Beyond HS2

GREENGAUGE21
Shaping tomorrow's railway

May 2018

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Contents

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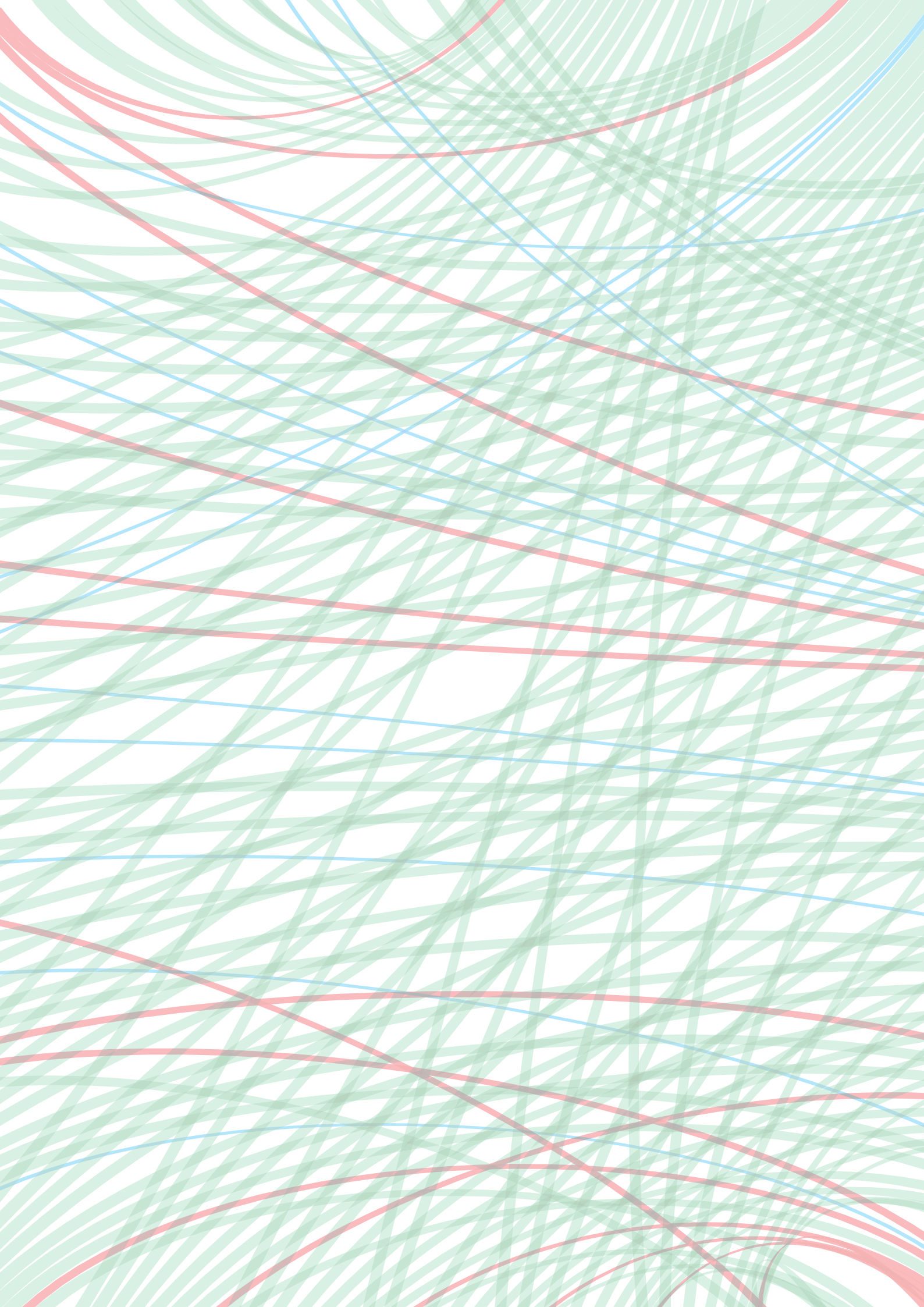


Preface

It took us 10 months to produce this comprehensive view of what Britain's railway should look like in 25 years' time, "beyond HS2". We suggest that Britain's rail strategy has a specific objective: to transform national productivity – as well as supporting greater regional and social equity and tackling climate change. The report sets out the measures needed to make this happen.

We show how to bring together the best of high-speed rail with the existing network suitably enhanced. Our thinking leads to a re-orientation for Britain's railway – from a single hub and spoke based around London to a national railway network, with HS2 developed from a "Y" to an "X" shaped network, and an extensive programme of major route and more localised improvements to achieve the transformation required.

Thinking on how best to use HS2 has evolved over the last few years with the emergence of the major regional 'sub-national bodies'. More emphasis has been placed on better connections between regional cities. HS2's lead designer, Professor Andrew McNaughton has recently spoken of the need to consider its services less as a 'surface airline' operating model, more as a high-speed metro, with an intensive service between eight of Britain's largest cities. Our report takes this thought and goes further, finding ways to enhance HS2's value and broaden its spread of benefits.

High-speed plays a part in this national rail strategy, but only a part. We looked much more widely and examined what is needed for those places that today lack rail services of any description; what is needed within city regions as well as between them; and, where appropriate, how other transport modes can be brought into the picture. We are aiming to fill a gap: there is no long-term plan for the nation's railway.

Some urged us to go further, and consider all of the available transport modes together. Instead, we sought to meet a simpler but still elusive objective: to make clear what rail does well in terms of meeting the major challenges facing the nation. The nation has a plan for the national motorway network; it was set out in the 1950s. The last pieces – such as the final section of the M8 in Scotland – are just being put in place. We can plan and we must plan long-term because transport networks act as systems. A piecemeal project by project approach carries risk of wasteful expenditure.

Of course, plans set for as far ahead as 2040 will be subject to change, but that is the nature of contemporary planning practice, just as it would be in any business. We would expect debate on the choices and conclusions reached in this report – and that could lead to a first update in due course. Outcomes of important work currently in hand, developing strategic outline business cases on options for major schemes such as Northern Powerhouse Rail, will have a major bearing, no doubt.

Because of the centrality of rail in facilitating the growth of cities which in turn affects commuting patterns, the strategy carries strong implications for housing policy. We hope the work here can contribute to future efforts to embrace the spatial planning needed to coordinate cost-effectively infrastructure and housing (and industrial) development.

It is a lengthy report, so some readers will find it best to go straight to areas of most interest. For those without the time for a full read-through, Chapter 10 Conclusions sets out the overall plan and can be regarded as an executive summary.

The relationship between rail and productivity is covered in depth in Chapter 2. We continue with a look at the markets and requirements of passengers (in chapter 3) and rail freight users (chapter 4). Chapter 5 analyses connectivity strengths and weaknesses across the whole country.

Chapter 6 centres on the services that will operate over HS2, and the implications for services in HS2 'corridors'.

Chapters 7 and 8 provide details of the key choices that need to be made region by region. Chapter 7 covers the north of the country and chapter 8 the south. We look at 'places left behind', drawing on work by the Government's Social Mobility Commission in Chapter 9. And we end with Chapter 10 – our conclusions and also our executive summary.

Greengauge 21
May 2018

Foreword

Beyond HS2 is a landmark report.

Not only do Greengauge 21 identify the clear need for a long term rail strategy for Britain but they go on and put one on the table for discussion. Beyond HS2 is an expansive and timely long term vision for our railways. It demands close consideration by the rail industry, the National Infrastructure Commission and Government.

Beyond HS2 is founded in a careful consideration of high level policy ambitions for Britain – for economic growth, for reducing the substantial economic and social disparities across Britain, for growing international trade, for carbon reduction and improving air quality. It is rail that is identified as the mode of transport that helps major towns and cities to prosper – the locations where the economy can be expected to grow most strongly and where concentrated demand flows can be well served by rail. The alternative – over-reliance on roads – offers by comparison the prospect of more congestion and more dispersed lower density development across the countryside.

And Beyond HS2 is truly a national strategy. It examines the services that should run on HS2 and the opportunities created on parallel existing lines; it identifies the rail services and developments needed across the English Regions and in Scotland and Wales; and it considers what should be done to re-connect places 'left behind' as well.

Moreover, Beyond HS2 addresses some key strategic choices. It proposes:

- A more cautious assumption of 16 trains per hour as a maximum throughput for the HS2 network over the stem of the 'Y', rather than the 18 trains per hour proposed by HS2 Ltd that has not been achieved with high-speed rail anywhere to date. This lower throughput, along with other measures, makes it possible to simplify the design and impact of the second phase development at Euston and avoids the need for all trains to stop at Old Oak Common.

- Upgrading the East Coast Main Line to 140 mph operation as a high priority alongside HS2 and to be delivered without delay. Newcastle-London timings across a shorter route could closely match those achievable by HS2.

- And this then frees up capacity on the eastern arm of HS2, once built, so the North East, Yorkshire and the East Midlands can benefit from an increase in fast cross-country services not only to Birmingham but also beyond to Bristol and Cardiff. In effect, HS2 is re-configured as an X rather than a Y – achieved by an additional HS2 junction in the Midlands and an upgrade of the Birmingham-Bristol line.

The strategy, in addition, backs upgrades of the Great Western Main Line, and the West Coast Main Line north of HS2. It expresses views about how a new line across the Pennines - Northern Powerhouse Rail - should be configured and proposes a new line in Scotland to halve journey times between Edinburgh and Perth and speed up onward journeys to Inverness and Dundee/Aberdeen. And in two areas, Beyond HS2 makes the case for new high-speed lines - from Stratford in East London to Stansted, Cambridge and Colchester and to relieve the northern end of the West Coast Main Line in Scotland.

Shorter term proposals needed by 2030 are set out as well. These include better city region rail services and networks in Birmingham, Bradford, Manchester, Leeds, Liverpool and Newcastle. Peripheral areas, for once, are also given consideration, and the essential need to provide resilience for rail in the far south west is addressed head on.

Links to ports and airports are not overlooked, so there are measures for freight around London and across the Pennines and to improve rail connectivity to Heathrow, Manchester and Edinburgh Airports too.

But in advancing all of these proposals, the report's authors repeatedly explain why projects cannot be sensibly developed across the railway system in isolation from one another. They argue that having a plan – which they acknowledge needs to be flexible and updateable – itself has an economic value.

Beyond HS2 is a tour de force - a report engaged in the lost art of planning that successive Governments have shied away from but that the National Infrastructure Commission now needs to foster and encourage the rail industry to take forward. Beyond HS2 offers a very credible start on a long term plan for Britain's railways. It demands careful consideration.

Thanks go to the Greengauge team - Deborah Carson, Richard Davies, Leo Eyles, John Jarvis and Jim Steer – for taking the initiative and producing Beyond HS2.

Professor David Begg
Chief Executive, *Transport Times*

1.0 Introduction

Delivery of HS2 is in hand. It represents a transformative development of our national transport system, and its completion is keenly awaited.

Its benefits in terms of economic stimulus have already started – just as Greengauge 21 suggested they would, based on experience elsewhere in Europe with high-speed rail.[1]

Here, we take as a given that HS2 infrastructure will be delivered in stages in 2026/7 and 2033, as currently planned. It is set to bring huge connectivity and network capacity and resilience gains.

So, in this report, we ask: what lies beyond the delivery of the new HS2 infrastructure? Which means, as a country, we also need to answer these further questions about the rail network and accessibility to public transport services:

- What are the development options for places that will miss out on the gains HS2 will bring?
- What should be done in parallel with building HS2 over the next 15 years to 2033, and indeed beyond (out to say 2040)?
- What services should operate over HS2 to optimise its value?

This report seeks to make at least a start to answering these connectivity and planning questions in the belief that a coherent national rail strategy and delivery plan is needed that will help frame a sustainable development approach for the country as a whole. It will also help with the planning of individual projects, where uncertainties over interfaces and assumptions about future train services often loom large and expensively.

1. Greengauge 21, *What will be the spatial effects of High Speed Rail in the UK?*. Evidence submitted to the Independent Transport Commission, November 2012.

A strategy would also, of course, need to be updated as events unfold, but as of now there is little in the way of a long term framework for national rail network development. Better connectivity is promoted and cherished as an outcome of HS2, but (oddly enough) is not expressed at a national policy level. Neither is there a national plan for rail capacity uplift, nor for enhanced network resilience; and there are no overall environmental targets for the rail sector either. Targets are, however, set for train service reliability by the Office for Rail and Road (for five years at a time) along with a safety framework that has helped Britain achieve a position of safety outcome leadership amongst the rail networks of Europe. Protection of this position must be a natural priority as part of any long-term plan.

In summary, Britain needs a clear plan for the strategic development of its rail network that will build on HS2 and identify how the whole country can progressively benefit from higher capacity and faster travel speeds designed to promote connectivity and to help address long-running regional economic imbalances.

Scope

HS2 is seen by some (wrongly) as benefitting only the large cities at either end of the planned new infrastructure – London, Birmingham, Manchester and Leeds. These cities will benefit, of course, and indeed in each case plans are already being developed to capture the development potential that HS2 brings.[2]

But also benefitting are the many cities and towns that HS2 services are planned to reach, including:

- Edinburgh, Glasgow, Carlisle, Newcastle, Lancaster, Darlington, Preston, York, Liverpool, Wigan and Warrington, Crewe, Sheffield and Chesterfield, Stafford and Stoke-on-Trent;[3]

alongside which should be listed the places where the creation of HS2 provides relief from capacity pressures on today's rail network and where much improved services can (and should) be provided once HS2 is open, including:

- Blackpool, Sunderland, Middlesbrough, Hull, Bradford, Harrogate, Grimsby, Lincoln, Wrexham and Shrewsbury (all can get better and in some cases new direct services to London, and in most cases, will have access to HS2 hub stations too);

- Doncaster, Retford, Newark and Grantham, Lichfield and Tamworth, Coventry and Nuneaton, Walsall, Northampton, Milton Keynes, Watford (stations on existing main lines that HS2 will relieve: all can get better services using released capacity);

2. Leeds city region HS2 growth strategy for example, January 2018.
3. Government publication, *HS2: Getting the best out of Britain*, 30 November 2017.

- North Wales; Blackburn and Burnley; Kidderminster; Rochdale, Bury and Bolton; Rotherham and Barnsley, Leicester and Loughborough (stations which all can benefit from improved rail services to HS2 hub stations, and in some cases, through HS2 services are possible too).

New infrastructure demands careful planning and we have in Britain an established process that ensures that local concerns are heard and considered in Parliament as the powers to construct major new railway lines are obtained. But the connectivity and capacity gains from new or improved infrastructure also require a further sort of planning in order to establish rail service plans. There are train service and timetable choices, for example, for the three exemplar groups of towns and cities noted earlier once HS2 starts operation, centred on the two options of either a 'hub and spoke' style of service plan reliant on passenger interchange; or, through services, reaching a wider set of destinations directly.

Thus far no commitments have been made on post-HS2 train services (or even over the new HS2 network itself) – and therefore on the train fleets needed to provide them. This report is in part intended to shine light on the choices available and provoke more urgency in the associated service planning processes that will be needed if the economic regeneration benefits (which could be experienced widely across the nation) are to be fully captured.

Thinking beyond HS2 also, of course, means looking at those places that will not see better rail services as a result of HS2 but which might be candidates for other improvements. We have an indication of where these improvements might be needed from work published by DfT in 2013 (See Figure 1.1).

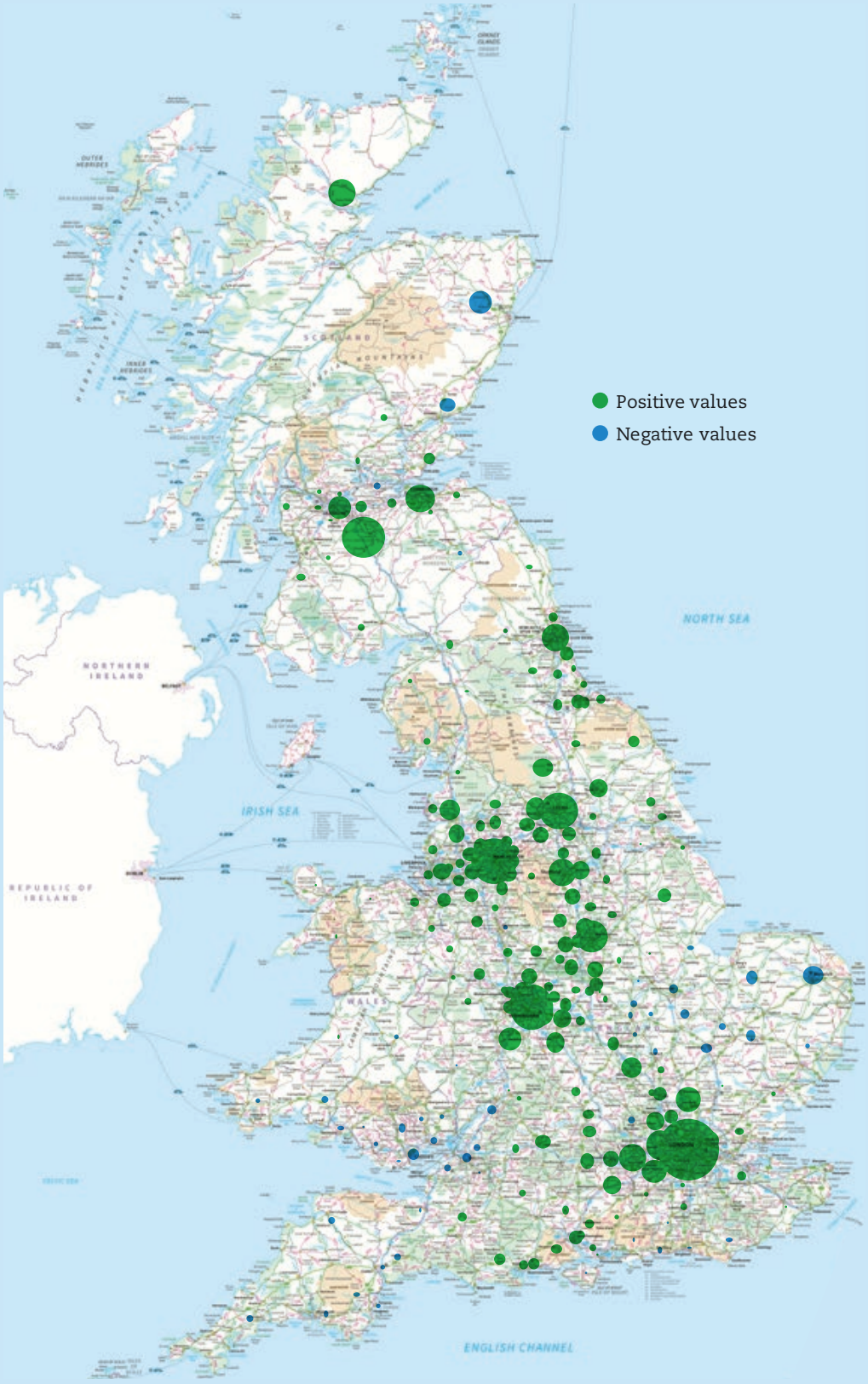
We can see from Figure 1.1 that alongside a core swathe of places lying on the planned Y-shaped HS2 network between London, Birmingham, Leeds and Manchester (as well as places beyond such as the central belt in Scotland, North East England and the Hampshire coast in the south) that are forecast to gain business benefits from HS2, there are others where there could be losses, as businesses or their customers switch their focus to better connected places.

