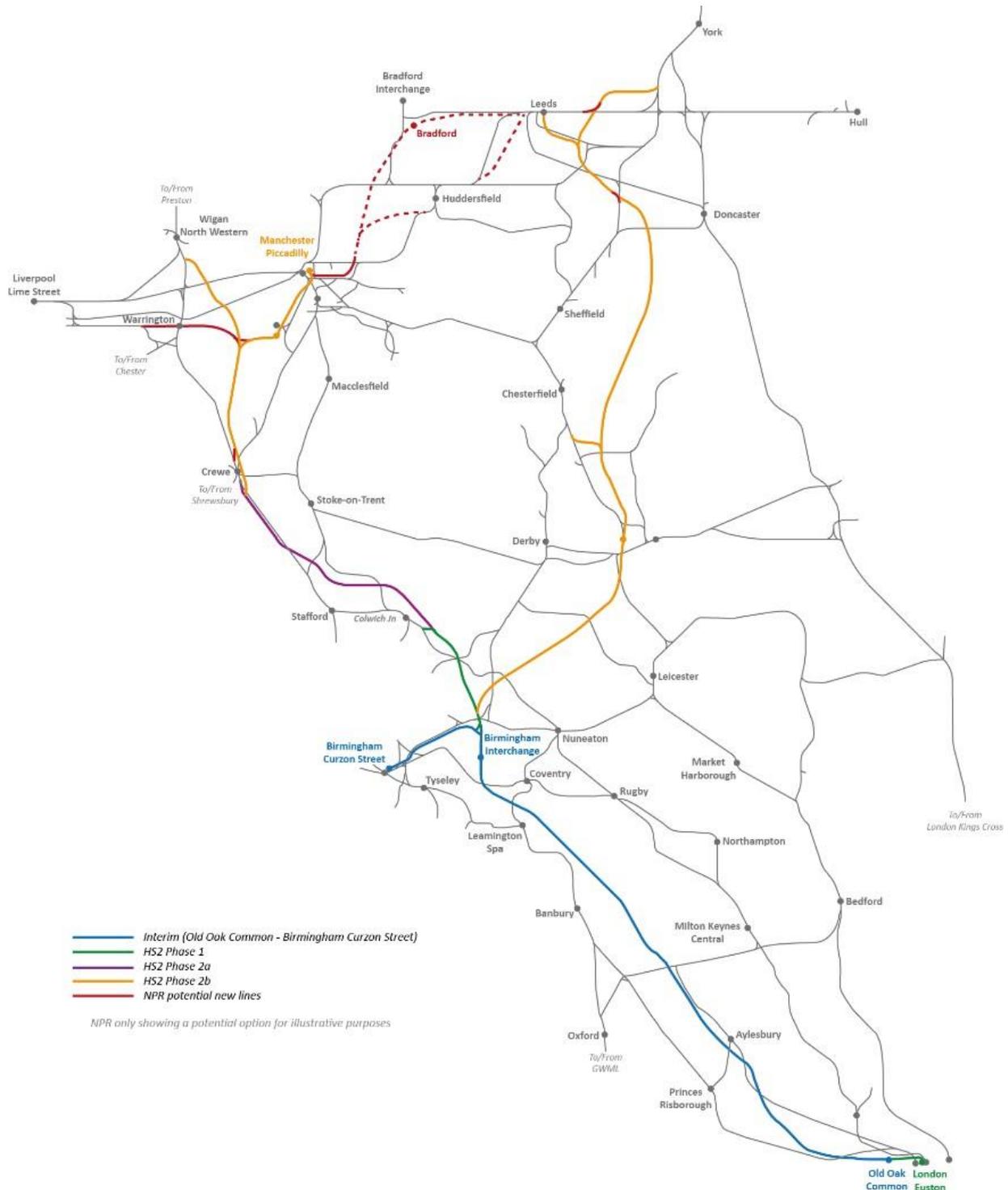


Figure 31: Map of the High Speed 2 Network and its respective phases

High Speed 2: Phase 1 and 2A

The addition of High-Speed 2 Phases 1 and 2a: London to Crewe, removes the requirement to operate the fastest intercity trains to Birmingham (3 trains per hour), Manchester (3 trains per hour), Liverpool (1 train per hour) and Scotland (1 train per hour) representing 8 trains an hour on the south end of the West Coast Main Line that no longer south of Rugby, i.e. in the EEH region.

With less of an imperative to deliver fast end to end journey times, the timetable can be recast, creating an opportunity for capacity to be redistributed across different service types. Although there is no final agreed proposition for the West Coast Main Line when High Speed Two is in operation, opportunities exist to improve the rail offering through a combination of the following improvements:

- Journey times / Frequency
- Connectivity between stations
- Commuter capacity
- Capacity for new services
- Increased capacity for freight
- Performance

All of these will contribute to an enhanced rail offering, improving the GJTs along the West Coast Main Line by providing more stops in the replacement passenger services along the route combined with a recasting of the timetable for those services that remain. This presents the opportunity for all stations along the WCML to have better connections to one another and improved GJTs by either:

- Increasing the number of calls per hour at stations
- Reducing the journey time between stations by faster services

When this is factored into the offering that East-West Rail will provide at Bletchley and Milton Keynes, the GJT benefits spread further than just the WCML via interchange opportunities that are provided at these stations. This will reduce GJTs from West Coast stations to stations on the EWR corridor.

High Speed 2: Phase 2B

Phase 2B to Manchester and the 'Eastern Leg' linking the core HS2 route with the East Midlands, Sheffield and Leeds before joining the classic network to reach York, Newcastle and Edinburgh presents opportunities for EEH with this infrastructure too.

The Midland Main Line operates 4 long distance trains per hour to destinations on HS2; two to Sheffield via Derby and two to Nottingham. Relieved of the requirement to provide the fastest journeys to Derby, Nottingham and Sheffield, the opportunity is then present to place additional calls in these services enabling greater connectivity.

Similarly, on the ECML, at least 4 trains an hour, two to Edinburgh and two to Leeds, are no longer required to achieve the same journey times, potentially opening up additional capacity for service improvements in the Heartland that could contribute to an enhancement of generalised journey times. The ECML released capacity situation will potentially have a large role to play in the ability to serve an interchange station through EWR with a level of service on the ECML that enables generalised journey times to decrease across the region.

Decarbonisation of Passenger Services in the Heartland

There is a global challenge to lessen reliance upon fossil fuels in our economy to reduce the impact human-induced emissions have on climate change.

In the UK, there has been an overall decline in emissions since 1990, driven mainly by reductions in the emissions of the power generation sector, but the surface transport sector has remained largely constant throughout that same period (Figure 32).

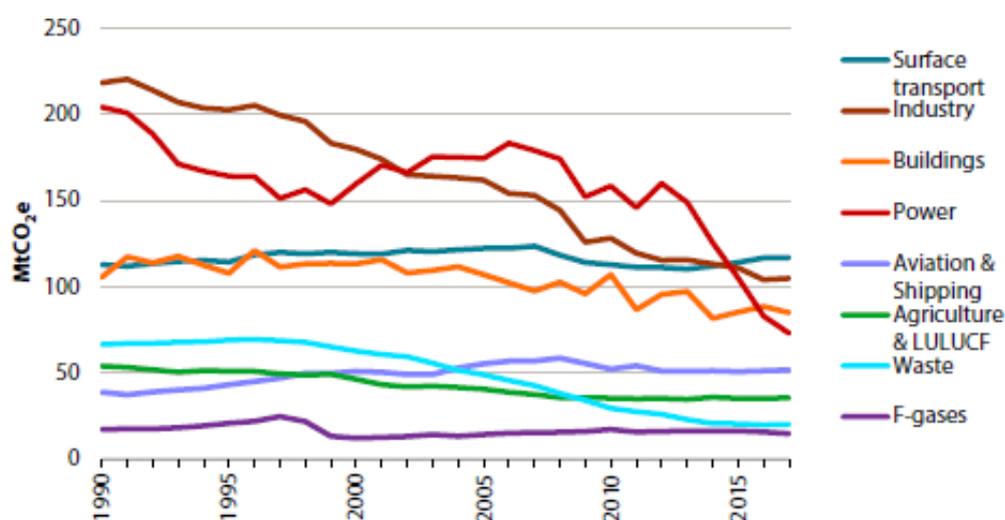


Figure 32: Contribution by sector to UK carbon emissions¹⁶

Domestically, surface transport includes all road traffic as well as the rail industry. 95% of the surface transport emissions are from cars, vans and HGVs, while 3% is from buses and 2% is from rail¹⁷. Whilst this means that rail's contribution is very small in comparison to the rest of surface transport. If the rail network stands still, but other transport sectors decarbonise, rail's proportion of emissions will increase

Rail has solutions to fully decarbonise its emissions at point of use, although this will require a significant amount of investment in the network and technology to deliver it – especially for freight. Factor in the legally binding requirement for EEH to achieve net-zero carbon no later than 2050 and rail has a key role to play by decarbonising its own services and by promoting modal shift to support the decarbonisation of other sectors of the transport industry.

This means, firstly, that rail needs to provide the capability to provide all the services it currently runs in a decarbonised manner. Secondly, the rail network needs to encourage modal shift. The rest of this section focuses on the first point; what parts of the Heartland rail network are electrified and what gaps remain.

There are three different types of electrified railway operating in the Heartland;

- 25kV AC Overhead (often referred to as OLE – Overhead Line Equipment)

¹⁶ Committee on Climate Change. *Net Zero – The UK's contribution to stopping global warming*, p. 140.)

¹⁷ Committee on Climate Change. *Net Zero – The UK's contribution to stopping global warming*, p. 140.)

- 750v DC 3rd Rail (often referred to as 3rd Rail)
- 650v DC 4th Rail (often referred to as 4th Rail)

OLE is the predominant method of electrification for this region and nationally; it being used on all except one of the London Terminals that can be reached directly from the Heartland area. The 3rd rail electrification is limited to one line and the 4th rail electrification is the method of electrification used by Transport for London on its London Underground network.