Of course, there are many assumptions (as always) in the modelling[4] that underlies the geographic pattern in Figure 1.1, but in general the distribution of places that might lose out (blue circles) accords with common-sense. They are, notably, in and across a substantial proportion of Britain:

- South West England
- South and West Wales
- East of England/East Anglia
- North East Scotland
- Sussex coast.

4. The techniques used were first developed for a study commissioned by Greengauge 21 (KPMG), *Consequences for Employment and Economic Growth*, 2010.

Figure 1.1: **The distribution of economic impact of HS2 on businesses – 2037 projection**



Source: HS2 Regional Economic Impacts, Figure 15 (low business response case), September 2013. KPMG for HS2 Ltd and DfT. Note that this research made limited assumptions about consequential changes on the use of the existing network, including on using released capacity on existing lines parallel to HS2.

Addressing the connectivity (and capacity) needs of such significant parts of Great Britain forms part of the challenge of formulating a national rail connectivity strategy to be addressed in Beyond HS2. Others share our sense this is needed:

> **"Ultimately, we want to see the UK having a high speed rail network worthy of the world's fifth largest economy, with extensions along the East and West coast to Scotland and West to Bristol and Cardiff, as well as improved East-West links across the Midlands and the North, and further consideration of building the schemes out from the North at the same time as the South, to speed up completion of the full network. HS2 is only part of that vision and Phase One is only the first step, but it is vital that we make that first step as quickly as possible."**[5]

There are also places within the Midlands and the North of England which will remain relatively remote and poorly connected by rail, even with new north-south HS2 services. In these parts of the country there are emerging plans for rail, with aims in each case to improve east-west intercity connectivity, and these may address some of the problems of poorly connected places. But characteristically, most transport projects are directed towards places with concentrations of demand and the best economic prospects, and this means the largest cities. These are important challenges to address. In *Beyond HS2* we consider the question of re-balancing – now an added criterion for DfT investment appraisals[6] – to ensure that options that address the needs of places 'left behind' are met as well as the needs of major cities.

Smart planning

The nation may lack a plan for rail network development, but there has been no shortage of strategies, many of them set at a regional level and developed as part of the sequential business case approach favoured by Government, often with major consultation exercises. Yet they can remain open to the criticism that they comprise a stream of projects ('wish lists'), rather than setting forward a clear strategy, the creation of which requires facing up to difficult choices. A strategy comprises objectives and a delivery plan. It must consider the long term as well as the short term. It must also ensure that the interaction between individual projects has been fully considered so that, amongst other things, capital expenditure is not wasted.

Published studies include the programme of route-based studies carried out by Network Rail under their Long Term Planning Process (LTPP)[7], and these remain a source of useful evidence, even as their provenance becomes a little dated.

5. Core Cities, *In Support of HS2*, 2016.

6. Department for Transport, *Strategic Case Supplementary Guidance Rebalancing Toolkit, Moving Britain Ahead*, December 2017.

7. While these studies provide valuable insights into the choices confronting Network Rail, they are not a response to wider strategic policy needs of the type identified below – see 'Defining Aims'.

Programmes of investment in the national rail network are under way – some nearing fruition, others with several years to run. Even for projects under construction, as of Spring 2018, it is sometimes hard to foresee the point at which they will be deemed 'completed'. For the record, the main current rail infrastructure projects are summarised in Table 1.1, along with their status in development and delivery terms.

Table 1.1: **Current major national rail infrastructure scheme status, Spring 2018**

Scheme	Possible Cost	Timing	Status
Thameslink	£5.5bn	Now nearing completion	New timetable being phased in during 2018/19
Crossrail	£15bn	Now being commissioned	Expected to be fully complete next year
Great Western Electrification	£4+bn	In stages; some complete Spring 2018. Completion date unknown	Has been de-scoped and slowed down because of cost escalation
Midland Main Line Upgrade and Electrification	£1bn	2019 (Phase 1 only)	Bedford – Corby to be electrified, rest of line on hold for now.
Trans-pennine Route Upgrade (Manchester-Leeds-York)	£2–3bn	TBC	Electrification or part electrification to speed up existing links between Northern cities
Northern Powerhouse Rail	TBC	TBC	New higher speed rail links between main Northern cities
Edinburgh-Glasgow (Queen Street) electrification (EGIP)	£2bn	Expected to complete this year	Electrification and acceleration of core Central Belt routes
Great North Rail Project/ Northern Hub	£1–2bn	Expected to be completed next year	Decongesting Manchester and longer trains on many lines. New Trans Pennine Express and Northern trains.
Western Access to Heathrow	£500m	Beyond CP6	No funding commitment as yet; planning consent to be applied for 2019

Scheme	Possible Cost	Timing	Status
Felixstowe – Nuneaton freight and Strategic Freight Network	£2bn	None yet agreed.	Programme to provide more capacity and capability for freight from Felixstowe. Some first steps (e.g. chord at Ipswich) already implemented.
East Coast Main Line Connectivity Funds	£247m (2014 prices and estimate – so say £0.5bn+)	By 2019 but DfT only 'minded to proceed' as of 2016	Increases capacity and facilitates new IEP train introduction
Digital Railway	£500m for first stages	By 2024	Initial stages of digital rail programme
East West Rail	£1bn for first (eastern) stage Oxford–Bletchley	None announced	Anticipated that much of the cost would be met by developers and other non-rail sources
Midlands Connect	Not known	None announced	Better links between Birmingham, Nottingham and Leicester, potentially using part of HS2 Eastern Limb via new junctions.
Crossrail 2	Not known	None announced	Affordability currently being independently reviewed.
Brighton Main Line 2	Not known	None announced	Not a scheme that government is sponsoring at present, includes a possible tunnel from Croydon to Isle of Dogs.

Account must be taken of these projects and programmes, and any risk of undermining existing commitments needs to be avoided. The strategy accordingly needs to take two perspectives: top down/long term and bottom up/extending from existing plans and ideas.

The 2017 budget settlement for the next 5-year planning period (Control Period 6 covering 2019 to 2024) provides £48bn for Network Rail operations, maintenance and renewals, but does not commit funding for specific enhancement schemes, although some have since been announced[8]. The foundations are firmly set in terms of looking after today's network, but not in terms of the short/medium term outlook for enhancements (or even the continuation and completion of projects currently underway). The implication is that when setting a long-term vision as intended here, account must be taken of the likelihood of the specific projects noted in Table 1.1 proceeding, rather than taking them as a given in the traditional style of a 'do minimum' case.

> "The UK desperately needs an infrastructure strategy to address regional inequalities, worsening productivity levels and the housing crisis, but the Government's decision-making process remains short-sighted and major infrastructure projects cost the taxpayer more than they should."

Source: Nick Davies of the Institute for Government, speaking to the Times Newspaper February 6th, 2018

Furthermore, rail is subject to two major inescapable shifts that affect all sectors of the economy[9]:

- Governmental commitments to environmental standards on carbon emission reduction and meeting air quality targets
- The increased availability of digital technologies, which has implications for the wider economy; for behaviour change in travel and social/personal behaviour patterns; and for the design and operation of rail systems.

A strategy also must face budget realities: the national economy as of Spring 2018 is not performing strongly. Growth prospects in travel demand – which have driven much of the rail investment of the last 15–20 years – are softening in South East England/London. But both longer distance and regional rail travel, especially for travel to the larger provincial cities, have continued their pattern of annual growth.

8. For example, funding for the design development stage of a major upgrade to East Croydon station and related track-work on the Brighton Main Line.

9. We do not attempt to develop technical strategies to develop a sector response to these two areas, although they are undoubtedly needed.

In looking for measures that might complement HS2 (which addresses the main north-south national rail network challenges) it would be a mistake simply to assume that equivalent funding (on say an annual basis) might be available. It could be, but only if there is an exceptionally clear case for it, given the other strong calls on public sector capital investment. New build approaches need to be considered only after full consideration has been given to less costly alternatives. But the most important point we want to make is that while planning the next wave of rail capital investment requires far more attention to regionally-set aims, it would be simply wrong to imagine that combined authorities or sub-national transport bodies have the resources to take on the challenge themselves.[10] These are large programmes, and a new funding mechanism is needed. We hope that this report will contribute to that aim being realised alongside greater devolution.

These various reality factors have shaped our approach, and we have crystallised the implications into ten 'smart planning' principles.

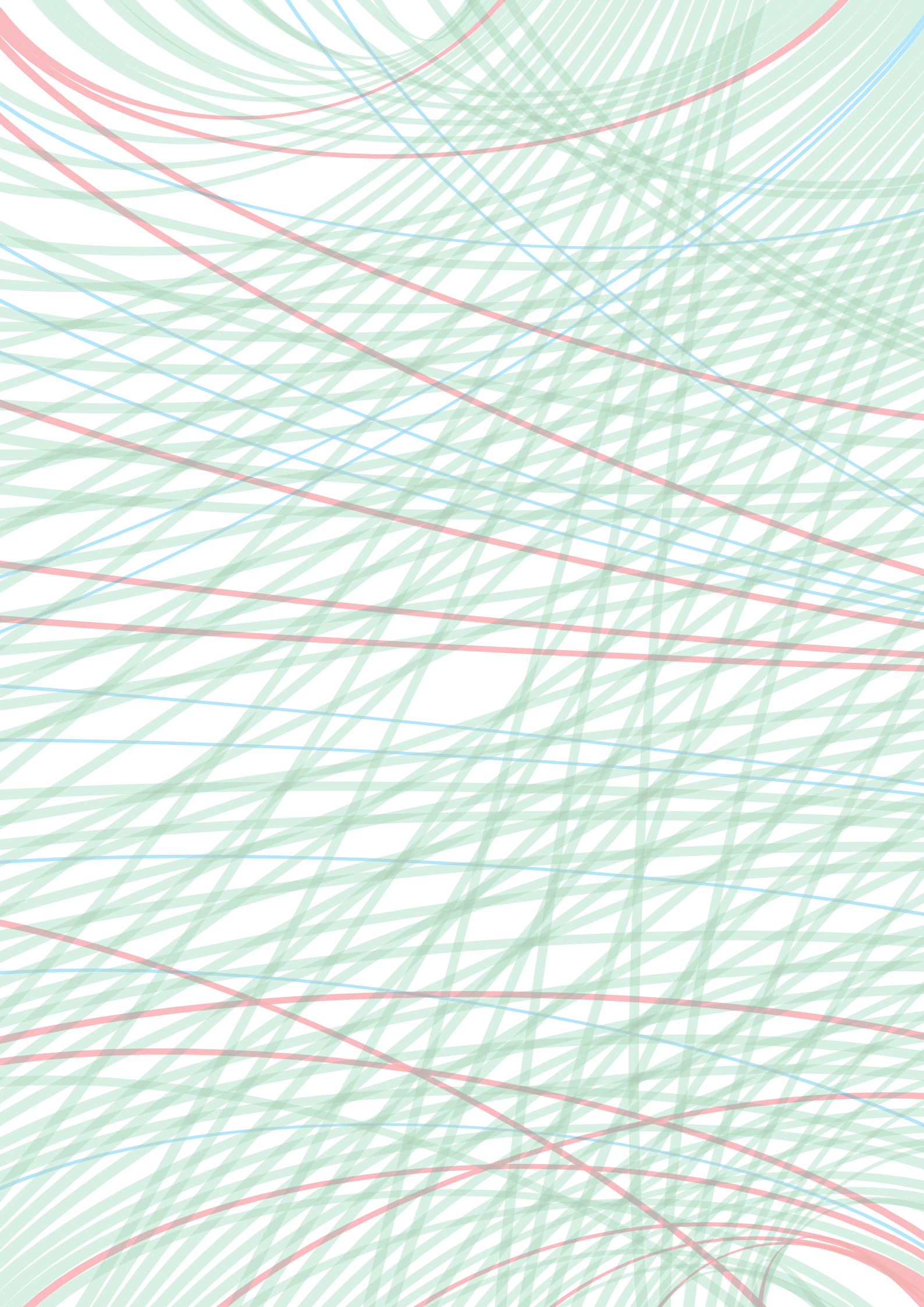
The Ten Smart Planning Principles

1. Multiple strategic aims;
2. Defined objectives;
3. Rail in the context of all travel modes;
4. Thinking about the requirements of customers first;
5. Dual perspectives, working strategically and top-down, from a long-term horizon year and starting from here/now at a route/local level;
6. Budget realism reflected in a management › upgrade › new-build logic sequence;
7. Incorporating digital technology implications;
8. Anticipating (and enhancing the prospects of) a positive economic trajectory;
9. Social equity and environmental responsibilities;
10. The need for flexibility in long term strategy.

Note: these principles are not listed in a rank order of importance; they all apply.

Reflecting the last principle, we developed this report not with an end-state in mind so much as the basis of a blueprint for debate amongst stakeholders and for triggering action that results in a long term national rail strategy. Planning is necessarily an ongoing process, with review and revision a key part of it. This includes keeping under review even the traditional analytical starting points of aims and objectives.

10. *i News*, 'Northerners handed new powers over transport, but lack London's ability to raise capital', 5 April 2018.



2.0 National and regional policies

In this chapter, we start by considering the wider policy aims relevant to developing our Beyond HS2 strategy. We progress through consideration of the key economic and social challenges Britain faces and then look at capacity and connectivity measures to address them.

Defining aims

By aims we mean the identifiable broader policy ambitions set by Government, rather than those which are set, from time to time, specifically, for the rail sector[1].

For Government, strong national economic performance is an over-riding priority. A major concern is continued poor productivity (output/head). With congestion on our transport networks the worst in Europe,[2] even those UK businesses that are world-class and fully invested in their workforce and equipment, suffer from the inefficiencies that it brings.[3]

Unreliable supply chains, with prolonged access to other businesses and customers, and insufficient and limited labour markets are a problem for the workforce and employers alike. Extended and unpredictable journey times (poor service reliability) and a lack of resilience are a characteristic of transport networks acting at capacity, which is the condition of much of the UK's road and rail networks. The result is frustration for users (overcrowded and unreliable trains), and for those charged with maintenance and renewals (restricted times of access for essential works), and is ultimately costly to wider economic performance.

1. Department for Transport, *A strategic vision for rail*, November 2017 (www.gov.uk/dft).
2. National infrastructure Commission, National Infrastructure Assessment (https://www.nic.org.uk/our-work/national-infrastructure-assessment/).
3. *Transport Times*, 'National Road and Rail budgets go their separate ways', 6 November 2017.

For businesses in the rail sector, having a secure forward workstream is important – and has wider economic impacts.[4]

Related to the question of poor productivity is the UK's regional economic disparity[5]; a long-standing problem but one which is not improving. Under-performance of the economies beyond London and the wider south east is endemic. A third of all UK business are located in London and the South East, along with over three quarters of FTSE 100 company headquarters. Bringing the Midlands and the North of England up to the average English performance in terms of Gross Value Added (GVA) per capita would alone be worth an economic boost of £130bn per annum, or 9.5%[6].

As the country approaches Brexit, the question of international connectivity assumes even greater importance. Access to airports, to HS1 and the channel tunnel, and to ports – crucial at any time – remain the subject of an inadequate process around port/airport expansion plans.[7] Brexit emphasises the need for urgency in tackling poor productivity and regional disparities as well.

The wider social and public sector costs of economic under-performance of those parts of the country where, typically, the losses of traditional employment happened some decades ago, are reflected in measures of social mobility, personal health and life expectancy. Alongside the persistent 'north-south' economic divide there is, for example, a persistent 'north-south' divide in life expectancy and healthy life expectancy. Those in southern regions can on average expect to live longer and with fewer years in poor health than those further north. Government objectives are diverse and include social and health improvement as well as those concerning the economy but the linkages between them are seldom drawn out in Government plans. Improving connectivity is often analysed as being solely an 'economic' benefit, but this benefit in turn helps improve these other factors.