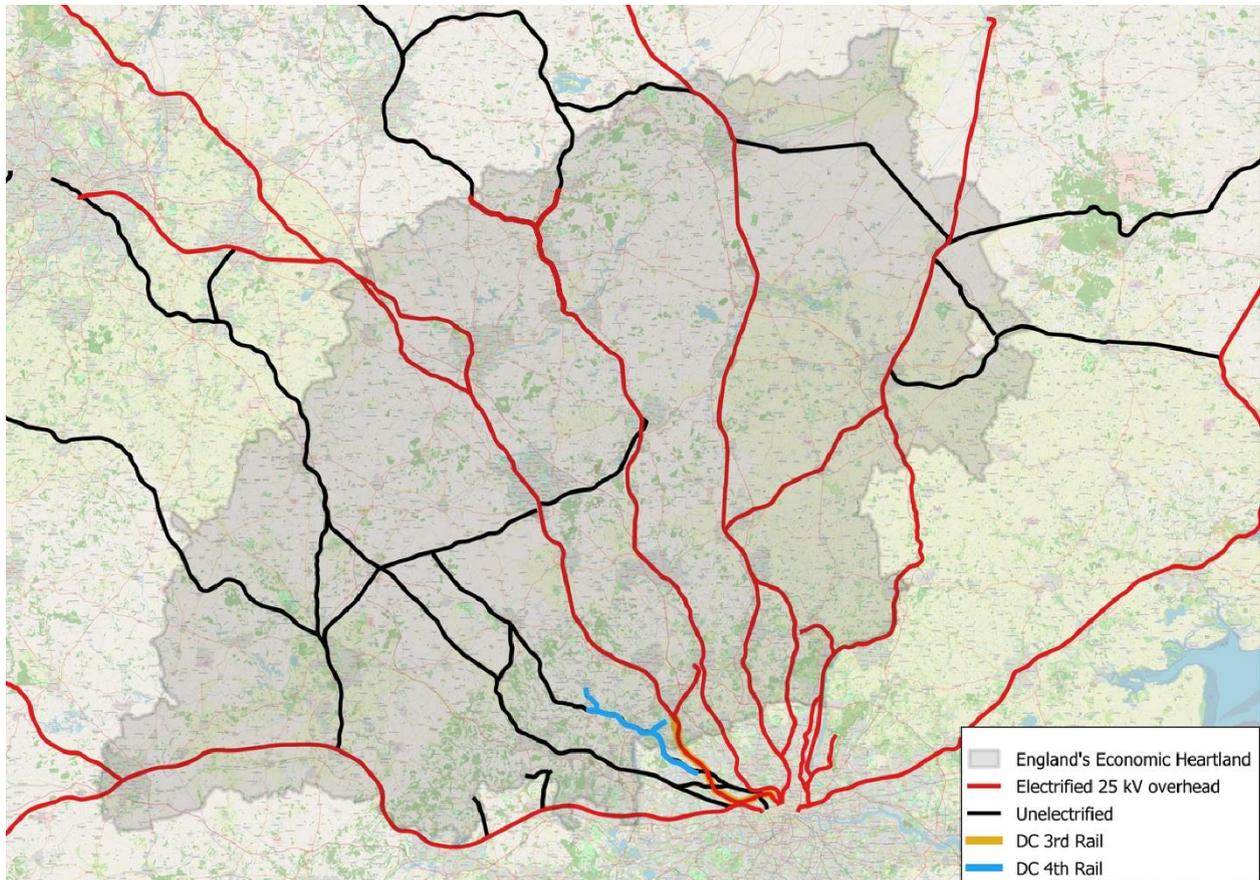


Figure 33: A map showing the extent of electrification of the rail routes in and around the Heartland area – For railway outside the EEH area, not all routes are shown.

Where the network is not electrified, traction power is provided by diesel engines. The last few years has seen the introduction of bi-mode fleets to the national rail network. ‘bi-mode’ refers to the ability to operate on more than one power source, in most cases, electricity and diesel although the term can be used for any type of traction power. These types of train can therefore make use of the electrified network where available before switching to an alternative traction source to complete its journey away from the electrified parts of the network.

Where there is higher speed railway (equal to or in excess of 100mph) or regular freight operations, the only technical solution available for the rail industry is to electrify with OLE (Figure 33). This covers almost everywhere in the Heartland area. Where those aren’t the case, usually lower speed branch lines, battery or hydrogen options are options that can be considered for further development.

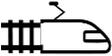
Traction Type	Battery 	Electric 	Hydrogen 
Passenger up to 75 mph			
Passenger up to 100mph	Limits distance		Up to 95mph in development
Passenger up to 125 mph			
Freight	Only when in bi-mode		

Figure 34: Traction Decarbonisation options available for different categories of rail traffic.

Working from East to West in the EEH area, this study will look at what services are operated by diesel power and what electrification would be required to decarbonise them.

Great Eastern Main Line (GEML)

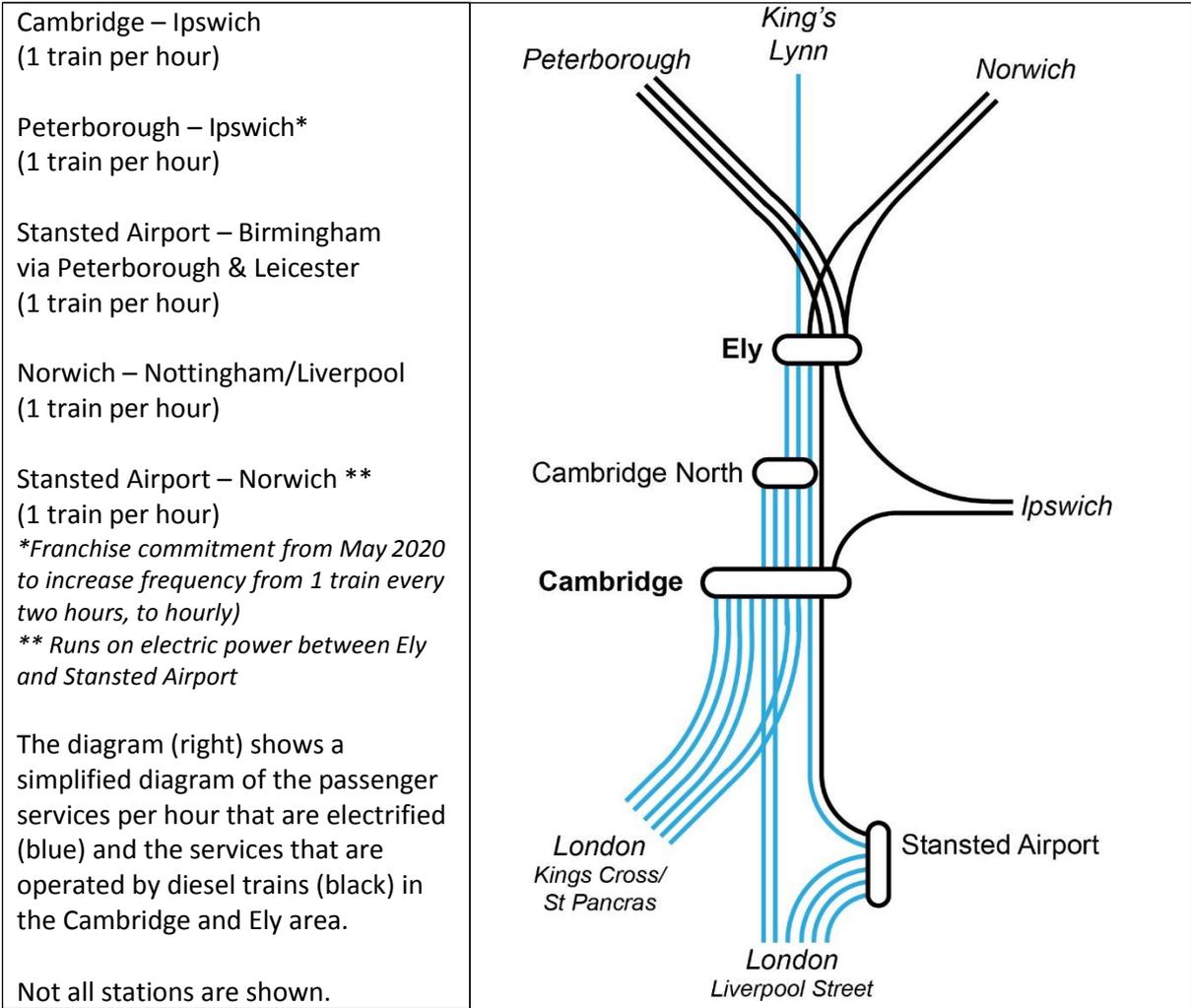
The GEML lies entirely outside of the EEH area, however the core route from Liverpool Street to Norwich and many of the branches are electrified with OLE. The notable exceptions are the branch lines around Ipswich and Norwich to Sheringham, Great Yarmouth, Lowestoft, Felixstowe. The Sudbury branch from Marks Tey is also operated by diesel traction.

The routes that cross in to EEH to Ely and Cambridge from Norwich and Ipswich are covered in the next section.

West Anglia Main Line (WAML)

All routes out of Liverpool Street are electrified as are all the passenger services that operate from the station. The Greater Anglia Franchise, awarded in 2016, has ordered a new fleet of bi-mode trains to replace the diesel fleet in East Anglia. This means that all services, when under OLE, will be able to operate on electric power where previously they ran on diesel, contributing to decarbonising the railway. An example of this is the Norwich to Stansted Airport services which can run on electric power between Ely and Stansted Airport.

In the Cambridge/Ely area, the only trains that remain operated by diesel services are the services on the following routes:



All of these services operate partially on sections of route that are electrified so would benefit from bi-mode stock until further electrification is added.

The diesel services all operate on an axis which is covered by the Felixstowe to Midlands and North scheme (“F2N&M”). This programme of enhancements is focussed around freight to increase the capacity and capability of the rail network to carry freight from the Port of Felixstowe to the Midlands and North of the country. This route travels from Ipswich via Bury St Edmunds to Ely and Peterborough to access the ECML and onwards towards Leicester to access the Midlands and WCML.

If this route were electrified, along with the link line to Cambridge via Newmarket, it would create an electrified freight artery. There is then the ability to decarbonise all passenger services in the area. The Birmingham – Stansted Airport trains could go to electric operation assuming that the section between Peterborough and Birmingham was electrified at the same time, otherwise bi-mode trains would be required.

Unless the route to Norwich from Ely is also electrified, bi-modes will continue to need to be used, both for the trains to Stansted and the services to Nottingham. Bi-mode stock on the latter would eliminate the diesel running in the Heartland and enable use of the OLE on the ECML to Grantham and electrification in the Manchester and Liverpool areas.

Electrification of the Ely to Norwich route would plug a gap in the electrified railway in the area, extending the benefits of decarbonisation and simplify fleet options and would be beneficial for any future eastern section of East-West Rail to Norwich.

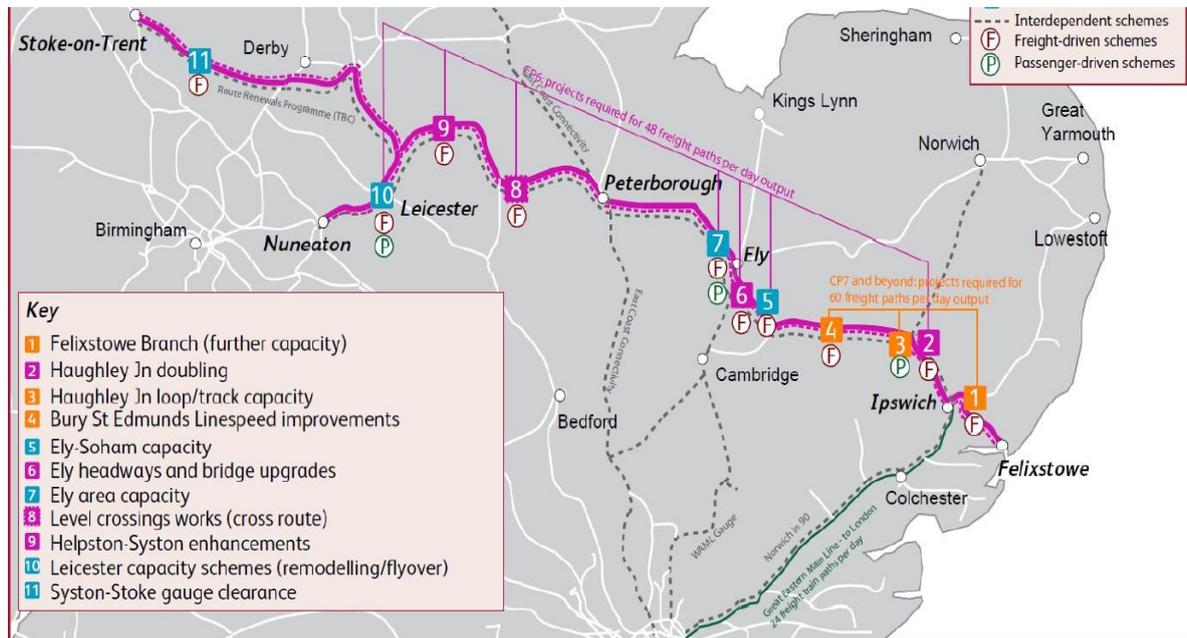
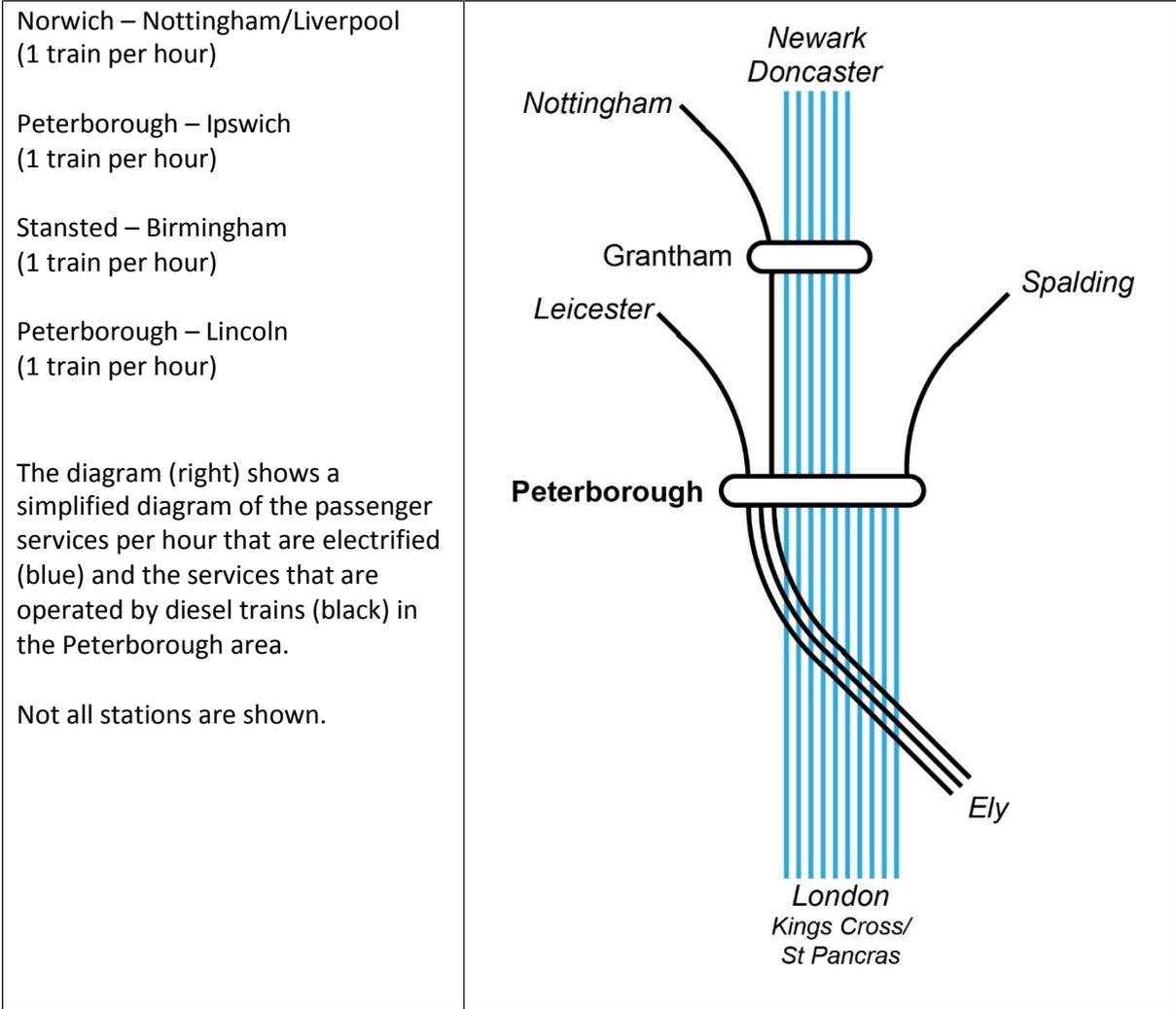


Figure 35: The Felixstowe to Midlands and North 'F2N&M' route showing the interaction with the EEH main lines in a wider geographical context.

East Coast Main Line (ECML)

Since the introduction of new bi-mode fleet to replace the diesel only High Speed Train (HST) all services on the routes operated by LNER and Hull Trains to be operated by Electric traction. Sections of the route that are not electrified and therefore require the diesel capability of these services extend far beyond the boundaries of EEH. The only passenger services that remain to be decarbonised on the ECML in the Heartland area will be the Grand Central services to Sunderland and Bradford. These services currently do not have a bi-mode fleet proposed, nor an electrification scheme that would enable their future operation by entirely electric trains, although there are plans to develop a lower emission option for these services. Grand Central operate just nine trains in each direction a day on the ECML.

In the Peterborough area there a handful of diesel passenger services that operate as non-electrified services, all operating on an hourly frequency:



As mentioned in the WAML section, the Peterborough – Ipswich and Stansted – Birmingham service could be decarbonised if ‘F2M&N’ were electrified, whilst the Norwich – Nottingham/Liverpool service could go over to bi-mode operation. The Peterborough – Lincoln route does not currently have an electrification programme but given the importance of this route as a freight corridor to keep freight off the congested ECML and being suitable for larger freight trains, this too could be decarbonised to accelerate the decarbonisation of freight. This would also enable the few London – Lincoln direct trains each day to operate as electric services throughout, decarbonising the Peterborough area entirely.

Midland Main Line (MML)

The Midland Main Line has been electrified from London to Bedford and has enabled Thameslink services to operate through St Albans and Luton and on to Bedford, however, the longer distance services to the East Midlands and those that provide services to Wellingborough, Kettering and Corby continue to be operated by diesel traction. Work to extend the electrification from Bedford to Corby and Market Harborough is due for completion in 2020 and will enable the introduction of electric only services to Corby and the announcement by the new franchisee, East Midlands Railway, that a bi-mode fleet is being procured to replace the current long distance fleet that handle services to the East Midlands. This means that once this fleet is delivered and electrification is complete to Market Harborough, all passenger services on the MML will have the ability to be powered by electric traction as they pass through the Heartland.

The hourly Marston Vale service between Bedford and Bletchley remains operated by diesel traction but future possible East-West electrification would enable this to become an electric service.

West Coast Main Line (WCML)

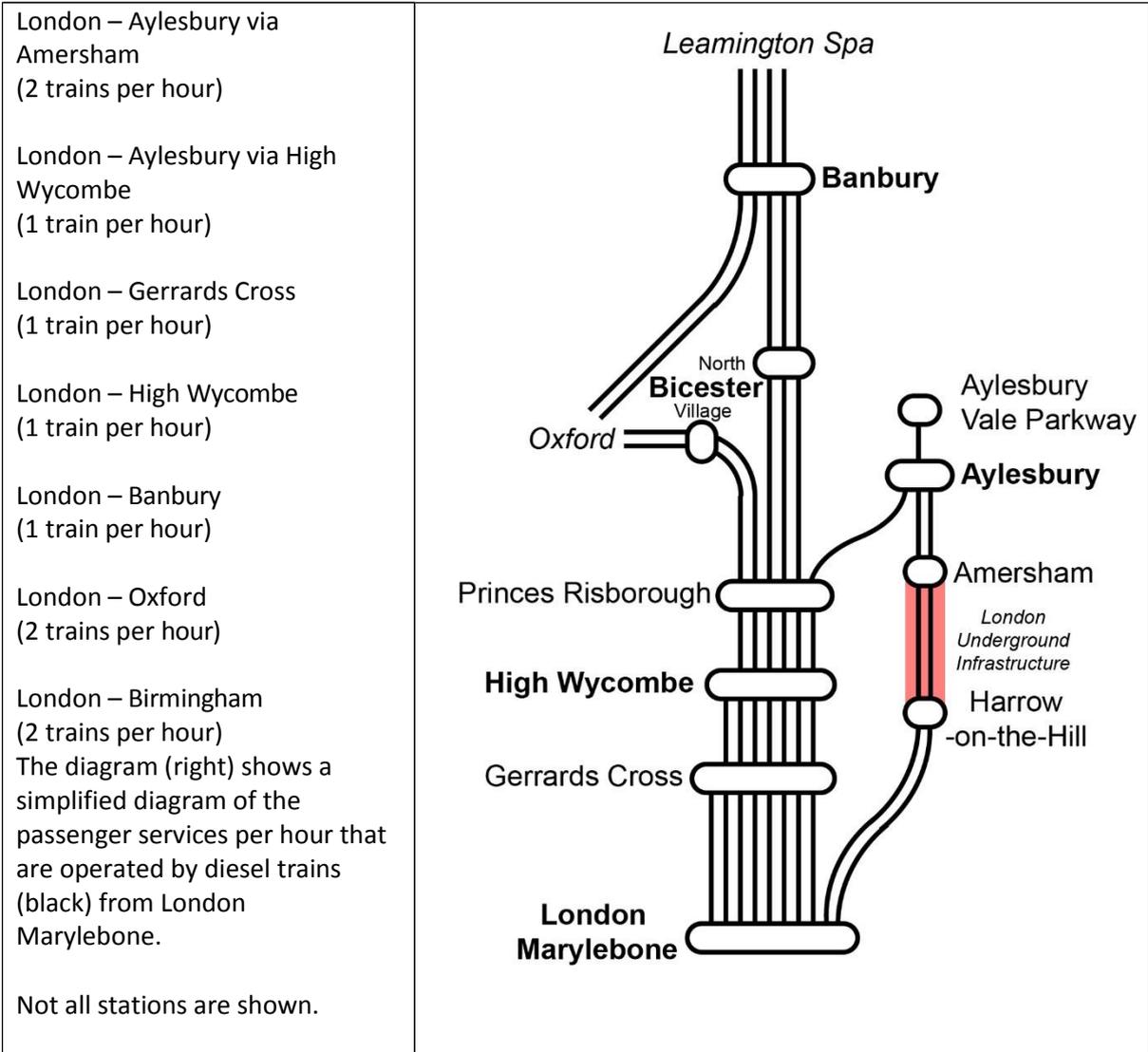
The WCML is electrified all the way from Euston to Rugby (and beyond) and means that almost all passenger services are provided by electric trains. At the south-end of the route, the 25kV OLE on the 4-track Main Line is supplemented by the parallel 'DC Lines', this is a pair of tracks that are used for London Overground services (and London Underground Bakerloo line services south of Harrow & Wealdstone) which are energised using the 3rd and 4th rail electrification systems. Although operating in the same corridor, the WCML and the 'DC Lines' are generally regarded as two separate railways by the rail industry. All services on the 'DC Lines' are operated by electric stock.

The only passenger services that are diesel operated on the WCML through the Heartland are those provided by the 'Super Voyager' trains operated by Avanti West Coast. Predominantly these serve Chester, North Wales, Shrewsbury that lie beyond the extent of electrification but also on some services that are entirely under the wires due to insufficient electric rolling stock. The new Avanti West Coast franchise has placed an order for new bi-mode rolling stock to replace the diesel fleet and due to enter service in 2022, meaning that all passenger services on the WCML in the Heartland will be decarbonised.