As well as helping foster economic regeneration, improved connectivity facilitating out-commuting from 'areas left behind' to neighbouring places (like cities – where jobs are available) is one way by which residents can be tempted to remain, with their income, at least in part contributing to the wider community at home: so much better than moving out and deepening local decay.

4. The UK's infrastructure sector posted a quarterly decline on 1/2/2018 for the first time in five years, largely due to a decline of work on the UK's railways. Figures released by the Civil Engineering Contractors Association (CECA) show that 50% of British infrastructure sectors have reported falling workloads, with the rail industry bringing up the rear.

5. *Economist*, 22 October 2017.

6. Greengauge analysis of Office for National Statistics (ONS) data for 2014 for NUTS-1 regions. Regions considered were East Midlands, West Midlands, North West, Yorkshire and the Humber, and North East and compared to the average for England, after the UK. *Regional Gross Value Added Income Approach*, ONS, December 2015.

7. Greengauge 21, *Response to the National Infrastructure Commission Call for Evidence*, January 2016.

While there may be no easy, short-term solutions to the UK's productivity problems, there is an emerging consensus that "improving infrastructure is key to addressing both the aggregate productivity gap between the UK and other countries, and the wide disparities in economic performance within the UK."[8] Rail has the advantage of offering sustainable, long-term solutions to the productivity conundrum, via the following mechanisms:

- increased rail capacity supports higher density development and enhanced environmental capacity of our major towns and cities: density is key to better-performing agglomeration clusters and in reducing housing market constraints;
- connecting businesses better by rail makes face-to-face deals easier and supports back-office and supply chain efficiencies, allowing regional specialisation;
- better rail access to airports and ports supports the expansion of international trade and exports;
- facilitating wider labour markets for firms to draw on, both through extending feasible commuter catchments and in relieving capacity constraints for existing journeys to work.

It is the development of cities that leads to improved productivity; cities can only grow sustainably if they are provided with an efficient transport system, and rail is the best available means to provide this capability.

Aims reflecting national policy ambitions	Rail sector deliverables (with rail helping reduce car and congested road network dependence)
Higher productivity	Reduced regional economic imbalances
Social equity, including health outcomes	Resurgent international trade in services and manufactures
Carbon reduction and air quality standards	Better connectivity
Greater network and train capacity	Enhanced train service reliability and network resilience
Highest safety standards	Contribution to environmental targets

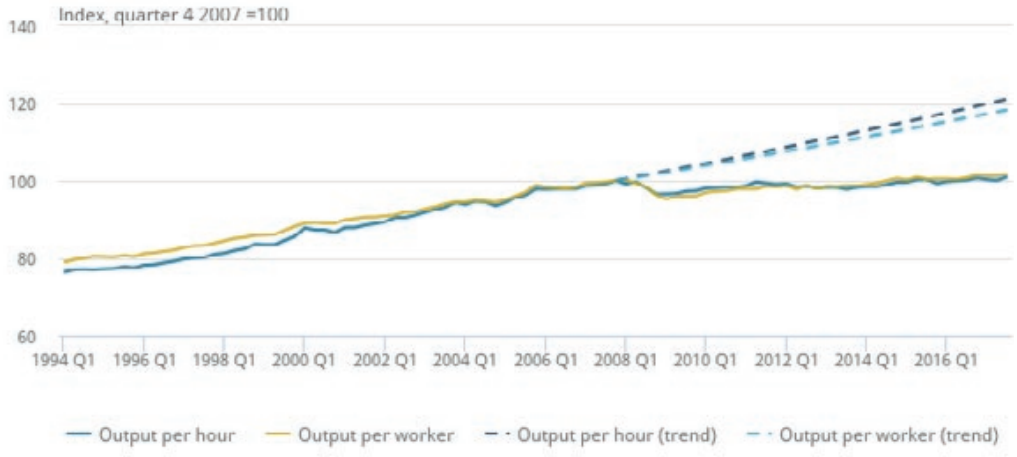
8. London School of Economics, 'Budget 2017: productivity is the focus, but 'fixes' are unlikely to be enough', 24 November 2017 (http://blogs.lse.ac.uk).

Concerns over capacity, connectivity, productivity, regional economic disparities, social inclusion and health inequalities, international trade, carbon reduction and air quality, reliability, resilience and reduced safety risks all drive the need for a long-term rail strategy for Britain. So here we look at these issues in a little more depth.

Productivity and efficiency

The UK suffered from poor productivity relative to other developed countries for many years in the 1970s and 80s. There was some improvement in the 1990s but productivity growth ended abruptly once the financial crisis started. It has been all but flat ever since (see Figure 2.1 below). The reasons for both the fall and its longevity are disputed but many commentators have pointed to low capital investment, including in infrastructure, as significant factors. This sustained period of almost flat productivity growth is one of the main reasons why average earnings have also been flat, leading to concern about whether the economy really is recovering as it should.

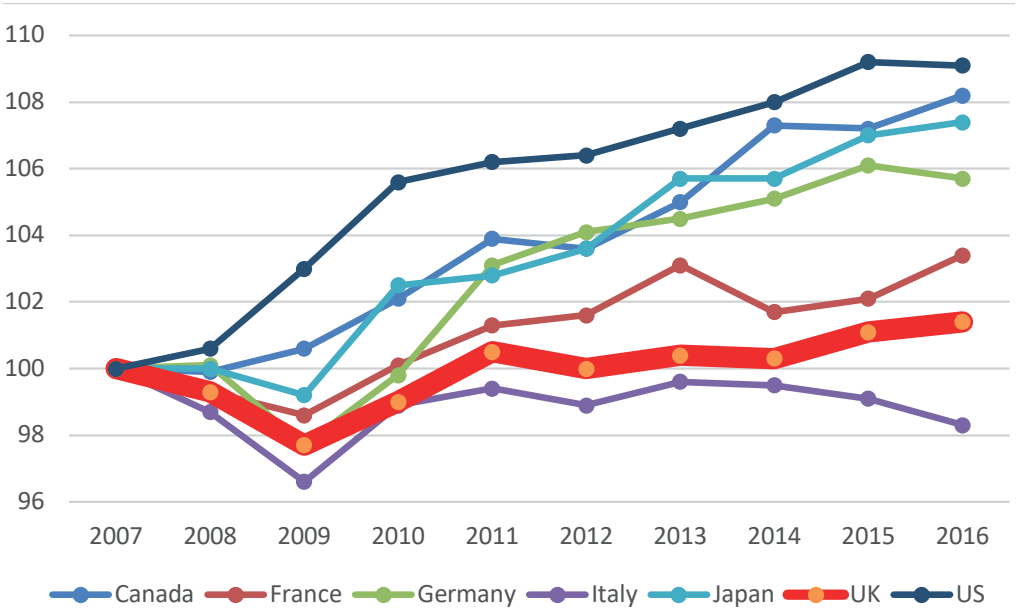
Figure 2.1: **Output per hour and output per worker (seasonally adjusted Q1 1994 to Q3 2017 (UK))**



Source: Office of National Statistics (ONS)

Overall, the UK is under-performing in comparison with the other major nations of the EU, and the USA (as well as the leading economies of SE Asia). UK productivity is around 30% lower than that in France and the US, and 36% less than in Germany. These differences are long-standing, but have widened since the 2008 financial crisis. See Figure 2.2.

Figure 2.2: **International comparison of UK productivity since 2007 (Index 2007 = 100)**



Source: ONS, Chart 4 of October 2016 international comparisons release

The OECD[9] in reviewing the situation in its most recent analysis of the UK economy, says that:

> **"Low transport infrastructure investment outside the south of England may have created bottlenecks, holding back agglomeration effects and associated productivity gains."**

Its recommendation is that the UK should:

> **"champion the recently created strategic planning and delivery agencies for transport infrastructure to achieve a stable and more efficient long-term investment framework. Invest in improving inter- and intra-city transport links where such investments can foster agglomeration effects and unlock related productivity benefits."**[10]

Two further points are of note in the OECD assessment:

1. the OECD attributes transport infrastructure investment weaknesses as holding the UK back on productivity; and

2. while it looks for investment beyond 'the south of England', its emphasis on agglomeration benefits leads it to have a city emphasis.

9. OECD, 'GDP per capita and productivity levels', Productivity statistics (database), September 2017.
10. OECD, *Economic Survey overview UK*, October 2017.

The significance of cities to the UK economy as growth poles that foster knowledge-intensive businesses has been well-documented elsewhere, including in relation to the case for HS2.[11] But cities do not operate in isolation from one another. Inter-city journeys entail use of networks fashioned to accommodate a rich diversity of traffics, including freight flows and local travel. At peak times, the networks are dominated by commuter travel. Achieving the economic stimulus effect that the OECD says is available at an inter-city level, through agglomeration and other productivity benefits, therefore requires – alongside a recognition of the type of journey improvement needed (faster and more reliable city to city services) – careful thinking about the needs and likely trends of those using the transport systems for purposes besides city to city travel, and how they can best be accommodated.

According to the National Infrastructure Commission (NIC)[12], 71% of knowledge jobs are found in cities (which account for just 54% of the population) and it is in the knowledge economy where there is the greatest potential source of jobs.[13] Nearly three quarters of UK's service exports come from cities which is why the National Infrastructure Commission sees connected, liveable city regions as an infrastructure policy priority. Connected here means digitally connected as well as in terms of transport accessibility.

The NIC priority reflects the OECD's advice which, it is worth noting, forms, in effect, advice to Government: its policy prescriptions may be circumscribed by its understanding of how interventionist governments should be.

Certainly, the reasons for the poor UK record on productivity run very much wider than just transport system weaknesses, significant though these are. Low levels of UK productivity – over many decades – are generally attributed to low levels of capital and R&D investment and relatively poor skills levels. These weaknesses are most critical in the private sector.

Even UK industries with world-class productivity standards – such as Rolls Royce – cannot necessarily be judged efficient, because poor connectivity can add costs in the supply chain for these top-level businesses and hamper their competitiveness.[14] There is an economic price to pay for a congested transport network affecting the nation's leading manufacturers as well as the service sector.

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11. DfT, *HS2 Strategic case and supporting reports*, September 2015.

12. The body established by Government to provide advice on longer term national infrastructure needs. A central responsibility of the National Infrastructure Commission is to carry out an overall assessment of the UK's infrastructure requirements once every five years. The first National Infrastructure Assessment will analyse the UK's long-term infrastructure needs, outline a strategic vision to 2050 and set out recommendations to strengthen the nation's infrastructure.

13. NESTA, *Creative Economy Employment in the US, Canada and the UK*, March 2016.

14. Sir John Peace, Chair of the Midlands Engine, pointed out, speaking on Radio 4's Today programme on October 26th, 2017, that it "was important not to mix up productivity with efficiency". Leading Midlands' industries such as Rolls Royce and Jaguar Land Rover had world-class on-site productivity levels, he said, but that didn't make them necessarily efficient, because of poor connectivity in their supply chains.

The UK Government's new Industrial Strategy[15] recognises that there is a need to understand which parts of the national economy are most competitive, and where therefore to focus investment to bolster competitiveness further. The answer differs across the regions.

A progenitor of the kind of place-based approach this might entail can be found in the North's Independent Economic Review (NIER) commissioned by Transport for the North.[16] The essence of the approach adopted in the NIER was to assess which of the industries across the north were globally competitive and to identify (in outline) the type of measures that would support their forward development. In such an endeavour, better connectivity is a factor. But while, for example, digital technology clusters typically arise in cities, other globally competitive sectors in the North tend to be based elsewhere, for example, along the coasts of NW and NE England in the case of innovative energy systems and at the edges of cities in the case of advanced manufacturing. The connectivity challenge arises across a complex geography.

The North is arguably leading the way in this territory having prepared the NIER to inform its thinking on transport strategy and investment priorities. So, the draft Transport Strategy issued by Transport for the North in January 2018[17] identified a set of strategic corridors across a very broadly-defined northern geography, each of which links together an industry cluster. In practice, some of the key businesses involved are poorly inter-connected and some are remote from the research centres on which their productivity and future competitiveness depend. Such analyses are valuable in helping devise enhanced transport networks and services that can support and stimulate the industrial and business sectoral linkages.

Regional productivity imbalances

Recent work at the Centre for Economic Performance (CEP) at the London School for Economics sheds light on the current imbalance in productivity across the UK and how it has changed in recent years. As well as the widely-known variation in performance across the regions of the UK, there is also substantial variation within regions.

15. Department for Business, Energy & Industrial Strategy, Industrial Strategy White Paper.

16. Transport for the North, *Northern Powerhouse Economic Review, Core Messages*, 2016. The Independent Economic Review identified four world-class industrial sectors in the north of England: Advanced Manufacturing; Energy; Health Innovation; Digital. A much earlier effort, illustrative of an era when there was greater belief in the value of data and planning, can be seen in the results of Nuffield College's Social Reconstruction Survey initiated by Government in 1941, published as Prospects of the Industrial Areas of Great Britain, M.P Fogarty, Methuen, July 1944.

17. Transport for the North, *Strategic Transport Plan consultation*, 2018.

The CEP work identifies those locations with a strong record of productivity performance, as reproduced in Figure 2.3. North East Scotland, driven by the oil industry; parts of Greater Manchester and Cheshire; central London and the Thames Valley; and some cities including Edinburgh and Milton Keynes. As the CEP report says:

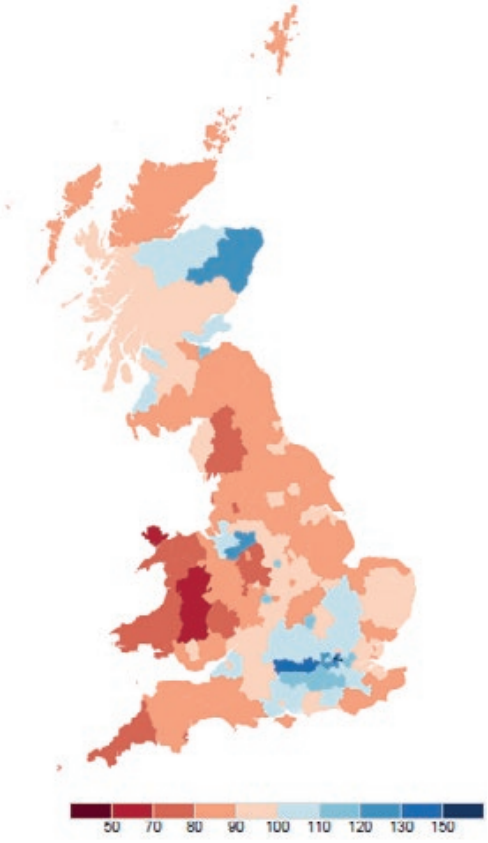
> **"Contrary to popular belief the high productivity of London does not spread into the South East but rather spreads west along the M4 to commuter towns like Reading and Slough. Productivity in London overall is 30 percentage points higher than the UK average, the figure for "Inner London-West" is 45 percentage points and this is the highest productivity sub-region in the UK."**[18]

On the other hand, North/Mid/West Wales, Staffordshire, Herefordshire, much of Cumbria, and the whole of Cornwall have productivity levels at least 20% below the national average, as do places such as Blackpool and Torbay.

Striking too is the correlation between peripherality and low productivity. Even places on the coast with good links to London, in Kent and East Sussex in the South East, only achieve productivity levels between 80 and 90% of the national average, as does virtually the whole of the South West peninsula, the Welsh and Scottish borders, nearly all of the North and the less central parts of the East and West Midlands. Variation in productivity levels appears to be greater within high productivity regions, such as London and the South East, than it is in lower performing regions (see Figure 2.3).

Figure 2.3: **Productivity across Britain**

Relative productivity index: GVA/hour in 2015 where national figure =100 (Source: ONS/ABS)



The need to re-balance the economy has been made repeatedly, and in the context of HS2, very clearly, with the dramatic difference in costs of commercial property in London £110 per square foot as against £28 in the North being seen as a key economic efficiency rationale in 2014.[19] The situation (in 2017, along with office rent trends) is further illustrated in Table 2.1.

18. Centre for Economic Performance, London School of Economics, *Industry In Britain – an atlas*, 2017.
19. HS2 Ltd, *Rebalancing Britain: From HS2 towards a national transport strategy*, 2014.

Table 2.1: Prime Office rents 2017

Location	GB £ SQ.FT YR	EURO € Sq.M YR	US $ SQ.FT YR	Growth % 1 YR	5 YR CAGR
London (City)	67.50	818	91.2	-1.5	4.2
London (West End)	110.00	1,333	148.7	-8.3	1.7
Manchester	33.50	406	45.3	3.1	3.3
Birmingham	33.00	400	44.6	3.1	3.7
Bristol	32.50	394	43.9	14.0	3.4
Leeds	30.00	364	40.6	11.1	4.1
Newcastle	23.50	285	31.8	2.2	3.3
Reading	35.00	424	47.3	0.0	3.1
Cardiff	25.00	303	33.8	0.0	2.6
Edinburgh	33.50	406	45.3	1.5	4.0
Glasgow	29.50	358	39.9	0.0	0.7

Source: Cushman and Wakefield research report on commercial office rents Q4 2017.

Table 2.1 shows that, in 2017, office rentals in Birmingham, Edinburgh and Manchester are typically two thirds cheaper than in the West End of London, and that cities such as Newcastle, Glasgow and Cardiff have rents three quarters cheaper. This wide disparity indicates the premia that companies are prepared to pay to be in London and gain access to its services and labour market, but equally indicates the opportunity in regional centres as their accessibility and attractiveness to the knowledge-intensive workforce increases.