Chiltern Main Line (CML)

Currently all services from Marylebone are operated by diesel rolling stock, this is because there is no electrification to Marylebone or on any of the main route via High Wycombe towards Banbury, Aylesbury and Oxford. Between Harrow-on-the-Hill and Amersham on the Aylesbury route, the national rail services operated by Chiltern Railways operate on London Underground (LU) infrastructure which is electrified with 4th rail electrification. All LU services on this section of route, some stations of which are in the EEH area, are operated by electric trains, however, the rolling stock used by National Rail services on these services does not currently have the capability to use this supply, instead running on diesel on this section route.

In the off-peak there are 10 arrivals and departures an hour from Marylebone that all extend in to the EEH area, this is supplemented in the peaks by additional services with up to 15 arrivals or departures an hour into the terminus. The off-peak services are:



Whilst some services could be operated by alternative traction methods (Battery or Hydrogen) the combination of high speed (up to 100mph), high frequency, heavy freight and lack of terminal capacity, along with the interactions with other parts of the electrified (or to be electrified) network mean that electrification with OLE is the only solution for the Chiltern Main Line. How this electrification interfaces with the London Underground infrastructure between Amersham and Harrow-on-the-Hill will require consideration although there are a number of possible solutions including, dual voltage rolling stock, or alternative power sources to find the best solution for this part of the network.

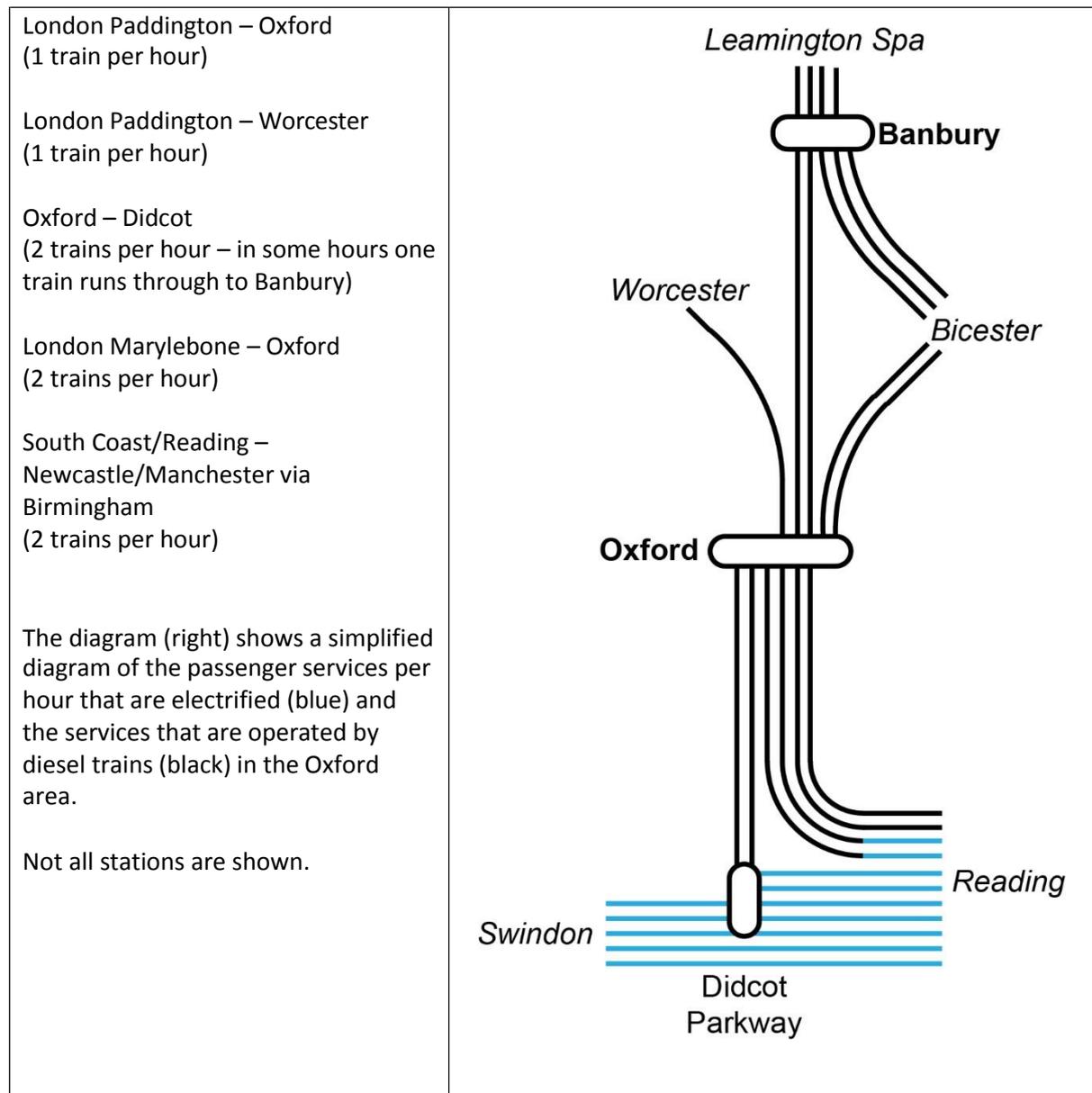
Great Western Main Line (GWML)

The Great Western Main Line was electrified as far Bristol Parkway in December 2018 enabling all passenger services on the main route to operate as electric traction. The original scope of the Great Western Electrification Programme (GWEP) included electrifying Didcot Parkway to Oxford and the Thames Valley Branches of which, the Henley and Marlow branch lines are of interest as they serve the southern edges of the region. The Oxford and Thames Valley branches currently have no active electrification programme meaning that services on these routes are operated by diesel traction. Oxford fast services are served by bi-mode rolling stock meaning that they operate under electric power between London and Didcot before switching to diesel to reach Oxford and Worcester.

However, options to explore decarbonisation of the branches through battery operation are being explored, as is extending the electrification from Didcot to Oxford.

CrossCountry services from the South Coast and Reading to the North of England via Birmingham that travel through along the GWML between Reading and Didcot to reach Oxford, operate as diesel traction throughout, despite operating along some fairly significant sections of already electrified route, especially from Coventry through to Manchester which is entirely electrified.

In the Oxford area, the following (off-peak) passenger services operate under diesel power.



Whilst the Branch lines to Bourne End, Marlow and Henley are candidates for alternative traction sources to decarbonise these routes, the Oxford area with high line speeds, long distances of services and large quantity of freight means that electrification is the only solution to decarbonising this section of the network.

East West Rail (EWR)

The Western Section of East-West Rail (between Bicester and Bletchley) will be built as a non-electrified piece of infrastructure. If this remains the case, then the following services will be operating as diesel services:

Milton Keynes – Oxford (2 trains per hour)
Milton Keynes – Aylesbury (1 train per hour)
Oxford – Bedford (1 train per hour)

The addition of Central Section services will add further services to Oxford, Bedford and Cambridge. East-West Railway Company are currently investigating decarbonisation options as they develop the business case for the new line, however, the opportunity exists to use East West Rail as a catalyst for electrification of the rest of the EEH rail network. As identified already in this chapter, there are two main diesel gaps in the EEH area; Didcot and Oxford through to Banbury and the Leicester to Ipswich route via Peterborough and Ely. East-West Rail connects both of these sections together, thereby providing a continuous electrified corridor that would eliminate the vast majority of diesel services in the Heartland and create a freight artery that links multiple different Main Lines, therefore enabling seamless transitions between each route, assisting in a wider decarbonisation objective by enabling modal shift towards rail.

By having an electrified East-West Rail, the ability to provide services to extended geographies is made easier as trains will be able to reach these destinations easily without the range limitations of alternative methods of traction power becoming a limiting factor in service provision.

A Decarbonised Rail Heartland

Electrifying the sections of route highlighted in Figure 36, this will enable all services in the region to be decarbonised as well as assisting significantly in decarbonising the national network of both passenger and freight services.

The electrification areas are:

Oxford – Worcester
East West Rail
Marylebone to Aylesbury and West Midlands
Cambridge to Ipswich
Ely to Ipswich
Ely to Norwich
Ely to Peterborough and Leicester

Whilst these are clearly lengthy sections of route, there will be incremental benefits if delivered in smaller sections, but the aspiration should be to electrify in the entirety to maximise the benefit of each smaller section.

In the shorter term, options for bi-mode fleets should be explored where possible to make the most of the electrification that exists and to make the case for further incremental schemes, both inside and outside the Heartland, increasing the viability of sections of in-fill electrification which don't necessary decarbonise entire service groups but enable partial running on electricity to keep cutting emissions.

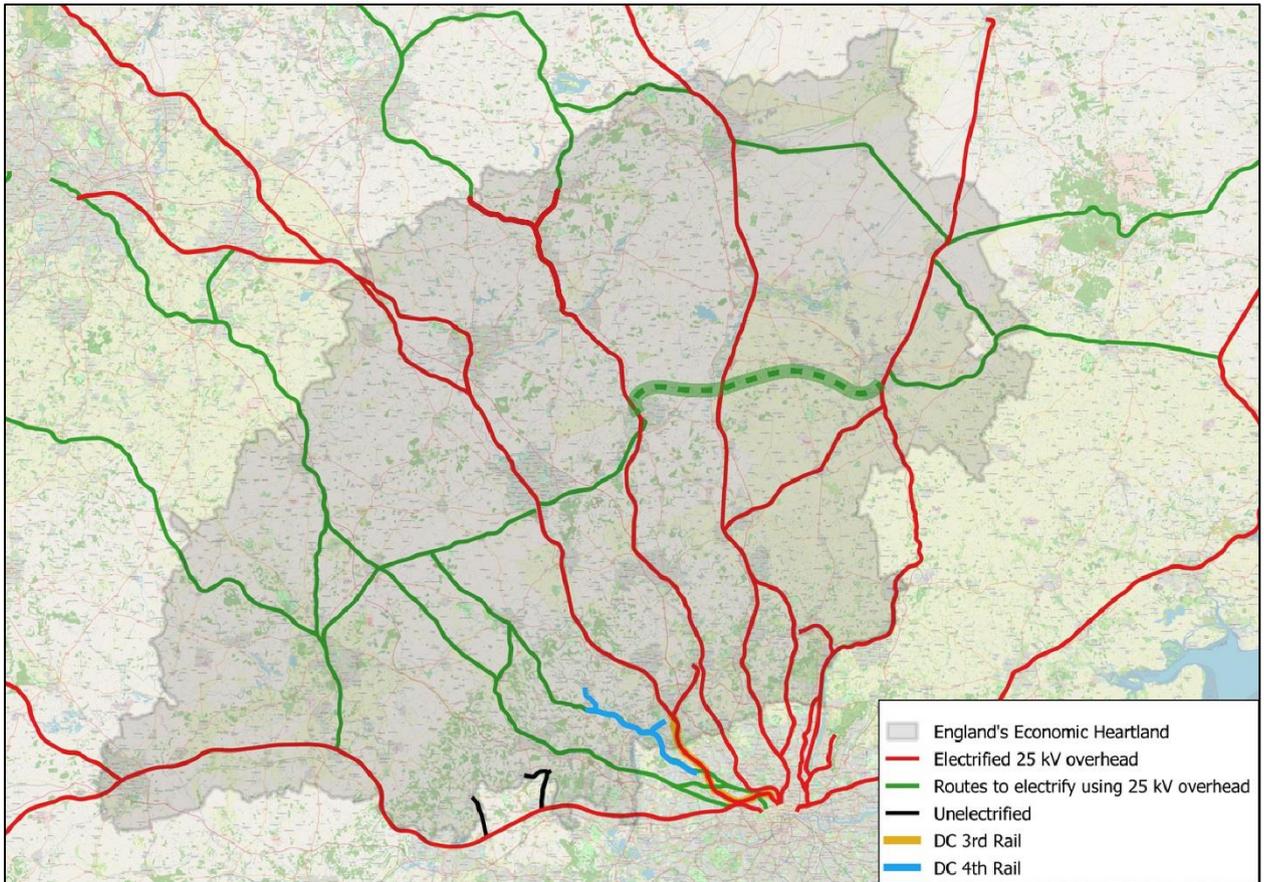


Figure 36: Routes to be electrified with OLE to support traction decarbonisation of the EEH Rail Network.