A 2015 analysis by the Centre for Cities of the tax income raised and public expenditure spent in large city regions argued that even the large cities were "punching below their weight" in terms of the taxes (such as VAT, employment taxes and rates) that they raise from economic activity in their area[20]. In Birmingham, Leeds and Manchester the tax raised from these sources is still below the UK average: if it could be raised up to that level, the exchequer would gain by some £9.4bn per annum, equivalent to just under a 2p increase in the level of income tax.

20. Centre for Cities, *Mapping Britain's Public Finances*, July 2015.

A 2017 study by the same organisation unpicked these trends still further and identified that productivity of the largest towns and cities outside the London and South East area was only in line with the national average, and that towns and cities in the London and South East region area are 44% more productive[21]. The location of 'knowledge-based' jobs is a particularly key determinant of this, and the study illustrates the tendency for these jobs to be in the South East, even whilst others employed within the same company are in the regions. For example, wind turbine fabrication and assembly for Siemens takes place in Hull, but the design work is done in Aldershot. One challenge, therefore, is to make regional towns and cities more attractive for knowledge-based staff.

However, the concentration of national income in London and the South East has become ever more marked. A recent analysis by Tony Travers for the National Institute of Economic and Social Research showed that this region's share of national GVA increased from 39% in 1966 to 45% in 2012. Ominously, that accounted for by the North (comprising the North West, North East, Yorkshire and the Humber) fell from 25% to 19% over the same time period.[22]

Left-behind places: the price of globalisation

According to the Economist,[23] "the forces that drive regional disparities are built into the mechanisms of globalisation". This is by no means a uniquely UK phenomenon, and similarities can be drawn, according to the Economist, between areas such as the rust belt towns of NE Pennsylvania (USA), Teesside in Britain and the industrial north of France. But it also adds:

> **"even if globalisation were to stop in its tracks, the regions it has weakened would not magically improve".**

Somewhat harshly, having noted the failure of regional policies of the past as its authors see it, the Economist suggests that:

> **"producers in less fortunate regions either have to up their game, specialise, move or go under".**

21. Centre for Cities, *New analysis shows UK's productivity problem stems from under performance of cities outside Greater South East*, 16 November 2017.

22. Tony Travers, 'Devolving Funding and Taxation in the UK: a Unique Challenge', NIESR Review No. 233, August 2015, Table 2.

23. *The Economist*, October 21st–27th, 2017, p19 *et seq*.

Although here it should be added that some of the problems of the areas 'left behind by globalisation' are attributed by others to weaknesses in domestic policy.[24] It is with the left behind parts of the country where the key employment opportunities have dried up and social mobility is diminished, that the Social Mobility Commission [25](which was set up by the Cameron government in 2010) has greatest concerns. The focus of the Commission is particularly on local areas of decline: even very prosperous cities and towns have some areas within them that are falling behind. The places of greatest concern are not just the one-time major industrial areas of the North and the Midlands – although these places have the lowest household income levels (see Table 2.2), but deep rural areas and coastal towns too.

Table 2.2: **Examples of low income places (England, Household Income per Capita)**

Local Authority (NUTS 3 Area)	Gross Domestic Household Income (GDHI) per capita in 2015 (£)
Wolverhampton	14,194
Walsall	14,186
Birmingham*	14,053
Stoke on Trent	13,804
Hull	13,642
Sandwell	13,408
Manchester*	13,307
Blackburn	13,033
Leicester	12,877
Nottingham	12,779
UK Average	19,106

Notes: *These NUTS 3 areas refer to the City in question, not the wider built-up area. GDHI is defined as the income received by those that live, as opposed to work, in each area.

Source: ONS, NUTS 3 Regional GDHI, May 2015.

With no jobs locally – at least at good pay levels – what follows is a hollowing out process that the Social Mobility Commission addresses. The labour market of left-behind places, instead of having close business rivals acting competitively, creating employment choices and driving up earnings (the agglomeration model that works for successful cities), has local employers joining a race to the bottom, there being no need or reason to offer more than the bare minimum wage. It's a local labour market in reality.[26]

24. See example at the Joseph Rowntree Foundation, *The most deprived areas have borne the brunt of local government budget cuts*, 11 March 2015.

25. Social Mobility Commission, *Social mobility in Great Britain: fifth state of the nation report*, 2017.

26. Jim Steer, 'The End of the Line', *Transport Times*, December 2017

As Social Mobility Commission Chairman Alan Milburn explained before resigning his post, there are three essential investments that must be made to turn around such places: investment in education, in employment and in transport. Better transport is needed to overcome the need to re-locate. Connectivity to areas of prosperity and a greater range of opportunities – often cities – may entail a lengthy commute, but at least earnings can then be brought home to be spent in the community.

Work is currently in hand to determine how the HM Treasury's Green Book, which defines Government's investment appraisal approaches, should be expanded to treat the need for greater social mobility explicitly: it will not be before time.

Congestion and capacity

Unreliable supply chains, with prolonged access to other businesses and customers, and insufficient and limited labour markets are a problem for the workforce and employers alike. Extended and unpredictable journey times are a characteristic of transport networks acting at capacity; the condition of much of the UK's road and rail networks.

This is why the National Infrastructure Commission (NIC) identifies capacity – as well as connectivity – as a challenge to be faced. Recognising the exciting developments in electrically-powered vehicles and in connected autonomous vehicle technology, the draft National Infrastructure Assessment of October 2017 found that while:

> **"new vehicles will be cleaner and safer, they will not solve the congestion problem. In fact, if driving is cheaper and more attractive, the report suggests they may make it worse".**[27]

Traffic congestion, it points out, is increasing, particularly in and around major cities. Is this a factor affecting economic performance? Well, the European Commission reported in 2012 that out of 20 European countries, the annual cost of traffic congestion was highest in the UK, so congestion levels may well be a key factor affecting relative national productivity levels.

Some may argue that building more road capacity is the solution to this problem, but this has not been Government policy for several decades (because of the wider adverse consequences – not to say impossibility – of trying to keep up with road demand growth in a small, cherished and intensively developed country). The highways capital programme has been increased in recent years but this is mainly directed towards enhancing existing roads, not building new ones. Former NIC Chairman Lord Adonis, writing the foreword to the draft National Infrastructure Assessment concluded a balance is needed:

27. National Infrastructure Commission, 'Congestion, Capacity, Carbon: Priorities for National Infrastructure' – speech by Lord Adonis, 2017.

> **"HS2 will treble rail capacity between the major conurbations of London, the Midlands and the North, but extra capacity is required to overcome bottlenecks on railways, motorways and inter-urban roads."**[28]

Yet the draft National Infrastructure Assessment may be lagging public opinion, which places investment in rail as the highest priority, ahead even of housebuilding, according to an October 2017 Ipsos-Mori poll.[29] Congestion isn't the only issue shaping public awareness and opinion: carbon emissions, air quality impacts and noise are critical environmental factors; safety is another; and there are social issues too: not everyone has access to a car, and the stress and unpredictability of car commuting is a factor affecting personal well-being.[30] For younger people living in major cities, at least, car ownership has not followed the historical linkage with income:[31] it is no longer a default life-style choice, and car manufacturers are distinctly worried, particularly those with investment in diesel plant.

In terms of Government and national policy, the target of greater productivity would be helped by reducing the inefficiencies in supply chains and labour markets brought about by travel in congested conditions. There are two specific aspects of the challenge identified in the draft National Infrastructure Assessment to which this *Beyond HS2* strategy can contribute:

- Improved connectivity between cities/city regions;
- Identifying the extra capacity that is required to overcome bottlenecks on the rail network.

More generally, government is seeking to rebalance the national economy and part of that aim involves improving connectivity and hence lower transport costs for those parts of the UK that are struggling.

Connectivity

We will consider connectivity under four headings:

(i) With London;
(ii) With international gateways;
(iii) Regional connectivity;
(iv) Connecting remote and left-behind areas.

28. *Ibid* p145.
29. Ipsos Mori, *Rail joins housing as top infrastructure priorities for Britons*, 25 October 2017.
30. *Psychology Today*, 'Commuting: "The Stress That Doesn't Pay"', 2017.
31. Greengauge 21, *Rail in the North: Stepping Stones to a rebalanced Britain*, November 2014.

With London

Good transport connectivity with London is a necessary but insufficient condition to foster economic development.

For remoter parts of Britain, one challenge is to provide dependable within-the-day travel to the capital and back for a meeting. Of course, in the high-productivity zone in London and along the Thames Valley close to Heathrow, as well as across the Oxford – Milton Keynes – Cambridge advanced research arc, the idea of needing to allocate a day to hold a meeting would be considered generous – wasteful even. The advantage of business clusters is that they allow rapid and ad hoc meetings to take place – the agglomeration effect noticed at Kings Cross after HS1 was completed at the adjoining St. Pancras station. The need for rapid turnrounds and delivery in modern business life is ever more noticeable: today working days are divided into half hour time slots rather than half days.

Connectivity matters and London is especially significant across the nation because of the high level of centralisation of Government; the location of the nation's major financial centre; the concentration of multi-national HQ offices (many of which cluster around Heathrow Airport in the Thames Valley rather than London); the capital's leading universities and hospitals and concentration of cultural attractions and national heritage; and the dominance of its international gateways too (Heathrow, Gatwick and Stansted airports; the Eurostar terminus at St Pancras). London's economic dominance is increasing: its share of national GVA increased from 15% (1976) to 19% (1997) and 23% by 2015.

So, it is unsurprising that there is an ever-sharper decline in economic activity and business start-ups as distance (and time) from London increases, as Greengauge 21 found from a literature review carried out in a study for the Great Western Partnership.[32] Beyond a two-hour London journey time, there is an observable fall-off in business activity and productivity. Along the length of the South West region, the further from London, the worse the economic outcomes.[33]

The effects of location on economic potential across Europe were used to assist the EU in setting the framework for structural (regional) funding (which benefitted remoter parts of Britain as well as other parts of the EU member states). It is not yet clear what the post-Brexit intention is with regard to such funding.

32. Greengauge 21, *A 25-year investment programme for the Great Western Main Line*, 2 July 2012.

33. Parsons Brinckerhoff, *Productivity and Wider Economic Impact Study – Peninsula Rail Task Force*, April 2015

Connectivity to international gateways

The configuration of the national rail network is such that London is also central to the question of international connectivity. The UK's international hub airport at Heathrow is (as yet) connected by rail only to London, so international travel from the rest of Britain generally tends to involve road-based and (from remoter locations) air travel modes to reach Heathrow because of the complexity of rail access trips. Stansted and Luton airports are slightly better connected, with longer distance direct rail links from the Midlands as well as London, but typically with only hourly connections and to a limited set of destinations. Gatwick has lost its longer distance, cross country rail services. The terminus for Eurostar services is at St Pancras, Central London, with no European services via HS1 and the channel tunnel extending any further in Britain, notwithstanding policy commitments made when the Channel Tunnel was approved.

Poor connectivity to Heathrow (and Eurostar services at St Pancras) is therefore a further factor disadvantaging businesses located beyond London and its immediate catchment.

Developing air services at regional airports is one possible response. Attracting air services that have a wider economic value (that is, beyond meeting the needs of the holiday market) depends in part on the catchment of the airport in question. Recent work for the Manchester China Forum about the impact of Manchester Airport's new direct flights to China suggests that securing further direct links to China and other key markets should sit at the heart of strategies to grow the North West economy.[34] The study also concludes that large-scale investment in projects like Northern Powerhouse Rail can be used to help attract other new air services.

International connectivity for freight is dominated by ports (but air travel is also important for low bulk/high value goods, and again Heathrow Airport dominates, accounting for the majority of the UK's freight shipments by air). Rail links to the key container ports – also heavily concentrated in the South-East in proximity to the major international shipping lanes through the English Channel – are all experiencing capacity limitations, resulting in increased road haulage that could be reduced if the rail network could accommodate more and better freight paths.

Regional connectivity

The overall aim, as expressed by the NIC, is to ensure connectivity features in plans for the nation's cities. To create energy and enthusiasm for inward investment and indigenous growth, access to markets and catchments across the nation – and not just London – is essential. Yet regional rail connections are often dismally slow (so Leeds-Birmingham takes the same time by train as Leeds-London, for example, despite the deployment of 125 mile/h train fleets on both routes).

34. *The China Dividend One Year In*. Study for Manchester China Forum, November 2017.

The value of enhanced connectivity that high-speed rail brings is recognised by city authorities across the regions and devolved nations. The Core Cities[35] believe that:

> **"increasing capacity on the rail network is critical to our economic future and we cannot go on relying on our Victorian network of routes alone… high speed rail is the best way to achieve a more sustainable, rebalanced economic future for the nation … reshaping the national economy… helping businesses to thrive in and around our major urban centres."**[36]

It was Sir David Higgins, in his role as Chairman of HS2 Ltd, who in 2014 identified the need to consider east-west connectivity improvements too, alongside the north-south improvements that HS2 will bring.[37] This prompted the North's city leaders to come together and identify complementary pan-Northern connectivity developments[38]. It has been quite common to hear it argued that these improvements between the cities of the North are even more important than HS2 itself, and should be prioritised.[39] This view reflects, no doubt, the poor state of east-west connectivity, with low speeds and low service frequencies on most routes, and the ambition in the Northern Powerhouse to harness the strengths of the North's major city economies together – in effect seeking to create the agglomeration economic benefits that London enjoys on its own. Similar ambitions emerged from the Midlands Engine, and as discussed in Chapter 6, these and the aims of other regions have become much more focused over the last 2–3 years, in seeking to establish a wider economic rationale for rail investment, rather than relying on a narrower transport user benefit type of analysis.

Yet the connectivity needs of Britain's main cities are both more extensive and more complex than a combination of what is achievable from a north-south spine route and better east-west connections. The nation's cities don't lie on a convenient single axis or grid, and connectivity needs run NE-SW and NW-SE too. The suburbs and surrounding centres of the major regional centres need to be better connected to their centres as well. And it is important that cities such as Edinburgh, Dundee and Aberdeen in Scotland, Swansea in Wales, and Leicester, Bradford, Sunderland, Norwich, Cambridge and Southampton in England, for example, none of which are members of the Core City Group, are not overlooked. All this means that it is not possible to develop a single quantified connectivity target for application across the range of measures and across all locations that we will be considering in this national rail strategy.

35. The 'Core Cities Group' comprises Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield; see (https://www.corecities.com/cities/cities).
36. Core Cities, *In support of HS2*, 2016.
37. DfT , *HS2 Plus*, March 2014.
38. Manchester, Liverpool, Leeds, Sheffield, Newcastle and Hull City Councils, *One North*, July 2014.
39. See for instance, Tatton MP Ester McVey in *Winsford Guardian*, 6 November, 2017.

Connecting remote and left-behind areas

The observable trend towards the clustering of businesses together around a core attraction (for instance, the research-based hot-spot of Cambridge) can be contrasted with the continuing sense of loss experienced by places where the primary local industry has long-closed, leaving behind disheartened and damaged communities.

The mining villages of the North, Midlands, Scotland and Wales; one-time steelworks or ship-building or clothing manufacturing or other specialist industry towns or the very extensive string of seaside towns whose well-being was based on the fishing industry and domestic holiday patterns that have long been replaced, come to mind. Rural areas too struggle to sustain communities as year-round employment in agriculture declines.

These are places that mainly suffered rail closures many decades ago. But there are continuing effects on local economies as new technology and automation reduces the number of jobs remaining for low skilled and semi-skilled workers. Higher skilled employment in local services has moved to larger towns and cities too, most recently in the shape of bank branch closures. Now is a time of major – and fundamental – change in the way the economy works and it is having far-reaching impacts on labour markets.

It is not just deep rural areas that can be remote from regional centres. It can take well over three hours to travel by train within the same region – from significant towns such as Whitehaven on the Cumbrian Coast to Manchester in the North West, or from Whitby to Leeds in Yorkshire, or from Newquay to Bristol in the South West, for example.

In other cases, run-down former industrial villages and towns can be located close to relatively thriving commercial centres – as the Social Mobility Commission has pointed out. It would be wrong to suggest that for such places it is physical remoteness alone that has caused the problem or that transport initiatives alone would necessarily help. But there are places, including coastal towns, where little thought has been given to connectivity improvements, the relatively low overall and seasonal and weekend levels of demand being a negative factor.

But then measures of regional disparity and of peripherality are not straight-forward. As a study of Wales and its regions by Martin Boddy and colleagues at the University of the West of England found[40], peripherality has many impacts: on access to markets, suppliers, people and skills; on information and access to agglomeration economies which benefit from scale; on specialist suppliers and services, larger pools of skills, supportive institutions and networks; on knowledge spill-overs and non-market forms of collaboration fostered by face to face contact.

40. See Boddy, M., Plumridge, A. and Webber, D. *Productivity in Wales: analysis of the impacts of peripherality on spatial patterns of productivity*, Welsh Assembly Government, 2010.

It is the combination of these effects which mean that (to stay with the Welsh context) – locations such as Cardiff and the industrial cluster on the North Wales/England border near Chester which are not peripheral, prosper and grow, while the economies of much of the rest of Wales which is geographically peripheral, and with poor connectivity, suffer as a consequence.

The right response is not to seek uniformity and a 'levelling' of accessibility across Britain. A recent year-long study by the British Academy demonstrated that national policy is largely 'place-blind', treating everywhere as if it were the same and imposing blanket solutions, top down[41] and that's not the right approach either. Instead what is needed is stronger empowerment (devolution) and trust in local communities, regional agencies and devolved governments. What this ***Beyond HS2*** strategy can contribute is to highlight the kind of (affordable) measures that might be available to them and would work for Britain as a whole.

41. British Academy, *Where we live now*, 2017.

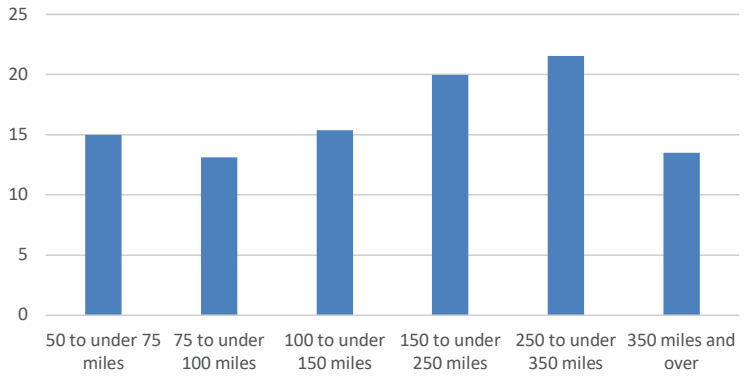
3.0 Market trends and passenger requirements

In this chapter we look at recent rail market trends and factors that will influence market demand in future. We also consider the pros and cons of inter-changing at hubs versus through journeys as well as clock-face timetabling ('taktfahrplan' on the Swiss railway network) before providing a perspective on rail customer requirements now and in future. First, we start with recent market trends.

Recent rail market trends

Rail accounts for just 3% of all travel journeys[1] but a much higher proportion of total distance travelled, 10%[2]. For longer distance trips (over 50 miles) the share by rail increases to 16%[3] (see Figure 3.1 for a breakdown by distance band). Five per cent of the population use rail very frequently (3 times per week or more) and 59% classify themselves as rail users – a figure that has grown from 48% in 2003[4].

Figure 3.1: **Rail Mode share as a function of journey length**



Source: National Travel Survey 2016.

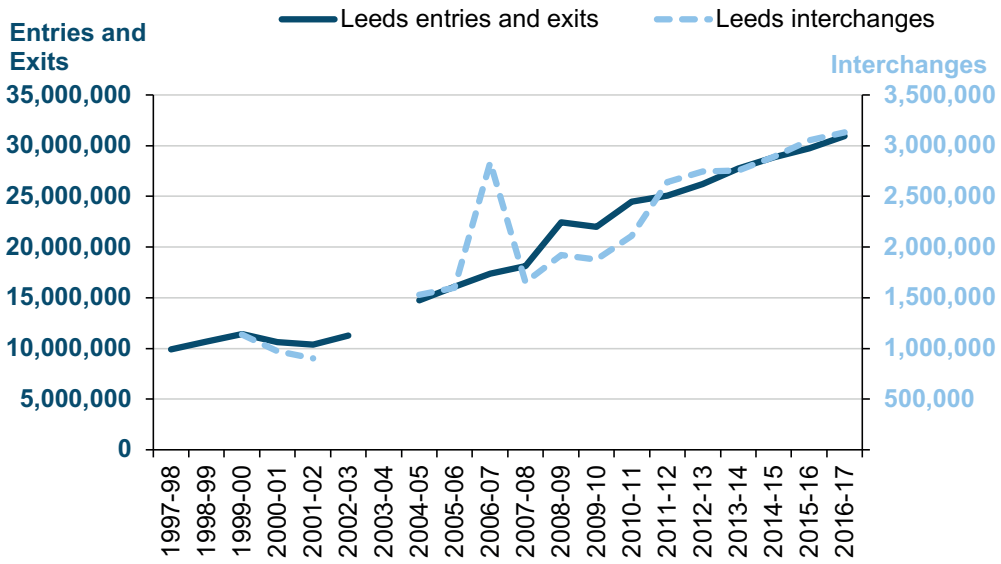
1. National Travel Survey 2016 (Table NTS0301). Note this is travel in Great Britain by English residents only and includes travel by Underground.
2. *Ibid* Table NTS0302.
3. *Ibid* Table NTS0317.
4. *Ibid* Table NTS0313.

Rail-based commuting accounts for 12% of all mechanised journeys-to-work[5] and 21% of distance travelled whilst commuting[6]. For business travel, national rail accounts for 18% of all business miles travelled[7]. Rail plays a much more significant role, therefore, for those journeys of economic importance than the headline share of all journeys would otherwise suggest.

As set out in the previous chapter, it is travel to and within (economy driving) cities where rail plays its most important role. In the capital, 45% of those commuting to central London in the morning peak arrive by rail, but more like 90% when tube is added to rail, compared with just 5% by car[8].

For a number of larger cities outside London, rail growth has also been very significant: Figure 3.2 uses ORR data for Leeds to illustrate this. Rail has been able to accommodate growth in city centre employment in the service sector as local economies have rebalanced and peak road-space and parking has been constrained. The result is that Leeds has seen very much larger rail growth than the national average.

Figure 3.2: **Analysis of Leeds station usage 1997-2016**



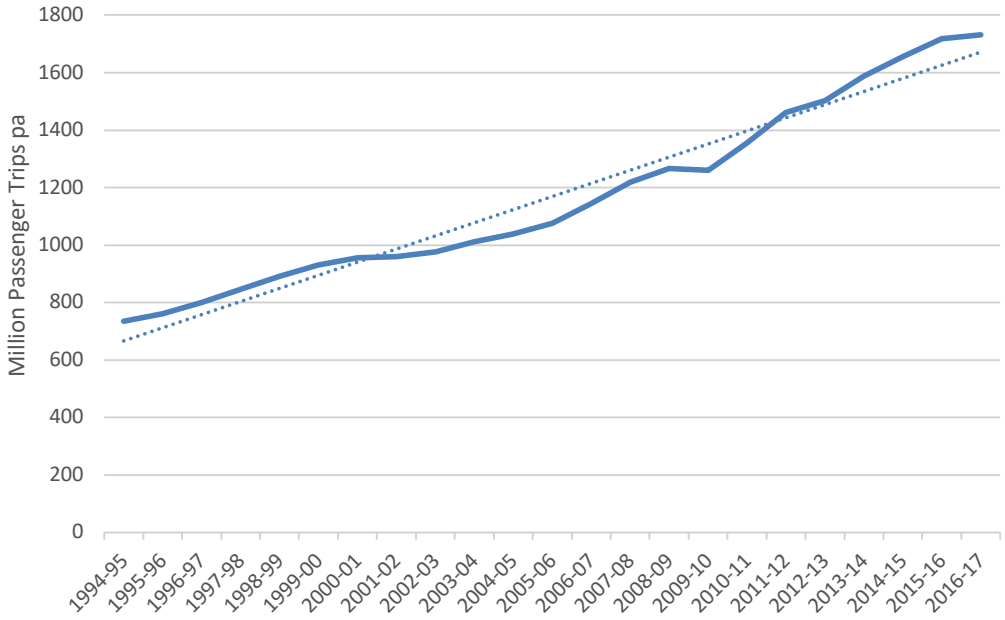
Source: Greengauge 21 analysis of ORR data.

5. *Ibid* Table NTS0409. Main mode of travel.
6. *Ibid* Table NTS0410.
7. *Ibid*.
8. Transport for London, *Travel in London* 10, p238, 2017.

Nevertheless, the North as a whole currently has a modal share for rail for commuting of just 3.4%, defined both in terms of residence and workplace. This is comparable with the rest of England outside of London and the South East, and masks the much higher rail modal share for journeys to the North's major urban centres (and an even lower market share elsewhere). It also indicates that, overall, a relatively small proportion of the North's population use rail to commute, and that there is significant scope for rail to continue to increase its share of the market as the North's economy grows[9].

Rail patronage nationally reached 1.73 billion passenger journeys in 2016/17[10]. The long term growth trend has been consistently strong since privatisation – on average 4% per annum – and this is demonstrated in Figure 3.3, which also shows whilst the growth rate may have moderated in the last full year of data, passenger demand remains above the medium-term trend. There have been dips in the growth pattern before, and it is too early to say whether this is a short-term phenomenon or a turning point.

Figure 3.3: **Passenger trips (solid blue line) against trend growth (dotted blue line)**

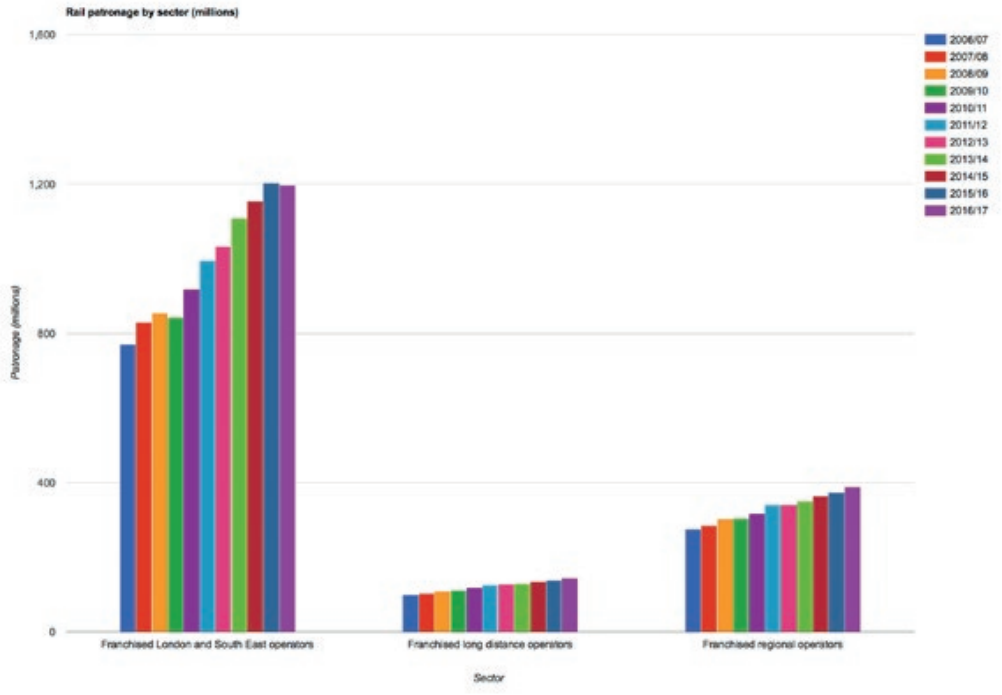


Source: ORR[11]

9. Transport for the North, *Long Term Rail Strategy*, 2018.
10. See Urban Transport Group.
11. Demand on franchised and open access operator services.

Figure 3.4 illustrates the extent of growth across different sectors of the rail market in the last 10 years.

Figure 3.4: **Passenger rail journeys by principal sector 2007–2016**



Source: Urban Transport Group (ORR data).

In London and the South East, growth of passenger journeys on national rail services averaged 5% per annum for the period 2000-01 to 2016-17, a total growth of 80%[12]. However, most recently, as the graph above shows, there has been a stalling in growth, reflecting in part the closure of London Bridge for major improvement works as well as difficulties of service delivery and quality, particularly on the largest franchise Thameslink/Southern. Growth in working from home on some days, compressed hours, as well as in part-time working is also thought to be playing an increasing role: the network is noticeably quieter on Fridays, for example. These trends have continued into 2017–18, with an overall decline in rail usage of 0.4% in Quarter 2 compared with a year previous[13], although this masks continuing growth in the Long Distance (+1.1%) and Regional (+2%) sectors.

12. Urban Transport Group, *op.cit*, p51. This measures growth in patronage in the London and South East Train Operating Companies, as defined by the ORR.

13. This decline is at least partly explained by a reduction in season ticket purchases on the London and South East franchises, which may reflect both the closure of London Waterloo for 3 weeks during August 2017 and the extension of pay-as-you-go Oyster/Debit card travel within the wider London area. South West Railway journeys declined by 9.5% during this period. See Office of Rail and Road, *Passenger Rail Usage 2017–18 Q2 Statistical Release*.

Earlier research[14] had shown that the fastest growth in rail travel is for non-commuting business purposes (which rose by nearly 170% between 1995/7 and 2005/7). As a result of sustained rail demand growth in the North and other regions, the proportion of all national rail journeys that are to/from or within London was down, from 63% in 1995/7 to 57% in 2005/7.

Rail usage has also been growing despite the divergence in rail fares from the costs of motoring, with fares growing by 48.7% in the last ten years and motoring costs by 29.5% over the same period[15].

Trends of travel for young people merit further observation. A recent research study[16] has demonstrated that whilst total travel for those between 17 and 29 has declined, reflecting a significant trend towards less and later full driving license acquisition, public transport use has continued to grow. Between 1995/97 and 2012, rail mode share for all trips undertaken by those aged 21–29 grew from 3.3% to 6.1% (+85%)[17]. There is evidence from this research that it is long-term lifestyle trends[18] that are helping to drive this shift in travel behaviour and that, in relation to reduced driving, it continues beyond youth in a 'persistent cohort' effect[19].

Rail market demand in the future

The government assumes that long distance rail demand will grow in future at 2% per annum. As can be seen from the previous analysis this appears to be a conservative forecast when compared with the long term trends of the last two decades. For project appraisal purposes, the government also goes on to assume that growth will be capped in 20 years' time (from a 2016 base) in 2036, a further conservative assumption that comes into play just three years after the full Y shaped HS2 network is planned to be completed. There is no evidence that long-distance travel will stop growing in the mid-2030s,[20] and this assumption places an arbitrary cap on growth in perpetuity, no doubt in a belief that it addresses the inevitable uncertainty in all forecasting.

Demand forecasting of course needs to reflect uncertainties and be an open and transparent process – as the Commission on Transport Demand concluded in its report of May 2018. But these uncertainties should not stop longer term planning, but add emphasis to the need for ongoing plan review processes.

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14. RAC Foundation, *On the Move: Making sense of car and train travel trends in Britain*, 2012.

15. RAC Foundation, *Cost of Transport Index*, 2018.

16. Chatterjee, K., Goodwin, P., Schwanen, T., Clark, B., Jain, J., Melia, S., Middleton, J., Plyushteva, A., Ricci, M., Santos, G. and Stokes, G. (2018). *Young People's Travel – What's Changed and Why? Review and Analysis*. Report to Department for Transport, UWE Bristol.

17. Urban Transport Group, *op.cit*, Table 1 p4.

18. Factors identified as significant include online social and economic interaction; increased urbanisation and precarity in home ownership and employment patterns; and, reduction in status of owning a car.

19. Stokes, G. (2013) The prospects for future levels of car access and use. Transport Reviews, 33(3), 360–375.

20. This hyper-cautious assumption has recently been modified by DfT, so that, where capacity is available, it is permitted to assume a continuation of growth post-2036 but only at the same level as projected population growth, which is, of course, lower than the pre-2036 demand growth rate of 2% pa.

In the real world, there will be a number of influences on future rail market demand, some at a macro level, some subject to more localised considerations, and some subject to behavioural and cultural change.

Significant influences will include the rate of economic growth, which itself is influenced by infrastructure investment, and also the rate of population growth.

Where new jobs and housing are located will also be important: there is a spatial factor. Evidence suggests that the focus for new jobs will be in and around the centres of our major towns and cities. The Northern Independent Economic Review, for example, concluded that growth in the North's 'prime' and 'enabling' economic capabilities will support growth in other sectors of the economy and that the jobs in these various sectors will largely be located in towns and cities and especially city centres[21]. Town and city centres are well placed to be served by rail.

As part of the commitment to increase housing supply, the government is promoting housing and mixed used development around railway stations in England. In 2016 alongside launching pilots in York, Taunton and Swindon, Government called for 20 councils to set out ambitious proposals for taking forward development opportunities around stations, and offered assistance from Network Rail and the Homes and Communities Agency. By contrast less well focussed and more dispersed development would be less conducive to growth in rail market demand.

As a step towards better understanding the spatial dimensions of growth across England, the Royal Town Planning Institute mapped the location of recent planning permissions across 12 English city-regions, representing over 165,000 housing units, and then analysed them by scale and proximity to major employment clusters and railway stations. They found just 13% of these housing units were located within walking distance (800m) of a rail, light rail or metro station[22] – a position that clearly needs to improve.

A recent response by the RTPI to the draft National Planning Policy Framework consultation is helpful on this point. It calls for "An objective for existing and proposed transport infrastructure should be to deliver sustainable settlement patterns by informing the scale, location, density and accessibility of development. This reflects the fact that transport is more than an infrastructure input to new development, but rather a significant driver of changing settlement patterns, economic activity and social interaction." [emphasis added].

21. *The Northern Powerhouse Independent Economic Review, Final Executive Summary Report*, June 2016.
22. RTPI and Bilfinger GVA, *The location of development*, 2016.

Technological change and ways of staying in touch – face to face or digitally – may also have a long-term influence on rail demand, but evidence to date suggests that the advent of mobile phones and now smart phones, video conferencing, and social media have proliferated the means of contact rather than replaced the need for face to face contact as some suggest. In short, rail demand has grown alongside the digital communications revolution. Rail use and mobile communications are fellow travellers more than they are alternatives. And as previously noted, behavioural and cultural change is seeing a significant trend towards less and later full driving licence acquisition and long-term lifestyle trends that are driving a shift in travel behaviour from car to public transport.

There are several variables within the influence of rail planners and operators that are known to influence the level of passenger demand. One of these – the effect of changing the time spent in each leg of a journey – has been very well researched over the years, and is of importance to HS2. The huge uplift in demand from the introduction of Pendolinos in 2004-9, with journey time reductions of 15-20%, in the same west coast corridor that HS2 will be open in 2026/7, is a valuable and reassuring precedent. Another variable has a bearing both on how HS2 services are specified and on the way the wider rail network is developed: this is the effect of whether or not a rail journey requires a train-train transfer or interchange.