If phase 2 of this study identifies corridors where it may be worth increasing the service levels that overlap with these sections of route to be electrified, this will strengthen the case for the electrification outlined and mitigate an increase in rail carbon emissions that would come about if additional diesel trains were introduced.

Conclusion

As this document has shown, while parts of the EEH rail network do a very good job, primarily in connecting the important towns and cities on the Main Lines in to London, rail links between these towns and cities are poor as a result of having to rely on journeys via Zone 1 of London. The result is that for the majority of journey pairs across the EEH region, rail does not provide a competitive alternative to road.

Where there are options to avoid London, low frequency of service often leads to situations where the GJT is long, limiting the effectiveness of rail as an alternative to road in these areas.

There are schemes in both development and delivery that will address some of the gaps that have been identified. Delivery of East West Rail is the highlight of this but as this work has shown, there are opportunities where East West Rail could be developed in to a Main Line in itself that serves the broader EEH area, linking more places together directly and consequently, bringing more places within one interchange of another.

Capacity that is released on the classic network, as a result of the construction of High Speed 2 has the potential to address some of the shortcomings in the network identified in this section as will some of the schemes that are in delivery at the moment. This includes the completion of the Midland Main Line Upgrade which will improve links to Corby, and the opening of the Elizabeth line amongst others will contribute to improved GJT's across the region.

This baselining exercise has identified eleven corridors to take forward into the next phase for benefits analysis. These corridors are a mixture of existing rail corridors where direct services are non-existent or infrequent, or corridors where rail there is no appropriate rail infrastructure to support a rail journey. These corridors are:

Northern Arc: A corridor linking North Oxfordshire with Northamptonshire and on to Peterborough

Central Arc: Linking Swindon and Reading through Oxford to Cambridge, Ipswich and Norwich via Milton Keynes and Bedford, overlapping with the East West Rail corridor

Southern Arc: Linking the southern edge of EEH north of the M25 corridor

Corridor 1 – Oxfordshire and Swindon: Cross Oxfordshire links and improvements to Swindon

Corridor 2 – Chiltern Main Line: The area covered by the two routes from London Marylebone improving connectivity between intermediate stations on the route and towards Oxford, Banbury and the West Midlands

Corridor 3 – East Midlands – Thames Valley: Linking Old Oak Common through the Chilterns to Aylesbury, Milton Keynes, Northampton towards the East Midlands

Corridor 4 – Milton Keynes – Peterborough Two of the biggest economies and growth in the region are not linked by direct services

Corridor 5 – East Hertfordshire – Cambridgeshire: Improving the connectivity between the towns on the West Anglia and East Coast Main Lines to Cambridge

Corridor 6 – Peterborough – Cambridge-Stansted Airport: Improving upon the hourly service that links these three key employment, leisure and housing centres

Corridor 7 – Peterborough – East Midlands – West Midlands: Improving upon the hourly service that links Peterborough with Leicester and Birmingham

Corridor 8: Bedfordshire & Northamptonshire to the East Midlands: Looking to strengthen the links between Bedfordshire and Northamptonshire to East Midlands cities

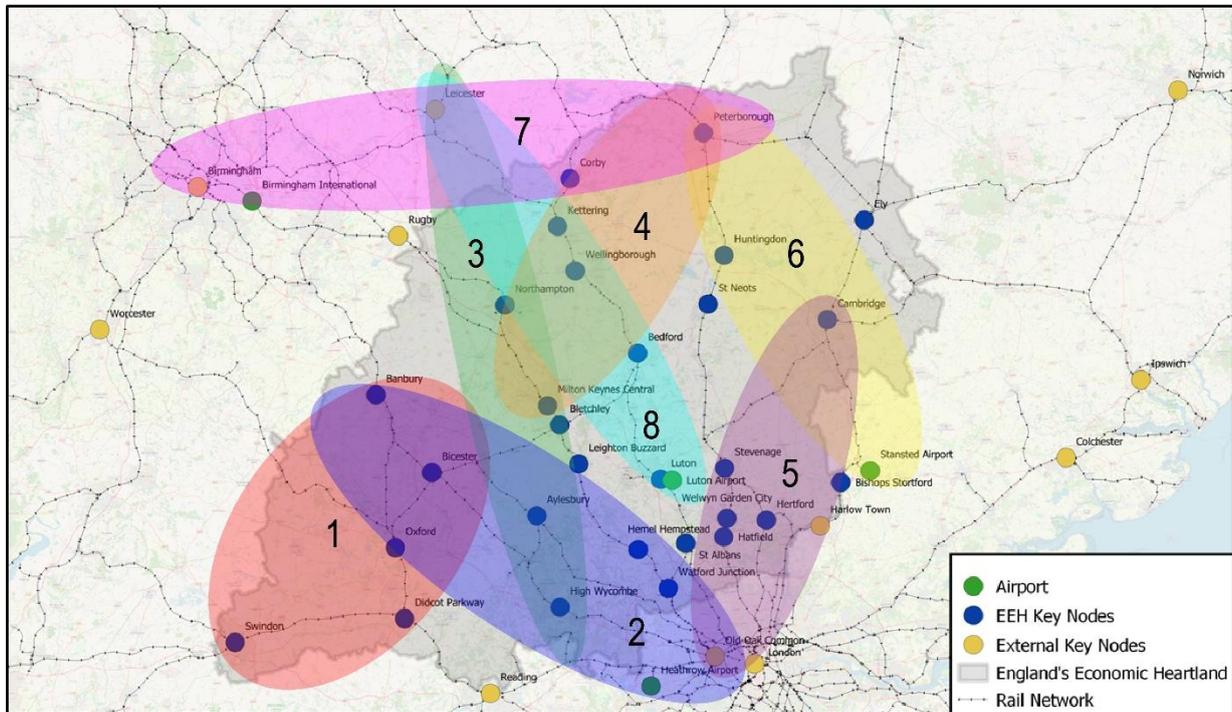
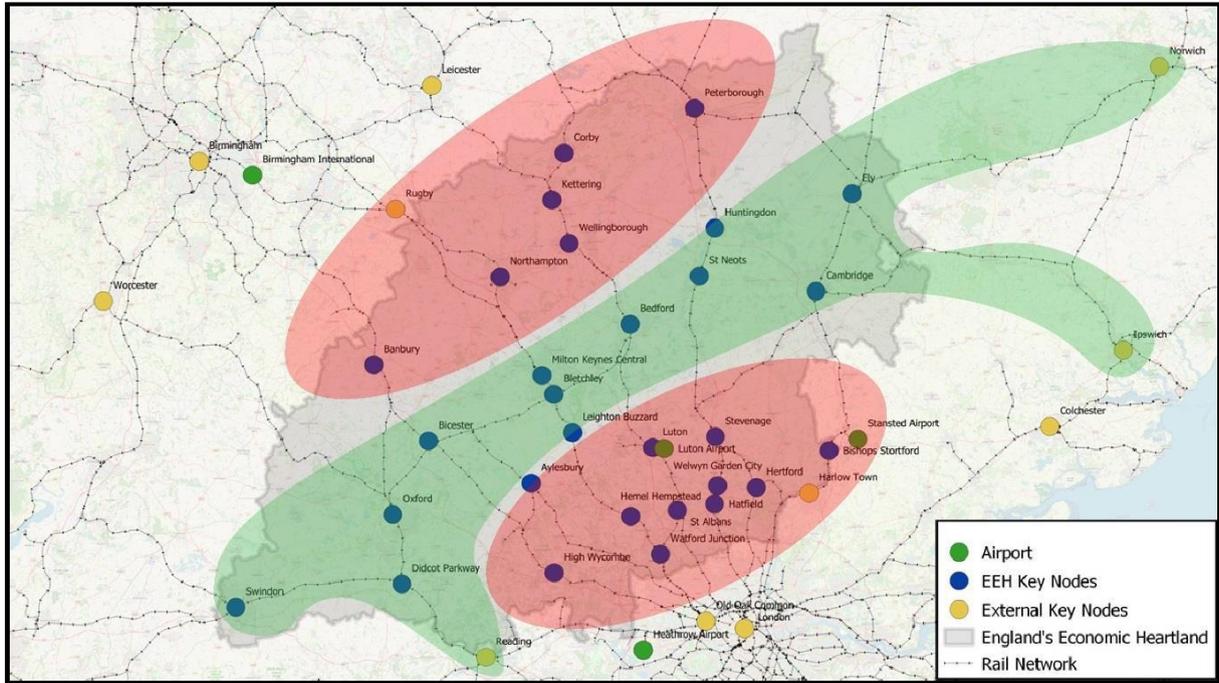


Figure 37: 11 Corridors for improved connectivity across the EEH area

The 11 corridors identified above in Figure 37 are not a wish list of improvements that should have infrastructure development carried out immediately but should be used to inform the second phase of this analysis. Phase 2 can then set out the potential benefits of improving connectivity along these corridors. Once the potential benefits have been established, Network Rail alongside EEH and other partners can work together to work out the best mechanism to deliver the benefits identified. This also presents the opportunity to incorporate decarbonisation of the rail network in EEH as part of that development.

To enable a fully decarbonised passenger railway, it has been identified that all the routes highlighted in green in the map below need to be electrified. These encompass the route around

Cambridge and Ely to Norwich, Ipswich and Peterborough; the lines through Oxford including the routes to London Marylebone and the entirety of East West Rail (Figure 38). With the exception of the branch lines to Marlow and Henley, this would give the appropriate infrastructure to operate a fully decarbonised passenger service within the Heartland, although bi-mode rolling stock may be required to enable services within the Heartland to reach their destination depending upon the extent of electrification in other parts of the country. Bi-mode fleets will play a key part in the interim to maximise the use of the electric network as it increases to aid the decarbonisation of the Heartland’s rail network.