Interchanging vs through journeys

It is important to consider the question of rail market reaction to the need to interchange. When it comes to considering HS2 train services from 2026 onwards, there may be choices (as we shall see) between providing connecting services to HS2, typically accessible through new or improved passenger interchanges at hub stations, and providing direct HS2 services extending over the existing rail network. There is a whole body of research evidence on how passengers respond to interchanging, and the future demand forecasts produced for HS2 will no doubt have used parameters that reflect this body of knowledge.

Evidence on these matters is based on rail customer research collated over several decades. This work shows that there is a perceived penalty associated with interchanging that adds to the passenger's apparent journey length. This penalty is known to vary by a host of factors. Regular commuters are less troubled by a need to interchange than those making longer distance and less frequent journeys. Journeys to airports involving interchanges, for example, might add a perception of a further 5-10 minutes (on top of the actual amount of time spent at the interchange) and likewise any journey where travellers have heavy baggage with them.

Over the years customer research has suggested a wide range of interchange time penalties as a function of travel distance: as low as a 10-minute penalty on top of the time actually spent travelling on the train and waiting at stations for short journeys, and over an hour on longer journeys: an interchange penalty on a 100-mile trip might be around 30 minutes.

The significance of this factor was borne out by studies in the West Country. Comparison of station usage and their population catchments in the West Country suggest that demand levels increase roughly threefold with the provision of a direct through service to London.[23] And open access service providers along the East Coast Main Line provide further evidence of this effect, having managed to pass the Regulator's 'not primarily abstractive' test by demonstrating that providing through London services generates significant levels of new business.

Insofar as HS2 is used to create not only much faster linkages between the nation's major cities, but also release existing line capacity to allow secondary centres to gain direct London train services, it will be especially effective in helping to re-balance national connectivity advantages.

But this evidence also suggests caution needs to be exercised in a train service planning approach that relies more extensively on passengers interchanging via hubs for longer distance travel. If a through train remains available, existing passenger behavioural research suggests many would prefer a slower journey that avoids a need to interchange. Against this, the perceived penalty for transferring between trains reflects current experiences, including expectations of only moderate service punctuality. On this score, HS2 is expected to bring a marked improvement, just as has happened with the high-speed commuter service on HS1, so it may be that passenger interchange with HS2 will be viewed more favourably than on today's railway.

It is also the case that many journeys, say from a suburb of one city region to the city centre of another or from a market town off the main intercity network to London, more often than not already involve an interchange. In a number of countries across Europe, rail timetables are designed with higher levels of passenger interchange as a core travel feature than is currently the case in Britain. Interchanges are a key feature of several European rail networks: the German ICE network is designed to connect cross-platform at places such as Frankfurt Airport, Hannover, Fulda and Mannheim; the Dutch intercity network relies on connections at major places such as Utrecht, Rotterdam and Eindhoven; and the equivalent Swiss network has connections at Zurich, Bern and Lausanne, all again mostly cross-platform. This approach mitigates customers' perceived interchange penalties: the ability to rely on making a connection and for the connection to be on the same platform are important factors.

23. Greengauge 21, *Rural Reconnections*, 2015.

Regular interval timetables

A common concern about the UK rail network is that it is not well co-ordinated: connecting services are often timetabled with significant gaps; when trains are late, connections are not necessarily held (and missed connections can be hourly or longer, especially in the evening) and, in addition, bus and coach services are seldom planned in conjunction with train services.

Timetabling in Britain is often dictated by fitting more services into an increasingly congested network, rather than with customer convenience to the fore. Arguably this has also been exacerbated by putting train services in the hands of competing train operators working within a regulatory (and competitive) structure that promotes competition and creates the risk of legal sanctions if train operators attempt to coordinate with each other.

In addition, there is no clear national hierarchy of services as in other European countries. For example, in Germany the service structure distinguishes between:

- Intercity/Eurocity services (ICE/IC/EC trains), which provide the main limited stop network on core national and international routes, are all operated by DB and receive no subsidies;
- Regional services (RE/IRE) which miss some stops and are subsidised;
- Local services (RB/S-Bahn), which generally stop at all stations and are also subsidised.

And Switzerland has a similar hierarchy:

- Intercity/Eurocity (IC/EC/RJ/ICE)
- Interregio (IR)
- RegioExpress (RE)
- Local and stopping services (R/S Bahn/RER).

The Swiss Railways' Taktfahrplan

The best known regular interval timetable is in Switzerland. This began in 1982 and covers the whole public transport system, including the two main passenger operators (SBB and BLS) as well as other standard gauge lines, narrow gauge lines, mountain railways, buses, trams, boats and cable cars. However, the origins of the idea go back to 1931 when the Dutch Railways first offered a 'cyclic timetable' on some of its routes.

The Swiss regular interval timetable is backed up by a simple, integrated ticketing system which allows tickets to be purchased at journey origins (via stations, machines or apps) to cover practically all public transport journeys (the limited exceptions being some cable cars and the like) rather than having to rebook en route. The model has been expanded to a number of other countries, particularly Austria, Denmark, Belgium and the Netherlands and (at regional level) in Germany.

In thinking about the long-term development of the UK rail network there is an opportunity to develop a clearer service structure and regular interval timetabling, in particular to promote better connections from secondary towns to the trunk network, as a means of promoting national connectivity. The advantages are:

- A more comprehensible service pattern for passengers, particularly those who use the network infrequently;
- Increased ability to make connecting journeys and confidence that they are dependable;
- Easier to operate, as there is no need for operational staff to remember the variations in service during the day;
- Supporting labour market flexibility and the evening economy through greater frequencies at the start and the end of the day than at present.

However, there are also some drawbacks:

- It is harder to run fast non-stop trains in the peaks or have different stopping patterns to manage passenger loads. These are common techniques in the UK to manage peak demand;
- It is relatively resource intensive at the start and end of the day when demand is lower and a lower frequency might well be justified;

- Many UK connecting services are actually part of longer routes, often to promote direct connectivity, so lateness can spill-over to other routes. For example, the Liverpool to Norwich service provides connections at key interchange stations: Sheffield, Nottingham and Peterborough. If the full regular interval timetable approach to get high reliability was applied, these might become stand-alone operations losing the direct across-country connectivity that (as we will see) is already in short supply in Britain;

- It becomes very hard to improve one route on its own, as the timetable is designed to work nationally not regionally. In Switzerland and the Netherlands, timetable changes have to be planned over three years in advance: nevertheless, they can be done and Switzerland completed a significant change in December 2016 to accommodate the new Gotthard Base Tunnel;

- An intense all-day operation means that more track maintenance and engineering work must be done at night, which is costlier.

In Britain, there are already some significant elements of a regular interval timetable. For example, the very high frequency timetable introduced on the West Coast in 2008 has a completely regular interval pattern, including services provided by other train operators in the West Midlands and North West. Wales and Scotland operate their own version of regular interval timetables, involving some peak additional services overlaid on a core plan. And the core off-peak timetable across the former Southern Region is also regular interval. But for other significant parts of the network there is no regular interval pattern and across Britain there is no clear service hierarchy.

But to succeed, a Swiss-type philosophy in Britain would also need to go beyond timetabling and service hierarchy, to include:

- Increasing both the number of 'parallel' train movements possible at major stations and the amount of cross-platform interchange that it is possible;
- Providing more than the minimum in terms of stairs, escalators and lifts at stations to make it easier to get to, and connect between, trains;
- Considering potential capacity interventions from the perspective of whether they contribute to making a 15, 30 or 60-minute timetable structure easier to operate;
- Significantly simplifying the fares system, possibly on a zonal basis;
- Making advance tickets easier to use to avoid passengers choosing to take earlier connecting services and so waiting longer than necessary for the main line train;
- Recognising that rail has a relationship with the various other travel modes – walking, cycling, bus, light rail and all of the car variants (parking, dropping off, car hire, taxi/uber…).

Some of these changes would be hugely expensive to bring about, others less so. Our presumption is that a Pareto 80:20 approach that seeks to deliver best value for money will be the best approach. The full Taktfahrplan model is probably unaffordable. But, as the Greengauge 21 report for the Campaign for Better Transport (CBT) Northern Rail: Stepping Stones to a rebalanced Britain of January 2015 argued, there is every reason to adopt the much simplified zonal fares structures common in metropolitan areas and extended successfully elsewhere to national rail systems - for instance across Denmark and southern Sweden.

The rail customers' perspective

These issues take us firmly into a further consideration of rail customer requirements, and good work in this are has been carried out by the consumer watchdog, Transport Focus. Building a brand new railway – HS2 – and its integration with the existing network offers the opportunity to deliver a world class passenger experience across Britain's rail network as a whole.

HS2 Ltd has been ambitious about the new high-speed network, describing HS2 from 2026 as:

> **"the most seamless, passenger-focused, technology-literate travel experience that any domestic transport has ever offered"[24].**

HS2 brings with it the possibility of driving excellence in rail travel experience for the many. For the project to act as an enabler of improved social mobility, it will need to be an integrated part of a transport network that has accessibility and social inclusion at its core, and the potential to ensure that no one is excluded from reaching places of employment and everyone has good, affordable, transport options to access health, education and leisure facilities[25].

Measures of customer satisfaction for rail use have traditionally focused on areas like value for money, punctuality and reliability of services, and more recently, overcrowding. Whether passengers appreciate or care about which company operates the service, which part of the network they are on at any given time, or who is responsible for signage, station information or ensuring the toilets are clean, may be up for debate – but what is clear is that what passengers want from their rail journey, whether with a high-speed element or not, is seamless, hassle-free and good value end to end travel.

Tickets

The current ticketing system in the UK is complicated, and while some headway has been made towards offering passengers an improved ticketing system, with more modern and flexible deals on fares, progress has been uneven to date[26]. Faster progress needs to be made but the arrival of HS2 provides an unrivalled opportunity to shift to a simpler, more streamlined approach.[27] Greengauge 21's Fast Forward report compared rail travel to other transport modes (air, car, bus) and found that the key advantages of train travel on today's network were around the journey itself[28], and highlighted that new high-speed services offer the very appealing prospect of fairer cost structures.

24. HS2 Ltd, 'Overview and customer experience', Presentation by Beth West, Commercial Director, 2017.
25. Sustainable Development Commission, *Fairness in a car dependant society*, 2012.
26. Campaign for Better Transport, Fares and Ticketing Review – Two years on, 2015.
27. There is a precedent. When France's TGV was launched in 1981, it was possible for the first time to book a seat from home (using the Minitel system).
28. Greengauge 21, *HSR and the Consumer, Part I*, 2009.

Messages from HS1

The only domestic high speed rail service currently operating in the UK is HS1, which celebrated its first decade in service in July 2017. Initially conceived to serve commuters, the service has been extremely successful:

- A doubling of passenger numbers since the service was launched in 2007;
- An unrivalled average delay per train of less than five seconds
- Passenger satisfaction at 93%;
- A significant uplift in economic growth in Kent[29];
- An increase in leisure journeys from 100,000 in 2010 to 890,000 in 2016.

Commuters from Kent have benefited from significant time savings. Commuting from Ashford to central London pre HS1 took 84 minutes and now takes 37 minutes, for example. Passengers using the HS1 service have come to expect the high levels of punctuality and reliability that have consistently been delivered – meaning that more recently passenger expectations have moved on and focussed on other issues like the station environment and wider improvements to on board technology.

The government has announced an £80m programme to bring about smart ticketing, using mobile phones, barcodes and smartcards across almost the entire rail network by the end of 2018[30]. The ambition is to provide people with greater information and choice, the greater ability to use mobile phones, contactless cards or smart cards to purchase tickets; encourage the use of web portals to access these services; and utilise technology such as fingerprint or facial recognition to collect or present tickets. Transport for the North has been clear about its ambition to see integrated and smart travel established across the North[31] and HS2 Ltd's continuing activity around passenger experience has brought forward the importance of facilities such as digital travel wallets, containing everything passengers might need for their journey, such as tickets, maps and timetables in one digital location[32].

29. HS1, *HS1 AT 10, Celebrating 10 Businesses at 10 Years*, 2017.
30. Paper train tickets will be a thing of the past by the end of 2018 as UK rolls out £80m Oyster-style smart card plans. See City AM, 2017.
31. Transport Focus, Research commissioned by TfN – *Smart Ticketing in the North*, 2016.
32. Transport Focus, for HS2 Ltd, 2018.

Advances in wireless technologies, image processing and biometrics will provide an opportunity to rethink areas like ticket barriers. This would of course need to be subject to overcoming growing customer and regulatory concerns around data protection; and changing physical barriers for electronic gates that can determine a passenger's permission to travel without the need for interaction on their part is one of the approaches being considered by the Future Ticket Detection programme[33]. Such developments could be helpful in reducing current delays and difficulties around ticket barriers and would, for example, be especially welcomed by travellers with impairments and those with heavy baggage, who find moving within stations problematic; especially during busy peak times[34].

The implementation of smart technology also has the potential to improve the travelling experience of people with impairments. Government policy on supporting people with impairments has shifted considerably over the last decade, with employers encouraged to support people into employment. Means of transport is a key part of this narrative, as non-accessible transport is often a barrier to seeking employment, and improving economic status[35]. For example, the delivery of Passenger Assist support, the system which impaired passengers use to book assistance and reservations on the national rail network, is currently inconsistently applied across the network[36]. However, it could be fully integrated with the overall booking system so that platform and train staff – who will continue to play an essential role in delivery – are provided with real-time updates on who needs what kind of help.[37]

The Campaign for Better Transport has long been arguing for more flexible season tickets; mostly on the basis that rail fares are increasing faster than wages and so passengers in lower paid work are at risk of being lost to other modes of transport. Changing work patterns demand new approaches to season tickets, with a growing segment of the workforce either employed part-time or describing themselves as employed full-time but travelling to work fewer than five days per week. Part of the smart ticketing offer could mirror areas such as gym membership or co-working spaces offering discounted travel for a number of journeys, say 12 or more journeys a month in peak time and 12 or more in off-peak. And future tickets with an inter-city or HS2 element might be based more closely on different travel markets, so business, tourist, families, premium or economy.

33. See RSSB Capability Delivery Plan.
34. Transport for London: Exploring the journey experiences of disabled commuters, 2010.
35. Uiversity of Oxford, *National Travel Survey Analysis*, 2011.
36. Transport Focus – *Passenger Assist Summary Report*, 2014.
37. At present, wheelchair users may be only able to book a place (in competition with other users) 24 hours ahead of their journey, making it impossible to access cheaper book-ahead fares.

Making advance tickets easier to use so that many passengers do not choose to take earlier connecting services and wait longer than necessary for the main line train would be another welcome innovation. Currently there remains some uncertainty in the 'rail industry rules' on which train operator bears the risk if connecting trains are missed, particularly where two or more tickets are used. Smart ticketing which records when connecting trains are boarded may help provide the solution. Another option might be to offer an affordable upgrade fare (of perhaps £10–20?) for travel on a train ahead of the one booked (whilst accepting that this would lead to some dilution in business revenue).

A similar situation arises with in-bound air travellers wishing to connect with rail. A flexible offer, allowing re-booking including of advance fares to a more convenient train at no charge if the in-bound flight is either early or late would benefit the traveller. This is not something currently offered in the UK or by many European operators. Customer behaviour tends towards booking a flight through the cheapest flight consolidator, and often months before train bookings open, and then addressing the ground transport later, much closer to travel date .

Seats

The busiest departures from London's Euston station in the evening peak period already carry 60% more passengers than there are seats, and the network operator predicts passenger growth of more than a quarter by 2023, when the first phase of HS2 to Birmingham will still be three years from being completed.

The success of the HS1 domestic service has resulted in passengers standing between Rochester and London St Pancras for a total of 37 minutes at peak times. These passengers could choose to get a seat on an alternative (slower) service, to Victoria or London Bridge. This suggests that commuters are prepared to stand to get to work and back home, even for longer distances than previously thought acceptable, but the preference is, of course, to have a seat.

Longer distance business and leisure travellers have a stronger expectation of a seat, and tend to prefer to choose an exact seat from a seat plan, for example, to be near their luggage or at a table, particularly for families or small groups. And, as discussed earlier in this chapter, changing work patterns will also mean that demand for peak and traditionally busy (commuter) services may be more difficult to predict over the next decade.

With regard to booking specific seats on a train, there are two opposing ways that it could be feasible to operate HS2 services. Less densely populated countries like France, Italy and Spain run high speed rail like an airline, with all seats reserved for a specific train. More densely populated Germany, Austria, Switzerland, Benelux, and Denmark, but not Japan, operate like the UK, with flexible walk up tickets valid on any train.

There are clearly pros and cons to both systems. The all-reserved method provides the certainty of a seat, whilst the turn up and go approach provides flexibility to passengers at the risk of having to stand. One proposition for Britain would be to allow passengers to choose seats from a seating plan on all legs of any journey, not just the HS2 leg, with the facility to switch to another train (say) within an hour time-band. Another customer choice could arise, for example, if there is a firm seat allocation system on HS2, but not on parallel, slower, West Coast Main Line trains, creating a customer choice between speed/seat certainty and longer journey time/ greater flexibility of train choice.

Space and facilities

Customer expectations for new infrastructure are high – being set to a large extent by customer experience with market-leaders in other industries. HS2 Ltd's objective is to design and provide a service that can be used safely, independently and easily by everyone[38] and for new high speed and intercity stations, comfort, safety, technology and innovation will be key components of that aspiration. Level or easy access to trains will be an important component of rail travel for many passengers, something that becomes a mainstream issue for any traveller encumbered with luggage, children, pushchairs, or older passengers who in addition may find walking difficult, or wheelchair users. New rolling stock must anticipate a range of customer requirements a decade and more ahead, promising not just more legroom and wider seats due to customers getting bigger[39], but catering for a variety of market segments, from the perspective of the provision of space for luggage and quality of train announcements, to much higher expectations around the speed and reliability of the available wi-fi network[40], and robust cybersecurity[41].