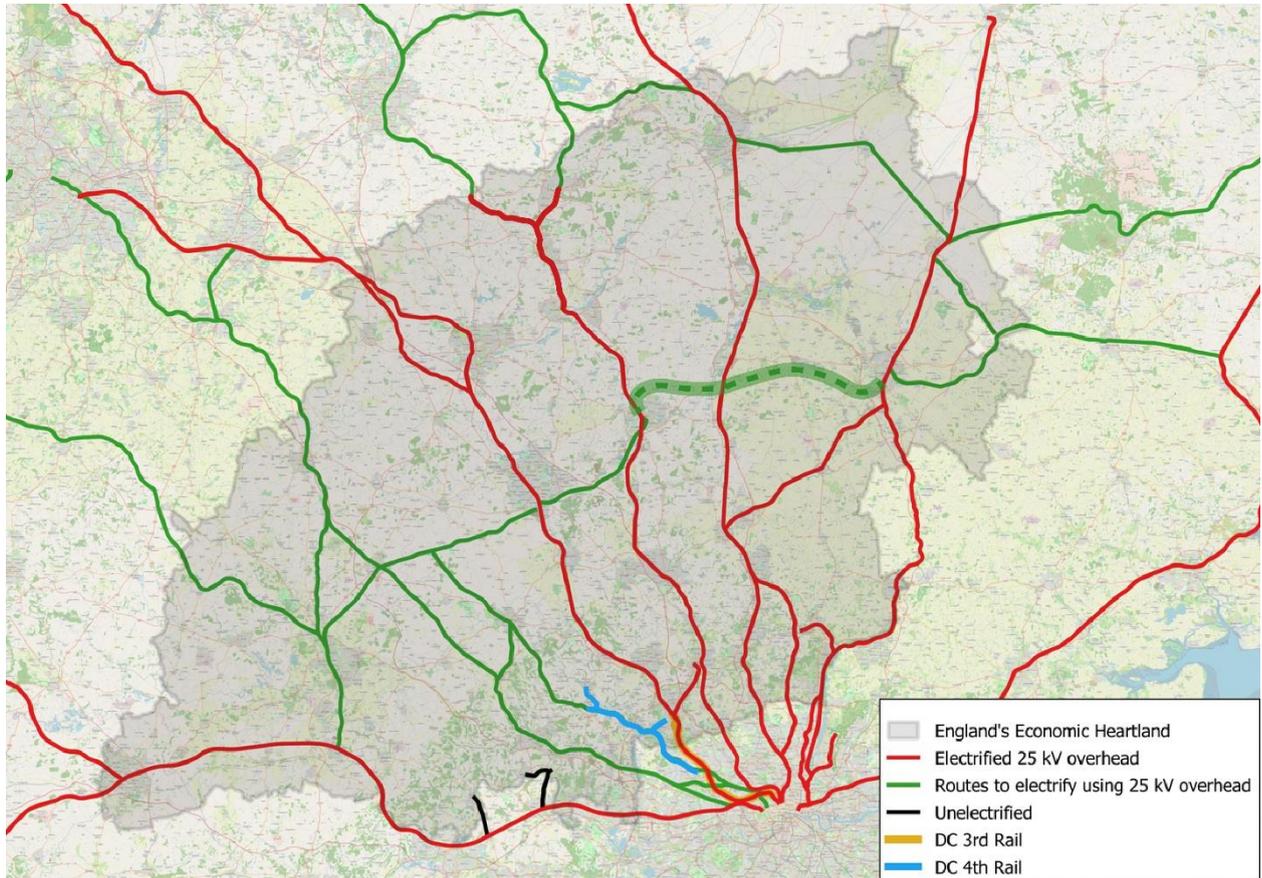


Figure 38: Currently electrified lines and lines identified in this study for electrification.

The second phase of this study continues throughout calendar year 2020 in conjunction with Network Rail and will conclude by the turn of the new year in 2021 with a set of conditional outputs that support the aims of the Transport Strategy. These conditional outputs can then begin to be factored in to Network Rail’s Long Term Planning Process (LTPP) and Continuous Modular Strategic Planning for the appropriate areas.

A key element will be integrating the passenger elements that are identified in this Rail Passenger study with freight aspirations to ensure the railway delivers for both passengers and freight users.

Appendices

Appendix 1

Sources of information used for the *Key Nodes: Supporting Economic Growth* chapter.

For all key nodes throughout;

Irwin Mitchell- UK Power House Report: <https://irwinmitchell.turtl.co/story/uk-powerhouse-january-2020/page/1>

Bucks Thames Valley LEP Local Industrial Strategy (LIS):
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818874/Buckinghamshire_SINGLE_PAGE.pdf

Oxfordshire LEP Local Industrial Strategy:
https://www.oxfordshirelep.com/sites/default/files/uploads/Oxfordshire-SINGLE-PAGE_1.pdf

South East Midlands LEP Local Industrial Strategy:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818893/South_East_Midlands_SINGLE_PAGE.pdf

Arc Economic Review: <https://pdf.euro.savills.co.uk/uk/residential---other/the-oxford-cambridge-innovation-arc.pdf>

Hertfordshire Economic Outlook: <https://www.hertfordshirelep.com/media/7210/hlep-economic-outlook-2018.pdf>

Aylesbury;

Aylesbury Population Growth: <http://old.buckscc.gov.uk/media/2437860/SNPP-2012-Buckinghamshire-and-Districts.xlsx>

Aylesbury Vale Enterprise Zone: <http://aylesburyvaleez.co.uk/about-the-enterprise-zone-sites/>

Aylesbury Vale Economic Development:
https://www.aylesburyvaledc.gov.uk/sites/default/files/page_downloads/FINAL%20VERSION%20ED%20STRATEGY%20SEPTEMBER%202016.pdf

Bedford;

East-West rail link: <https://www.bbc.co.uk/news/uk-england-beds-bucks-herts-51312450>

Bicester;

Bicester Area Strategy:
<https://m.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/roadsandtransport/transpo rtoliciesandplans/localtransportplan/ltp3/16-bicester.pdf>

Bishop's Stortford;

Town Wide Employment Study for Bishop's Stortford: https://cdn-eastherts.onwebcurl.com/s3fs-public/documents/Townwide_Employment_Study_joined.pdf

Bishop's Stortford's Regeneration: <https://www.hertfordshirelep.com/news-events/news/bishop-s-stortford-regeneration-project-secures-multi-million-funding/>

Cambridge;

Cambridge Research Park: http://www.cambridgeresearchpark.com/wp-content/uploads/2016/09/crp_brochure.pdf

Corby;

How Corby became England's fastest-growing town: <https://www.economist.com/britain/2019/04/27/how-corby-became-englands-fastest-growing-town>

Hemel Hempstead;

East Hemel Development: <http://easthemel.co.uk/>

Huntingdon and St Neots;

Huntingdon Economic Growth <https://huntingdonshire.gov.uk/media/3040/econ02-huntingdonshire-economic-growth-plan-2013-2023-compressed.pdf>

Huntingdon Neighbourhood Plan: <https://www.huntingdonshire.gov.uk/media/4021/huntingdon-neighbourhood-plan-final-version.pdf>

St Neots Master Plan: <https://cambridgeshirepeterborough-ca.gov.uk/assets/Combined-Authority/St-Neots-Masterplan-Phase-1.pdf>

Kettering;

Hanwood Park: https://www.kettering.gov.uk/info/20054/planning/87/hanwood_park

Why Kettering?: <https://enterprisekettering.co.uk/why-kettering/>

Milton Keynes;

Milton Keynes Economic Development: <https://www.milton-keynes.gov.uk/assets/attach/46815/FINAL-Economic-Development-Strategy-2017-2027.pdf>

Milton Keynes Strategy for 2050 <https://www.mkfutures2050.com/>

Northampton;

Northampton Economic Development: https://www.east-northamptonshire.gov.uk/site/scripts/download_info.php?downloadID=479&fileID=2016

Peterborough;

Economic Intelligence Report 2019: <https://www.opportunitypeterborough.co.uk/peterboroughs-economy/>

Stevenage;

Stevenage Better: <https://stevenage-even-better.com/>

Swindon;

Swindon's Economy: https://www.swindon.gov.uk/info/20017/business_and_investment/891/swindons_economy

Watford;

Investing in Watford: <http://www.watfordbid.co.uk/about/document-library/BID%20investment%20pack.pdf>

Wellingborough;

Stanton Cross:

http://www.wellingborough.gov.uk/news/article/1410/green_light_for_115_acre_town_and_county_parks_at_stanton_cross

Economic Development Strategy for Wellingborough:

http://www.wellingborough.gov.uk/download/downloads/id/7189/economic_development_strategy_2016-2021.pdf

Welwyn and Hatfield;

Welwyn Hatfield Economy Topic Paper: https://www.welhat.gov.uk/media/12339/Topic-Paper-Economy/pdf/TPA_3_Economy_Topic_Paper_May_2017.pdf?m=636306227830600000

Regional Profile Welwyn Garden City:

<https://www.cordantrecruitment.com/branches/labourmarketprofiledownload/30>

Hatfield Regeneration: <https://www.hertfordshirelep.com/what-we-do/projects/hatfield/>

Wycombe;

Wycombe Economic Development Strategy:

<https://councillors.wycombe.gov.uk/documents/s29942/Economic%20Development%20Strategy%202017-22.pdf>

Appendix 2

Generalised Journey Time full matrix with all key nodes from Passenger Rail Study included. All GJT data is in minutes

Key Node	Birmingham Intl	Stansted Airport	Northampton	Luton/Airport	Swindon	Milton Keynes	Peterborough	Oxford	Cambridge	Watford	High Wycombe	Stevenage	Bedford	St Albans	Aylesbury	Banbury	Bletchley	Didcot	Ely	Kettering	Corby	Wellingborough	Hemel Hempstead	Welwyn Garden City	Hatfield	Bicester	Leighton Buzzard	Rugby	Bishops Stortford	Hertford	Huntingdon	Harlow Town	St Neots	London*	Birmingham	Leicester	Reading	Norwich	Ipswich	Worcester	Colchester	Crewe
Birmingham Intl		262	70	215	189	81	193	97	249	100	161	222	193	166	228	80	99	153	238	195	249	209	122	230	224	120	106	49	248	262	245	239	243	99	22	114	124	341	296	104	268	99
Stansted Airport	262		231	175	239	199	131	238	63	165	202	137	204	157	239	253	208	219	86	233	264	222	180	157	160	243	195	232	35	110	185	40	184	68	241	188	189	165	177	333	163	301
Northampton	70	231		178	239	36	220	159	238	74	211	192	129	129	247	133	45	210	266	207	242	197	79	200	196	183	52	42	219	231	245	208	236	78	82	153	184	330	266	175	239	143
Luton/Airport	215	175	178		209	146	174	206	169	132	173	111	32	23	212	226	124	186	216	91	123	79	153	147	141	216	151	186	163	141	161	153	152	43	223	126	158	279	214	310	186	265
Swindon	189	239	239	209		219	248	79	247	182	177	199	234	191	217	124	225	38	282	255	296	250	197	213	207	132	214	223	225	241	254	219	242	68	161	254	42	342	282	166	252	264
Milton Keynes	81	199	36	146	219		187	167	202	53	181	158	106	104	217	144	22	191	230	174	212	166	53	169	162	192	29	56	183	197	212	174	200	57	93	137	162	299	235	182	206	115
Peterborough	193	131	220	174	248	187		244	90	179	218	67	186	165	255	240	205	228	62	178		182	193	110	115	247	197	183	157	133	42	166	50	70	148	95	201	133	164	239	202	231
Oxford	97	238	159	206	79	167	244		284	168	74	202	234	193	142	43	190	40	276	249	286	245	193	213	208	40	195	127	228	246	252	217	241	72	94	195	43	339	278	111	252	195
Cambridge	249	63	238	169	247	202	90	284		176	212	62	191	163	247	269	218	226	34	201	227	197	190	81	87	256	202	236	62	120	120	74	111	76	219	151	197	115	121	303	170	279
Watford	100	165	74	132	182	53	179	168	176		152	128	135	50	190	151	52	160	209	181	217	169	22	137	132	186	48	105	155	168	178	142	168	31	110	186	134	268	203	212	175	178
High Wycombe	161	202	211	173	177	181	218	74	212	152		166	202	157	73	78	197	128	247	230	272	219	167	175	170	58	182	192	192	205	216	181	205	47	138	229	122	307	243	201	213	266
Stevenage	222	137	192	111	199	158	67	202	62	128	166		136	97	204	218	172	178	99	153	186	144	143	37	43	207	159	197	129	57	53	136	46	39	229	163	162	188	185	310	181	266
Bedford	193	204	129	32	234	106	186	234	191	135	202	136		49	238	236	81	213	228	82	113	61	135	175	170	235	109	161	191	206	177	180	171	64	196	90	184	297	241	286	213	261
St Albans	166	157	129	23	191	104	165	193	163	50	157	97	49		195	209	105	170	199	108	150	98	75	132	126	198	100	156	146	160	147	135	139	29	179	139	155	260	196	297	168	259
Aylesbury	228	239	247	212	217	217	255	142	247	190	73	204	238	195		140		190	287	272	308	263	209	219	213	116		241	234	248	260	222	249	75	207	273	180	345	284	287	253	316
Banbury	80	253	133	226	124	144	240	43	269	151	78	218	236	209	140		162	87	288	240	287	243	186	231	224	40	171	102	246	258	265	237	259	85	67	167	72	359	299	149	269	170
Bletchley	99	208	45	124	225	22	205	190	218	52	197	172	81	105		162		203	247	172	212	153	47	181	176	212	24	71	197	208	224	186	220	64	110	171	175	310	245	212	219	156
Didcot	153	219	210	186	38	191	228	40	226	160	128	178	213	170	190	87	203		264	237	273	231	179	193	188	85	193	185	210	223	231	202	220	55	146	234	31	322	260	153	232	261
Ely	238	86	266	216	282	230	62	276	34	209	247	99	228	199	287	288	247	264		207	237	218	222	124	131	290	234	228	99	162	116	110	125	104	187	134	227	85	119	287	162	275
Kettering	195	233	207	91	255	174	178	249	201	181	230	153	82	108	272	240	172	237	207		43	36	192	205	204	259	180	181	226	194	193	216		84	152	54	217	311	271	249	250	242
Corby	249	264	242	123	296	212		286	227	217	272	186	113	150	308	287	212	273	237	43		63	222	234	234	302	206	226	252	265	213	246		113	201	93	245	338	297	307	279	290
Wellingborough	209	222	197	79	250	166	182	245	197	169	219	144	61	98	263	243	153	231	218	36	63		186	200	196	252	172	189	217	234		209	184	83	160	63	209	310	267	259	240	252
Hemel Hempstead	122	180	79	153	197	53	193	193	190	22	167	143	135	75	209	186	47	179	222	192	222	186		153	146	206	42	112	168	184	196	158	184	44	146	201	148	282	218	241	190	188
Welwyn Garden City	230	157	200	147	213	169	110	213	81	137	175	37	175	132	219	231	181	193	124	205	234	200	153		14	217	170	202	152	85	96	153	87	50	245	217	165	212	206	329	178	281
Hatfield	224	160	196	141	207	162	115	208	87	132	170	43	170	126	213	224	176	188	131	204	234	196	146	14		210	164	197	152	85	102	151	93	45	239	217	155	219	204	323	174	276
Bicester	120	243	183	216	132	192	247	40	256	186	58	207	235	198	116	40	212	85	290	259	302	252	206	217	210		215	150	235	251	264	228	252	76	96	219	89	344	285	165	258	230
Leighton Buzzard	106	195	52	151	214	29	197	195	202	48	182	159	109	100		171	24	193	234	180	206	172	42	170	164	215		78	187	200	216	178	203	53	120	183	168	301	237	219	210	163
Rugby	49	232	42	186	223	56	183	127	236	105	192	197	161	156	241	102	71	185	228	181	226	189	112	202	197	150	78		223	236	232	213	231	84	65	109	160	324	272	144	244	98
Bishops Stortford	248	35	219	163	225	183	157	228	62	155	192	129	191	146	234	246	197	210	99	226	252	217	168	152	152	235	187	223		85	193	28	182	54	260	223	181	187	170	344	150	297
Hertford	262	110	231	141	241	197	133	246	120	168	205	57	206	160	248	258	208	223	162	194	265	234	184	85	85	251	200	236	85		119	71	111	62	276	206	194	243	194	357	168	321
Huntingdon	245	185	245	161	254	212	42	252	120	178	216	53	177	147	260	265	224	231	116	193	213		196	96	102	264	216	232	193	119		199	31	77	206	144	207	200	215	309	233	289
Harlow Town	239	40	208	153	219	174	166	217	74	142	181	136	180	135	222	237	186	202	110	216	246	209	158	153	151	228	178	213	28	71	199		187	47	253	227	171	197	166	331	140	289
St Neots	243	184	236	152	242	200	50	241	111	168	205	46	171	139	249	259	220	220	125			184	184	87	93	252	203	231	182	111	31	187		69	215	155	197	210	220	317	226	292
London*	99	68	78	43	68	57	70	72	76	31	47	39	64	29	75	85	64	55	104	84	113	83	44	50	45	76	53	84	54	62	77	47	69		118	95	34	138	90	163	69	130
Birmingham	22	241	82	223	161	93	148	94	219	110	138	229	196	179	207	67	110	146	187	152	201	160	146	245	239	96	120	65	260	276	206	253	215	118		79	121	323	303	68	284	77
Leicester	114	188	153	126	254	137	95	195	151	186	229	163	90	139	273	167																										

Appendix 3

Generalised Journey Speed full matrix with all key nodes from Passenger Rail Study included. All GJS data is in mph.

Location	Birmingham Intl	Stansted Airport	Northampton	Luton/Airport	Swindon	Milton Keynes	Peterborough	Oxford	Cambridge	Watford	High Wycombe	Stevenage	Bedford	St Albans	Aylesbury	Banbury	Bletchley	Didcot	Ely	Kettering	Corby	Wellingborough	Hemel Hempstead	Welwyn Garden City	Hatfield	Bicester	Leighton Buzzard	Rugby	Bishops Stortford	Hertford	Huntingdon	Harlow Town	St Neots	London*	Birmingham	Leicester	Reading	Norwich	Ipswich	Worcester	Colchester	Crewe
Birmingham Intl		33	36	26	30	41	28	39	33	53	30	36	23	34	21	30	35	29	31	21	18	21	40	33	33	29	37	27	33	28	27	32	29	64	23	21	44	30	35	20	35	36
Stansted Airport	33		27	25	31	27	32	28	23	20	24	24	27	24	24	29	24	27	27	29	25	29	21	22	20	30	24	31	12	15	25	21	23	33	38	39	26	34	27	30	32	37
Northampton	36	27		19	29	26	28	31	31	39	28	29	17	26	24	27	25	26	30	17	16	16	31	26	26	24	29	27	27	22	30	26	30	51	37	20	32	33	31	26	30	40
Luton/Airport	26	25	19		34	16	31	31	32	24	27	33	37	28	26	30	18	31	29	27	24	27	23	22	22	31	17	23	24	23	34	23	34	42	28	33	30	32	29	25	28	33
Swindon	30	31	29	34		34	39	26	34	30	31	34	35	34	25	28	32	38	33	33	30	36	30	30	30	22	32	26	31	26	34	30	34	68	33	27	59	35	33	23	33	32
Milton Keynes	41	27	26	16	34		29	35	32	37	27	29	11	22	27	31	9	31	31	14	14	13	29	25	25	27	20	35	27	21	30	25	30	53	41	29	31	33	31	29	30	57
Peterborough	28	32	28	31	39	29		33	30	31	33	44	33	36	32	27	25	36	30	27		28	31	31	31	33	28	28	27	26	25	28	30	66	37	33	36	37	30	29	29	31
Oxford	39	28	31	31	26	35	33		27	28	46	29	30	30	23	32	31	16	31	26	24	28	26	26	25	23	31	30	27	22	31	26	30	53	42	25	38	33	30	31	30	36
Cambridge	33	23	31	32	34	32	30	27		25	28	29	35	30	28	31	29	31	26	28	23	30	26	28	28	32	29	33	24	20	27	27	25	44	38	39	31	36	27	32	26	35
Watford	53	20	39	24	30	37	31	28	25		19	21	20	23	20	36	34	25	26	23	21	22	20	16	16	28	28	37	19	13	26	18	25	34	52	31	23	30	26	34	24	47
High Wycombe	30	24	28	27	31	27	33	46	28	19		25	28	26	13	31	24	31	28	31	28	30	20	21	21	70	24	25	23	18	28	22	27	34	36	26	31	31	28	33	27	31
Stevenage	36	24	29	33	34	29	44	29	29	21	25		36	31	25	30	26	30	27	38	29	40	22	12	14	31	25	34	26	10	35	22	32	43	37	37	28	32	28	30	26	38
Bedford	23	27	17	37	35	11	33	30	35	20	28	36		37	28	24	12	32	26	16	16	15	17	25	25	27	13	20	27	21	30	26	33	47	26	33	31	30	31	23	30	29
St Albans	34	24	26	28	34	22	36	30	30	23	26	31	37		25	31	20	30	29	29	24	28	23	20	19	28	22	28	23	16	33	21	32	41	34	34	26	32	29	28	27	37
Aylesbury	21	24	24	26	25	27	32	23	28	20	13	25	28	25		17		21	27	27	26	29	21	21	21	13		20	23	19	27	22	26	30	24	21	26	30	27	23	26	26
Banbury	30	29	27	30	28	31	27	32	31	36	31	30	24	31	17		28	23	29	21	19	23	31	27	27	20	29	24	28	24	29	27	31	47	38	21	42	32	31	28	30	34
Bletchley	35	24	25	18	32	9	25	31	29	34	24	26	12	20		28		29	28	14	13	13	29	22	22	26	16	30	24	19	28	23	27	44	36	23	27	32	29	26	27	43
Didcot	29	27	26	31	38	31	36	16	31	25	31	30	32	30	21	23	29		30	30	28	32	25	25	25	20	28	24	26	22	31	25	31	58	31	23	34	33	30	26	29	30
Ely	31	27	30	29	33	31	30	31	26	26	28	27	26	29	27	29	28	30		23	18	23	26	25	25	29	29	30	24	20	25	26	26	41	39	37	30	38	26	31	25	32
Kettering	21	29	17	27	33	14	27	26	28	23	31	38	16	29	27	21	14	30	23		11	11	19	28	27	23	15	20	28	29	20	28		51	26	30	33	25	29	22	31	26
Corby	18	25	16	24	30	14		24	23	21	28	29	16	24	26	19	13	28	18	11		14	19	25	25	21	15	18	26	22	16	26		42	22	22	31	22	25	19	29	23
Wellingborough	21	29	16	27	36	13	28	28	30	22	30	40	15	28	29	23	13	32	23	11	14		17	27	26	25	13	21	28	23		27	26	47	28	32	32	26	30	23	30	27
Hemel Hempstead	40	21	31	23	30	29	31	26	26	20	20	22	17	23	21	31	29	25	26	19	19	17		17	17	24	23	31	20	14	25	18	25	33	37	26	23	30	26	28	24	43
Welwyn Garden City	33	22	26	22	30	25	31	26	28	16	21	12	25	20	21	27	22	25	25	28	25	27	17		11	25	21	30	20	12	24	17	22	25	33	30	25	30	26	27	24	37
Hatfield	33	20	26	22	30	25	31	25	28	16	21	14	25	19	21	27	22	25	25	27	25	26	17	11		25	21	30	19	14	24	16	22	24	33	31	24	30	25	27	24	38
Bicester	29	30	24	31	22	27	33	23	32	28	70	31	27	28	13	20	26	20	29	23	21	25	24	25	25		27	22	26	21	29	25	29	60	35	22	30	35	32	26	32	29
Leighton Buzzard	37	24	29	17	32	20	28	31	29	28	24	25	13	22		29	16	28	29	15	15	13	23	21	21	27		33	23	18	27	22	27	45	37	24	26	31	28	27	27	43
Rugby	27	31	27	23	26	35	28	30	33	37	25	34	20	28	20	24	30	24	30	20	18	21	31	30	30	22	33		31	26	26	30	29	59	28	18	34	31	34	24	33	46
Bishops Stortford	33	12	27	24	31	27	27	27	24	19	23	26	27	23	23	28	24	26	24	28	26	28	20	20	19	26	23	31		14	24	16	23	34	33	33	25	30	29	28	32	38
Hertford	28	15	22	23	26	21	26	22	20	13	18	10	21	16	19	24	19	22	20	29	22	23	14	12	14	21	18	26	14		20	11	18	19	29	32	19	27	27	25	25	33
Huntingdon	27	25	30	34	34	30	25	31	27	26	28	35	30	33	27	29	28	31	25	20	16		25	24	24	29	27	26	24	20		24	14	46	32	29	30	30	28	26	28	28
Harlow Town	32	21	26	23	30	25	28	26	27	18	22	22	26	21	22	27	23	25	26	28	26	27	18	17	16	25	22	30	16	11	24		24	29	33	33	24	31	32	28	31	38
St Neots	29	23	30	34	34	30	30	30	25	25	27	32	33	32	26	31	27	31	26			26	25	22	22	29	27	29	23	18	14	24		45	33	30	29	30	28	27	27	29
London*	64	33	51	42	68	53	66	53	44	34	34	43	47	41	30	47	44	58	41	51	42	47	33	25	24	60	45	59	34	19	46	29	45		56	63	64	50	46	44	45	73
Birmingham	23	38	37	28	33	41	37	42	38	52	36	37	26	34	24	38	36	31	39	26	22	28	37	33	33	35	37	28	33	29	32	33	33	56		30	46	32	34	23	35	40
Leicester	21	39	20	33	27	29	33	25	39	31	26	37	33	34	21	21	23	23	37	30	22	32	26	30	31	22	24	18	33	32	29	33	30	63	30		30	32	30	23	34	32
Reading	44	26	32	30	59	31	36	38	31	23	31	28	31	26	26	42	27	34	30	33	31	32	23	25	24	30	26	34	25	19	30	24	29	64	46	30		33	30	36	28	39
Norwich	30	34	33	32	35	33	37	33	36	30	31	32	30	32	30	32	32	33	38	25	22	26	30	30	30	35	31	31	30	27	30	31	30	50	32	32	33		41	28	43	32
Ipswich	35	27	31	29	33	31	30	30	27	26	28	28	31	29	27	31	29	30	26	29	25	30	26	26	25	32	28	34	29	27	28	32	28	46	34	30	30		30	26	35	
Worcester	20	30	26	25	23	29	29	31	32	34	33	30																														