Poor toilet facilities, both on trains and in stations, uniformly bring down passenger satisfaction scores. And many stations, even St Pancras International, don't offer sufficient provision for female toilets, meaning there are often long queues at peak times. Currently some stations charge for toilet use and some don't, but passengers are emphatic on wanting toilets to be clean and free to use in stations. On the design of on-board toilets - the hope perhaps is that there will be a simpler and reassuringly more secure mechanism for closing and locking the door, avoiding the inevitable question of "is the door actually locked" that is a frustrating and uncertain part of the current passenger experience.

38. HS2 Ltd, Inclusive Design policy, 2017.
39. See *The Times*, 'Trains bulk up for the bulky', 2017.
40. Passenger Focus, *National Rail Passenger Survey*, 2017.
41. YouGov survey commissioned by Cobham Wireless, in *Computer Weekly*, 'UK rail passengers don't trust on-board Wi-Fi', 2017.

Illustrative future journey – scenario 1

Oli is travelling to Middlesbrough. He begins his journey on HS1 in Rochester, in Kent. The station has good facilities, with clear signage to the platforms, and the first leg of the trip starts on a high-speed train travelling on the conventional network to Gravesend, switching to the high-speed network at Ebbsfleet, through Stratford International to London St Pancras. Oli is a homeworker, who travels into London perhaps 2 or 3 days a week for his job, but not always at peak time. So, his experience is informed not only by the punctuality of the service, but by the quality of the Wi-Fi and space available to work. It is only in recent years that Oli has been able to purchase a season ticket that offers flexibility, not being a 'traditional' commuter. He uses this for the journey into London and has purchased a ticket that allows him flexibility for the return from Middlesbrough the next day.

On this occasion he is traveling with one suitcase for the overnight stay. He enters the network in a classic station, his local station, and so might expect or assume that the rest of his journey offers the same consistency in terms of access, signage, reliability and levels of service. Once in London, he makes his way to the new Euston Station (via a travelator), where there is the facility to sit down, recharge his devices, and purchase coffee and lunch (a vegan option, as experience tells him that he will have greater choice than from on-board provision).

He takes his lunch on to the service bound for Darlington. He has booked a seat which accommodates his requirement to make some phone calls, open and use his laptop comfortably and access the wi-fi easily and consistently. The on-board toilet is well maintained, and has an easily operated locking system. Oli's journey to the new Hub station in Darlington will take 1h52, a saving of 27 minutes from pre HS2 days. At Darlington, he decides to use the new business hub space and remain in Darlington for the afternoon, getting on the train to Middlesbrough mid-afternoon to make his 5pm meeting.

The following day Oli is required to stay in Middlesbrough longer than anticipated. He changes the time of his return journey which he is able to do as his ticket allows him to switch between services via an App on his Smart phone.

Passengers are increasingly used to being able to buy good quality food and drinks at many stations, with fast and efficient customer service. A HS2 journey from London Euston to Birmingham Curzon Street of between 40 and 50 minutes is similar to many people's morning commute. But passengers on longer journeys will no doubt welcome a quality trolley service offer, while a more substantial catering offer is likely to be desirable for future three hour plus journeys from London to Scotland. Machine learning technology can be used to forecast need on different services, and at different times of the day, and pre-booked catering could also be considered as part of future ticket offers.

Stations

St Pancras, Kings Cross and Birmingham New Street have become destinations in their own right, with a mixed-use retail offer that combines shops, restaurants and bars with other community based elements like music and cultural space, and the sale of local food and goods, connecting to the local tourism offer. This sets a bar that will get higher with time for rail customer expectations for all intercity stations whether on the HS2 network or not – at Leeds, Manchester, Newcastle and Bristol and so on as part of locally-driven city regeneration strategies.

Developing legible, well-designed spaces with a wide range of facilities; and with effective use of surface treatments, materials and lighting to ensure that passengers with a variety of needs feel safe and able to navigate to their destination effectively are all likely to be future drivers of customer satisfaction.

Birmingham's plan for the new station at Curzon Street will see almost £1bn spent on regenerating the wider area, creating several new neighbourhoods across 141 hectares, including 4,000 homes and 36,000 jobs[42]. Such redevelopment offers world class integrated transport hubs, where HS2, the classic railway, buses, trams and vehicle pick up and drop off points are accessible in a single place, supporting a shift away from less sustainable travel modes. New HS2 and existing station developments can also offer much larger secure bike storage facilities and hire schemes that are integrated into station design and incorporate cycling hubs and repair units, as is the norm in the Netherlands.

Ongoing engagement with local stakeholders and the wider community is needed to inject a sense of locale, and of community engagement to avoid a bland 'suits anywhere' style. The development of environmental interventions such as public art to create pathways, landmarks and destinations should also continue to be a significant part of the rail station of the future.

42. HS2 Ltd regional factsheet.

Illustrative future journey – scenario 2

Hui Yin is from China, and is spending a few days in London before travelling to the University of Birmingham to deliver a lecture and attend a number of meetings – the main purpose of her visit. She will then continue her journey up to Glasgow, to visit some family.

She has booked her ticket via a one stop shop booking platform as a whole journey trip, which includes return flights and a number of flexible rail connections which she can amend with an App. Having travelled in Europe previously, she had hoped for a through luggage service that handled her cases from the airport to her destinations (as previously used in Switzerland) but she wasn't able to find this service through her UK booking.

Hui Yin arrives into the UK at Heathrow Terminal 5 and travels into Central London on the Elizabeth Line. She travels up to Birmingham Curzon Street from Euston a few days later and uses the tram to New Street to catch a local train to University station, later returning for an onward rail journey by HS2 north from Curzon Street to Glasgow. She returns by train to Manchester Airport where Hui Yin catches her return flight to China.

Hui Yin's journey may seem complex, but individual journeys are complex. Key issues for her are flexibility, luggage provision, a feeling of security and quality of information. Her English is good, and she is familiar with train travel in China, but others won't always be so well-placed.

Summary

From the evidence review in this chapter we can see that there are many factors that drive rail use and passenger satisfaction with the experience.

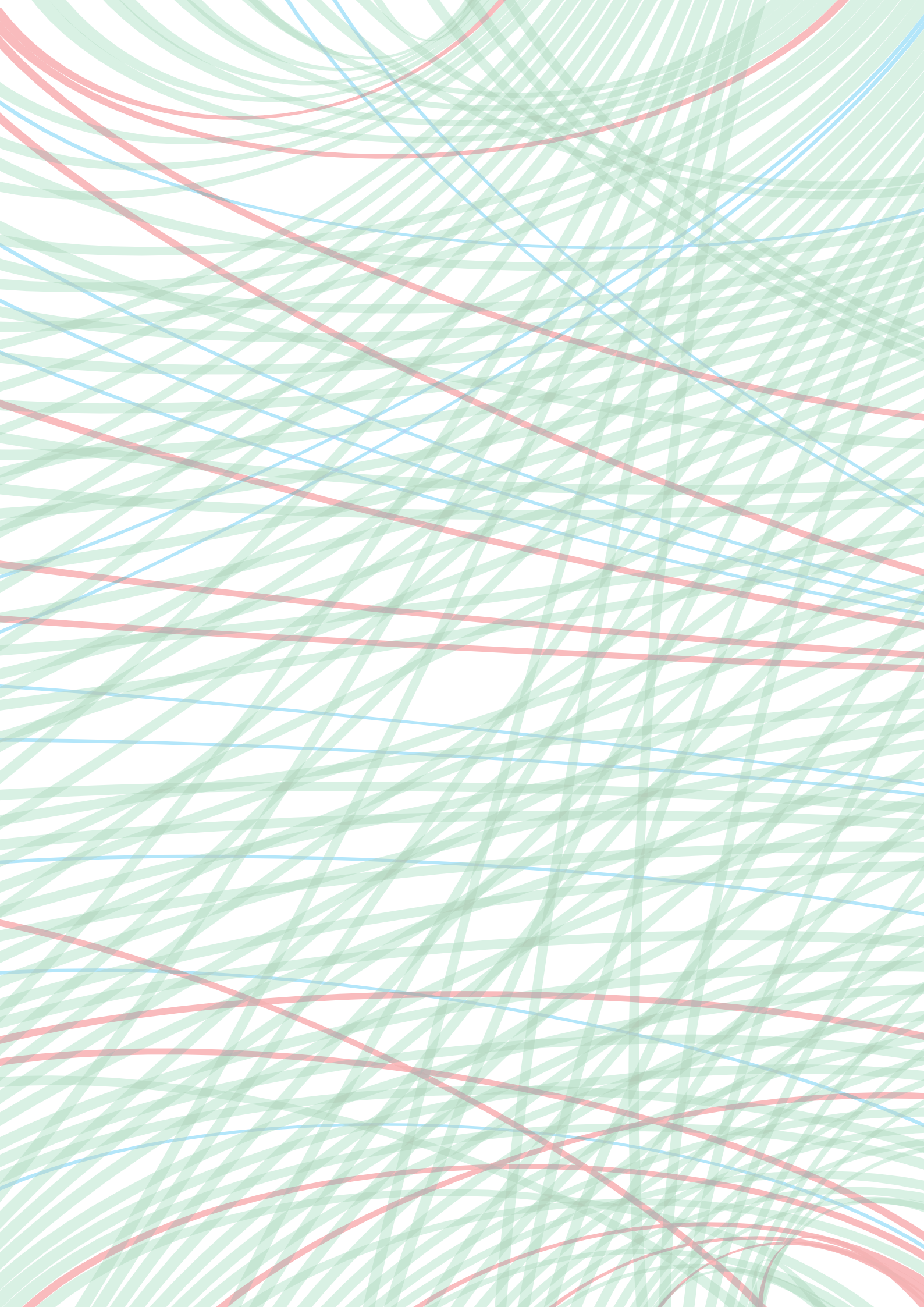
The background trend over two decades is one of consistently strong growth in passenger numbers - over 4% per annum – even though rail fares have been growing by almost twice the rate of increase in motoring costs in the last decade. Rail has been well placed to serve the growth in city centre employment as well as long-distance travel, but a generational trend also seems to be taking place with less and later full driving license acquisition amongst younger age groups and public transport use growing.

The rate of economic and population growth can be expected to be important influences on future rail demand and the trend towards urbanisation and city based employment suggests rail will be increasingly well placed to serve the nation's travel needs, provided new housing is well located too.

It will also be important for the rail experience to improve as well – reliability and increased frequencies and into the evening, a greater range and choice of through services, easier interchange where interchange is necessary, simpler and more affordable fares, better use of technology, the quality of facilities on board and at stations, the ease of handling luggage, and recognising that rail is just one part of an end-to-end journey and has a relationship with other travel modes.

These customer service features, together with a much simplified fares system, will allow the realisation of many of the benefits of 'Swiss-style' integrated connectional timetables without triggering a need to rebuild all of the key junction stations to allow for 'pulse' patterns of train arrivals and departures. And whatever technology is in place, travellers depend on helpful, friendly and reassuring staff.

We will take these messages into our consideration of our *Beyond HS2* strategy but first we also need to consider the needs of freight.



4.0 **Freight**

Today's rail networks are heavily used by freight trains, although the pattern of use is more varied than passenger with some lines heavily used and others hardly at all, and traffics carried and services operated varying by day of week and season. In this chapter we examine the future challenges facing railfreight from both the perspective of customers and the rail industry and the issues to be considered in the development of a freight network strategy.

Challenges facing railfreight

Freight traffic is increasingly integrated within complex, often international, supply and production chains: meaning freight delivery must be highly efficient for businesses to stay competitive. Customers want goods shipped to fit their production and supply chain requirements and this capability is increasingly an absolute requirement if freight shippers are to use rail rather than road. The rail sector needs to continue to work to make it easier to deal with and to deliver reliably the freight capacity and timings it promises. The recent formation of Network Rail's Freight and National Operator Route is an important step forward in recognising this imperative.

The pressure to run larger, heavier and longer freight trains, particularly with higher containers to increase productivity, is strong. A 775m freight train length has emerged as a de facto standard for planning purposes (approximately twice the length of future HS2 trains), but most of the national network can only accommodate trains much shorter than this (typically 400 to 500m).[1] Longer freight trains, provided that they can operate at the same speeds, use up fewer paths to move the same volume of goods.

The programme to clear more of the trunk rail network to carry boxes of 9'6" height (known in the rail industry as W10/W12) has been planned for some time and is largely implemented, but needs reinvigoration to bring it to a finish.

1. See Table 3.2 of the Network Rail *Route Utilisation Study for West Coast Main Line*, July 2011.

There are four major challenges for railfreight at present:

- The sector's markets are changing rapidly (see Figure 4.1). The decline in coal and petroleum traffic, particularly the former which has dropped by 90% in two years, has left some of the operators with substantial assets, notably fleet and depots, that cannot readily be redeployed to other markets and may need to be taken out of use. Construction traffic has grown rapidly, approximately doubling over 20 years, and is particularly driven by building work in major cities;

- Overall, railfreight's profitability is low and competition is high. Customers benefit from this, but railfreight companies are understandably cautious about new capital commitments such as purchasing locomotives or wagons without long term customer commitments (in general, terminals are normally funded and operated by customers);

- Railfreight grants have been reduced – by 21% last year – and are now tiny in relation to the benefits the sector brings in terms of reduced congestion and pollution: research by the operators suggests that each freight train avoids something in the region of up to 75 lorries on the road.[2] Grants, oddly, are essentially restricted to intermodal (container) traffic and grants for new freight terminals were scrapped over 15 years ago;

- Intermodal traffic continues to grow but is increasingly coming up against network capacity constraints. One option might be to have a general strategy of accelerating intermodal trains with paths timed up to 90mile/h rather than today's 75mile/h, but this would require expenditure on wagons, locomotives and (potentially) clearances to ensure safety. Other approaches involve changes to other types of freight path, for instance uprating 'Class 6' paths for heavier freight trains (60 mile/h maximum speed) to 'Class 4' (designed for intermodal trains of 75 mile/h) wherever possible. This would be particularly useful if it allowed more consistent end-to-end paths to be created. Freight operators have been successfully working with Network Rail over the past five years to review their inherited pool of paths and have given up about 1,000 daily paths, which also helps.

2. Network Rail, Value and Importance of Rail Freight, April 2013.

Figure 4.1: **Freight Volume since 1982/83 (in m tes/annum)**

Source: ORR, National Rail Trends Data Portal, Table 13.6, as at March 2018

Freight is commercial, margins are low but long-term demand prospects are good

The railfreight companies are completely standalone from Government: unlike passenger Train Operating Companies (TOCs), they have complete freedom over the services they offer and the prices they charge, constrained only by overall competition law and practice. There are no franchise or concession agreements with Government telling them what to do.

The business environment of the period 1997–2015 has been positive for railfreight companies, even though margins are low, and they have been able to invest significant sums to support growth. They have re-started domestic intermodal traffic, which had almost died out under British Rail. Investment since privatisation – in the form of new wagons, locomotives and terminals – is reported by the Rail Delivery Group to amount to some £2bn.

The railfreight companies also serve Network Rail's major engineering and renewal programmes by moving ballast and track around the country. It is thought that 10% of their turnover comes from this and, given the planned increase in renewal spend in CP6, this proportion could grow.

As noted, there have been significant losses of coal traffic – long a mainstay of railfreight – in response to government policy to reduce carbon emissions. Until recently, 25% of railfreight carryings (mainly coal imports) were from ports on the Humber and various network improvements had been made to accommodate it, such as at Joan Croft Junction to remove crossing movements on the East Coast Main Line. While this loss of traffic has been much sharper than anticipated, with consequential problems for railfreight companies, its loss is also an opportunity for new freight flows that can be accommodated on the rail network using the upgraded route infrastructure. The experience also serves as a warning of the risks of infrastructure investment to support highly specific freight flows.

Non-coal traffic however has grown, led by construction and intermodal. Biomass has replaced some of the coal - the UK's largest power station (Drax) has been modified to accept this fuel which is imported via a variety of ports, including Liverpool, Tyne, Immingham and Hull.

The other main current types of freight traffic on the network are:

- Construction, primarily aggregate and sand imported into cities for use in concrete production from sources in Somerset, the Midlands and the Pennines (half of materials for London's building sector is supplied by rail);
- Steel, moving finished and part-finished product from the remaining UK steelworks in South Wales and Scunthorpe for example;
- Automotive; finished cars being moved from Merseyside and the Midlands to Southampton for export, for example;
- Container trains from the major ports at Southampton and Felixstowe, and also from the Channel Tunnel, Thames Gateway, Tilbury and Teesport;
- Domestic intermodal trains, primarily used by supermarkets as part of their logistics chains to transport goods from warehouses in the Midlands (notably Daventry) to South Wales and Scotland, where there are further flows to Inverness and Aberdeen from the central belt;
- Wagonload traffic, including some van traffic to/from the Continent, movements for the MoD and nuclear fuel;
- Royal Mail trains between London and Scotland, of normally one or two trains per day, using the specialist train fleet that Royal Mail procured in the early 1990s (and still own);
- Specialist fluids, including oil and china clay.

See Table 4.1 for a quantified breakdown.