Appendix 4

Road Journey Time comparisons for each case study area.

From Milton Keynes	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	65.6	97	11	108	219	110
	Oxford	40.8	59	11	70	167	97
	Bedford	17.4	25	9	34	106	72
	St Albans	31.8	37	10	47	104	57
	Aylesbury	22.6	32	6	38	217	180
	Cambridge	48.3	64	12	76	202	125
	Peterborough	57.8	64	12	76	187	111
	Hertford	47.7	57	15	72	197	126
	Northampton	20.1	30	5	35	36	1
	Watford	38.2	42	12	54	53	-1
	Bicester	25.1	35	7	42	192	151
	Corby	38.5	60	10	70	212	142
	Wellingborough	22.1	34	6	40	166	127
	Kettering	34.1	44	9	53	174	121
	St Neots	31.2	39	8	47	200	153
Leighton Buzzard	13.2	19	5	24	29	6	

From St Albans	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	87.4	102	15	117	191	74
	Oxford	55.7	66	14	80	193	113
	Bedford	37.7	47	13	60	49	-11
	Milton Keynes	32	40	8	48	104	56
	Peterborough	71.1	82	8	90	165	76
	Cambridge	47.9	68	12	80	163	83
	Aylesbury	27	35	7	42	195	153
	Hertford	15.8	26	7	33	160	126
	Northampton	44.8	57	11	68	129	60
	Hatfield	8.2	17	4	21	126	105
	Hemel	5.9	14	3	17	75	59
	Welwyn Garden City	7.8	19	4	23	132	109
	Watford	8.9	18	4	22	50	28
	Luton	11.8	22	9	31	23	-9
	Harlow Town	24	40	7	47	135	89
	Stansted Airport	41.8	49	12	61	157	96

From Cambridge	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	113	160	20	180	247	68
	Oxford	84	119	11	130	284	154
	Bedford	29.4	42	11	53	191	138
	Milton Keynes	47.4	62	12	74	202	128
	St Albans	48.1	67	15	82	163	82
	Northampton	57	74	14	88	238	149
	Aylesbury	61.9	87	8	95	247	152
	Hertford	40.9	57	13	70	120	51
	Peterborough	42.8	55	9	64	90	25
	Hatfield	41.8	57	13	70	87	17
	Harlow Town	42.4	52	12	64	74	10
	Ely	16.6	29	6	35	34	-1
	Stevenage	31.7	45	10	55	62	7
	St Neots	18.2	29	7	36	111	75
	Stansted Airport	32.2	40	9	49	63	14
	Norwich	63.9	80	7	87	115	28
	Ipswich	54.2	76	13	89	121	32
Colchester	61.9	74	9	83	170	87	

From Peterborough	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	113	148	20	168	248	80
	Oxford	86.8	117	11	128	244	115
	Bedford	39.7	48	14	62	186	124
	Milton Keynes	57.7	65	14	79	187	108
	St Albans	73	80	11	91	165	74
	Cambridge	43.1	56	11	67	90	22
	Aylesbury	72.2	89	9	98	255	157
	Hertford	65.1	75	10	85	133	48
	Northampton	43.3	60	11	71	220	149
	Ely	30.3	46	8	54	62	8
	Norwich	77.6	110	9	119	133	15
	Ipswich	93.3	105	11	116	164	48
	Colchester	97.2	108	14	122	202	80
	Stansted Airport	66.4	70	9	79	131	51
	Stevenage	53.8	61	16	77	67	-11
	Corby	25	34	6	40		
	Wellingborough	34.5	47	9	56	182	127
	Leicester	41.2	60	32	92	95	4
	Kettering	32.3	42	8	50	178	128

From Aylesbur	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	56.9	82	20	102	217	115
	Oxford	22.9	41	6	47	142	96
	Bedford	36.2	56	13	69	238	169
	Milton Keynes	21.6	34	5	39	217	178
	St Albans	24.9	35	8	43	195	152
	Cambridge	63.1	91	8	99	247	148
	Peterborough	72.6	90	8	98	255	157
	Hertford	39.8	48	12	60	248	188
	Northampton	39.5	60	10	70	247	177
	Watford	24.6	34	8	42	190	149
	Leighton Buzzard	10.9	22	4	26		
	Bicester	17.2	28	7	35	116	82
	High Wycombe	14.8	27	6	33	73	41
	Bletchley	18.4	31	7	38		

From Hertfor	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	99.6	116	17	133	241	107
	Oxford	67.9	80	9	89	246	157
	Bedford	37.5	49	13	62	206	144
	Milton Keynes	47.4	56	12	68	197	130
	St Albans	13.6	25	6	31	160	128
	Cambridge	35.1	55	9	64	120	56
	Peterborough	64.9	75	7	82	133	51
	Northampton	60.4	74	8	82	231	149
	Aylesbury	39.3	48	10	58	248	190
	Watford	21	31	6	37	168	131
	Welwyn Garden City	6.1	12	3	15	85	71
	Harlow Town	10.7	18	5	23	71	48
	Stansted Airport	21.1	28	6	34	110	76
	Hatfield	7.1	11	3	14	85	70
Stevenage	10.5	19	5	24	57	34	
Bishops Stortford	16.1	22	7	29	85	56	

From Oxford	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	30.5	45	11	56	79	24
	Bedford	58.8	79	21	100	234	134
	Milton Keynes	43	58	10	68	167	99
	St Albans	54.3	63	17	80	193	114
	Aylesbury	22.8	38	6	44	142	99
	Cambridge	87.4	121	11	132	284	152
	Peterborough	87.4	112	9	121	244	122
	Hertford	67.2	78	10	88	246	157
	Northampton	44.9	59	11	70	159	89
	Watford	50.3	60	15	75	168	93
	Bletchley	40.7	55	10	65	190	125
	High Wycombe	26.9	34	7	41	74	33
	Northampton	44.9	59	11	70	159	89
	Didcot	13.9	20	5	25	40	15
Bicester	14.9	22	6	28	40	13	

From Swindo	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Oxford	30.6	47	8	55	79	24
	Bedford	84.5	117	15	132	234	102
	Milton Keynes	68.8	94	8	102	219	116
	St Albans	86.7	103	13	116	191	75
	Cambridge	113.2	157	15	172	247	76
	Peterborough	113.1	148	12	160	248	88
	Northampton	70.7	95	9	104	239	135
	Hertford	99.5	117	15	132	241	109
	Aylesbury	56.8	83	14	97	217	119
	Watford	74.9	96	11	107	182	75
	Didcot	37.1	45	10	55	38	-16
	Bicester	40.7	58	11	69	132	64
	Banbury	55.3	73	14	87	124	36
	Reading	39.8	52	34	86	42	-44
High Wycombe	64.1	75	8	83	177	94	

From Bedford	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Oxford	56.1	83	15	98	234	136
	Swindon	82	119	14	133	234	101
	Milton Keynes	17.8	27	7	34	106	72
	St Albans	34.3	41	11	52	49	-2
	Cambridge	30.2	45	8	53	191	138
	Peterborough	38.8	48	8	56	186	130
	Northampton	22.1	35	6	41	129	89
	Hertford	37.6	53	12	65	206	142
	Aylesbury	31.6	54	8	62	238	176
	Luton	19.5	31	15	46	32	-14
	Welwyn Garden City	33.6	42	10	52	175	122
	Corby	33.1	44	8	52	113	60
	Kettering	26	41	7	48	82	35
	Wellingborough	18.7	31	7	38	61	23
St Neots	13.2	22	5	27	171	144	
Stansted Airport	54.6	64	15	79	204	124	
Huntingdon	21.3	29	5	34	177	142	

From Northampton	To	Distance (Miles)	Car JT (Mins)	Congestion factor	Total Congested Car JT	Rail GJT	Difference in Time
	Swindon	71.1	97	12	109	239	129
	Oxford	45.1	61	12	73	159	86
	Bedford	22.2	36	8	44	129	85
	Milton Keynes	20.1	30	5	35	36	1
	St Albans	44.8	57	14	71	129	58
	Cambridge	57.7	76	15	91	238	147
	Aylesbury	39.4	59	10	69	247	178
	Hertford	60.9	76	9	85	231	146
	Peterborough	43.7	63	9	72	220	148
	Corby	23.5	38	6	44	242	198
	Wellingborough	12.6	22	5	27	197	170
	Kettering	14.5	27	6	33	207	175
	St Neots	35.2	56	9	65	236	171
	Huntingdon	39.2	54	10	64	245	181
Banbury	31.5	52	8	60	133	73	
Bicester	31.9	42	8	50	183	133	

Get in touch

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