Table 4.1: **Railfreight markets**

Market Sector	%	Railfreight Activity
Intermodal	38	Movement of containers from ports and between inland terminals.
Construction	25	Movement of aggregates, cement and spoil for the construction industry.
Metals	9	Movement semi-finished steel between works and finished steel to consuming manufacturing or fabricating industries.
Coal	8	Movement to power stations for electricity generation and steel works for steel production.
Oil & Petroleum	7	Movement of oil, petroleum and diesel to distribution terminals.
International	3	Movements via the Channel Tunnel
Other (includes biomass)	10	e.g. Movements of biomass, cars, military equipment, spent nuclear fuel.

Source: Network Rail Strategic Business Plan, Freight and National Passenger Operators, February 2018, based on data from ORR Railfreight usage 2016/17 Q4, June 2017

Railfreight operators have become more efficient over time. But it seems that the process of price-based on-track competition may have gone too far, judging by the current operating losses made by the two largest operators (DB Cargo and Freightliner), and some pricing discipline in the market needs to be re-established. DB Cargo has already reduced its operations considerably, along with Freightliner, as bulk freight has dropped.

The four main operators are noted in Table 4.2.

Table 4.2: **Principal railfreight operating companies**

Operator	Main markets
DB Cargo	Rooted in bulk freight, particularly coal, steel and petroleum
Freightliner	Originally only intermodal traffic, expanded into bulk but now refocussing on intermodal again.
GBRf	Set up by First Group post privatisation and now owned by Hector Rail, a Swedish company. Originally set up to support bulk traffic but now strong in all traffic types.
DRS	Set up by the nuclear industry at privatisation to move nuclear fuel shipment. Its main depot is at Carlisle.

Other operators are Colas, Devon and Cornwall, and Mendip Rail. ORR has recently published an assessment of the freight companies' profitability[3], showing that they currently are either losing money or delivering low margins (in the case of GBRf). It is unlikely that freight, which faces such strong competition from road will ever be highly profitable but it is entirely possible for it to return to the world of steady margins that it enjoyed for the first twenty years since it was deregulated in 1994.

A further challenge at present is the impact of Brexit, which has the potential to change the shape and direction of railfreight in a number of ways (although it is worth noting that, not least because of the difficulty in developing viable Channel Tunnel operations, comparatively little railfreight arises from UK-EU 27 trade):

- Business uncertainty on how the UK's relationship with the EU-27 will evolve may lead to lower investment, particularly in the 'just in time' supply chains across Europe that are particularly prevalent in the automotive and food sectors;

- A lower economic growth rate, if as a result of tariffs are re-imposed on UK-EU trade, may lead to lower growth and affect both imports and exports to the UK. Currently, the Channel Tunnel is only used by about 2-3 freight trains a day per direction[4]. But, against this, if better trade agreements lead to lower tariffs than apply under current EU agreements with non-EU countries such as China, India and Malaysia, then railfreight volumes may increase as a larger share of external trade from remoter countries would increase the use of container shipping and rail haulage to/from the ports of entry;

- Should customs checks for accompanied road freight be reintroduced at major ports such as Dover (although the Government's policy is to avoid this), shippers could switch some of this to the unaccompanied product that railfreight offers through the Channel Tunnel; even a modest impact of this type would have major implications for freight path requirements in South East England;

- Recruitment of staff may become more difficult, leading to higher costs.

Network Rail is assuming railfreight growth of 16% over the next five yearly control period;[5] forecasts by consultancy MDS Transmodal suggest a higher figure – up to 50%. Higher growth rates in particular will cause network capacity challenges. The idea of a national strategic railfreight network being a set of core routes that would have the capacity and capability to meet market needs has been proposed on several occasions over the past 15 years, and it makes evident sense.

3. Table 2.16 of the ORR 'Rail Industry Financial Information 2016/17', 18 January 2018.
4. Getlink (successor to Eurotunnel), Traffic Figures for 2017.
5. Network Rail, *Freight and National Passenger Operators Route Strategic Plan*, February 2018, Page 4.

The freight companies, shippers, funders with Network Rail are progressing definition and agreement about what the network strategic railfreight network should consist of, building on the decision to create a Freight 'Route' within Network Rail and its recently published Strategic Business Plan, which suggests that between £2.9 and 6bn might be spent on freight capacity and capability schemes over the next 15 years.[6]

Time to agree a more enlightened grant/charging regime

EU policy makers are again seeking to level the playing field between road and railfreight through an integrated tax on road freight vehicles, the 'Eurovignette', which would be a higher charge on road freight over and above existing vehicle registration taxes. This could be distance-based: Germany, for instance, has now been charging road freight on a distance basis through a network of cameras on its main routes and Autobahns for almost a decade. Nevertheless, the appetite amongst member states for further EU legislation of this kind is weak and it seems more likely that the initiative in this area will stay with national governments, not least because they can use any revenues that they raise to reduce national deficits.

The transport planning and environmental logic of a similar charging system for the UK has always been strong, but opposition to it has been consistent and, to date, very effective. There is no sign of this changing. Indeed, given concern about levels of trade post-Brexit, it seems more likely that there will be pressure for road freight to be advantaged through tax concessions to maintain its competitiveness rather than disadvantaged by higher charges. So, while the economic case for a road charging scheme is, theoretically, very compelling, the lack of political appetite to implement it has consequences for railfreight. In particular, it would make no sense to continue to propose to increase freight access charges for rail to be closer to its theoretical full track costs if the same doesn't apply for the major competitor, road haulage. A more pragmatic approach is needed.

6. *Ibid*, Appendix C1.

The current railfreight grant schemes amount to only £15m per annum to a sector which earns £790m per annum in turnover so cannot be said either to be lavish or, more fundamentally, fully reflective of the benefits that railfreight brings. Work for the Rail Delivery Group in 2013 by KPMG estimated that railfreight as a whole moves goods worth £30bn per annum and drives benefits of £1.6bn per annum in doing so[7], far outweighing the grant support it receives. Railfreight traffic directly reduces HGV traffic on the road network, cutting noise, carbon emissions, reducing congestion and taking pressure off the road maintenance budget because heavy freight lorries cause a higher degree of damage than passenger cars and vans. At a strategic level, more railfreight means less needs to be spent on expensive road widening schemes, of the kind already put in place in parts of the M25, now nearing completion on the M1 and which might be the next step for the M62.

Given the benefits that railfreight brings, there is a good case for a very substantial increase in grant support, perhaps ten-fold increase over the next 5–10 years. At the same time, the eligibility criteria should be reviewed: at present, grant is only really applied to intermodal traffic and is in effect weighted to encourage mode shift from regional roads rather than from the trunk road network. The grant might be reshaped to give greater credit for decongesting the trunk road network, improving air quality and reducing emissions, which would suggest the weighting of motorway traffic should be increased. In addition, it might be structured to help develop new rail freight flows and get ports established, for example container and bulk movements from Liverpool 2 and Teesport.

Further, the scheme should be expanded to permit funding of environmental protection measures to reduce the negative consequences of railfreight growth. Freight trains are normally heavier and noisier than passenger and, on lines where capacity constraints mean that railfreight has to switch to night-time operation, it is entirely sensible to fit noise barriers or landscaping to reduce the impacts, as is normal practice in many European countries, notably Germany and Switzerland.

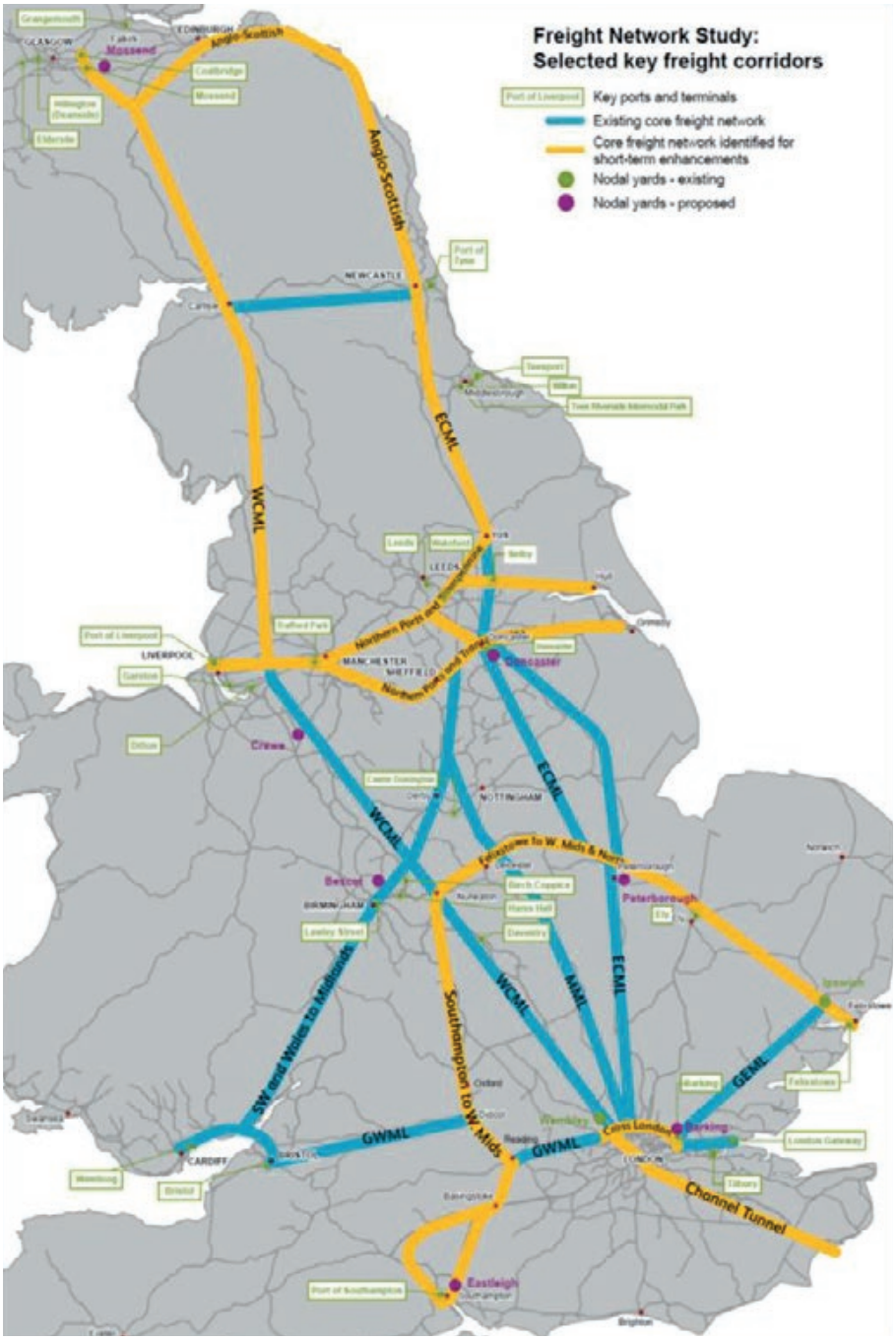
Similarly, the freight track access regime itself might be better structured to offer discounts on routes with spare capacity and away from those that are, for practical purposes, full and to offer more advantageous rates for new flows that are just beginning. In combination with a much increased grant regime, it would make sense to look at network capacity surcharges to help encourage the move away from busy routes and times of day.

7. Rail Delivery Group, *Continuity and Certainty for Rail Freight*, 2015, pages 3 and 4.

Meeting the demand for railfreight

Figure 4.2 below shows the routes that Network Rail currently considers to be the Strategic Freight Network. It is notable for having no direct links to the South West, Wales (other than Cardiff) or any part of Scotland north of the Central Belt. It is also notable for the inclusion of routes into London (the southern parts of the Midland Main Line and the East Coast Main Line) that are about to be stretched to accommodate, respectively, intensified and new, cross-London passenger services (Thameslink).

Figure 4.2: **Current Strategic Freight Network**



Source: Network Rail Freight and National Passenger Operators Route Strategic Plan, February 2018, page 29.

The Strategic Freight Network concept should be adapted and developed further:

- To protect the available freight capacity over the links to the major railfreight generating ports, particularly Southampton, Felixstowe, Tilbury, Immingham, Liverpool, Teesport and the Channel Tunnel.

- To ensure that the 'core' national railfreight network has capacity to accommodate a diversity of railfreight flows, recognising that market demands will shift over time and cannot be assured in contrast to passenger demand trends which are more stable. This network needs to include the whole of the West Coast Main Line, the Great Western Main Line, the Channel Tunnel routes, a selected Trans-Pennine route, the Hope Valley line to serve Peak District Quarries[8] and the Aberdeen and Inverness routes in Scotland. The East Coast should also be part of it, although the practical issues involved with expanding freight traffic on this route in southern England (or on the nearby Midland Main Line) means that it is more sensible to route any new freight flows onto other lines, including the West Coast where there will be some spare capacity post HS2.

- Logistics centres should be served, particularly Daventry but also those in the Scottish Central Belt, the West Midlands, the North West and Yorkshire and active consideration needs to be given to locating strategic freight interchanges where there will be adjoining rail network capacity to accommodate growth and discouraging those which are poorly aligned in respect of available path capacity. Indeed, the approach we propose here would make planning the strategic freight network and interchanges a unified process.

Particular network weaknesses occur in the largest conurbations, where a combination of multiple terminals for waste, cement and aggregates traffic and the need to accommodate cross-city freight flows may conflict with ambitions to expand city region passenger services. This problem arises in particular at Manchester (where access to the major intermodal terminal entails using the city's busiest cross-city passenger rail link); potentially in Birmingham, where a cross-city freight route that avoids the city's main central stations is being considered to facilitate new local passenger services, while another – through the Black Country – remains unused; and significantly in London, where there are conflicts with Transport for London ambitions to expand services to meet passenger demand on London Overground routes that are critical components of the national railfreight network.

8. The recent freight operator-led intention to study the alternative of using a re-opened Buxton-Matlock line is notable, and when it comes to its appraisal, should reflect the considerable capacity relief to, and potential simplification of, the upgrade needed to the Hope Valley line, which forms the key Sheffield-Manchester rail connection (see Chapter 7). In other words – this is a critical case of project interaction where there is a risk that the best overall outcome is missed using narrow project-bounded appraisal criteria rather than a strategic, corridor-level, plan-led approach. Of course, the National Park authorities will have a view on which is most appropriate, along with other bodies including Transport for the North.

The case for investment in dedicated railfreight infrastructure has always proved problematic because of the indeterminacy of specific railfreight flows over the longer term. So, capital programme solutions to these problems need to be a combination of measures designed to increase capacity for both freight and passenger flows – and we describe how this could be developed to address this challenge further in Chapter 8.

The key aim is to ensure that there is a least one path per hour[9] (and often more) on the routes designated as part of the agreed national strategic freight network to provide for current and future freight flows.

Equally, it is essential for railfreight investment to be focussed on routes that are likely to be able offer the capacity and links to freight origins and destinations at a realistic capital cost.

Intermodal traffic

The economics of the deep-sea shipping network linking Europe with North America and China leads to pressure to reduce the number of ports being used by shipping lines. Ships have become larger, with each ship only making direct calls at two or three ports in Europe where there are substantial container volumes available to load and unload. Traffic in Britain is increasingly concentrated in just a few ports, currently Felixstowe (Britain's largest container port and ranked 37th in the world), Southampton, and Tilbury – all strategically located close to the main international shipping routes through the English Channel. The main European gateway container ports are at Rotterdam (11th biggest in the world), Antwerp (14th) and Hamburg (18th). Smaller ships are then used to trans-ship goods, including to ports in Britain.

New container ports, such as London Gateway, Liverpool 2 and at Teesport, are not yet of sufficient size to be part of the major global networks although it is possible that they could grow substantially over coming decades.

New intermodal freight terminals in Britain, as noted, need to be situated in places where there is realistic rail capacity and should become multi-operator in nature. Freight traffic can and should be expanded on the West Coast Main Line and potentially the East Coast Main Line north of Peterborough (where a diversionary route is available), as well as over routes to South Wales and the South West. Equally there are a number of locations where further freight cannot readily be accommodated, even with substantial investment (such as on the East – West routes across London and the busy approach route to Manchester from the South).

9. References to trains per hour in this chapter for railfreight paths should be regarded as a rough average over an 18-hour working day: on the busiest routes today, there are typically fewer (or no) paths in peak periods and more in off-peak periods.

There is currently no intermodal terminal operational in the London area, and the gradual return of domestic intermodal traffic (most of which was lost in the 1980s) would be promoted with such a facility if it was well-sited, and with the proactive support of city authorities and Transport for London (TfL). London is not alone in having a city authority that is keen to see an expansion of railfreight as part of a more sustainable distribution system.

Even so, there is a long-term question posed by the National Infrastructure Commission which may complicate commitment to further strategic investment. The NIC has suggested that new road vehicle technologies could be used to platoon Heavy Goods Vehicles (HGVs) together on the major road routes and so increase capacity of road routes. This could, it is argued, remove the need for rail upgrades. Current trials of the technology in Sweden are leaving large gaps between succeeding trucks for safety reasons, which precludes any environmental or energy benefit from platooning. But these are early days. Platooning technology may yet offer some advantages, but is far from proven in practical operation today. The logistics and safety implications of linking together heavy road vehicles in this way need to be fully addressed – and it would therefore be unwise to rely on it transforming the merits of road haulage.

From the perspective of de-carbonisation and improving air quality, it is much more straightforward to transfer more freight on to electrically-hauled railfreight (including by expanding the scope of the electrified network) than to rely on battery or hybrid-powered solutions for road freight to replace diesel engines. Improvements continue to be made in battery technology, but the energy/weight ratio that they either now or are likely to offer in future (compared with the equivalent from diesel fuel) are unlikely to make this option realistic even if it can be made commercial to road freight operators (the high cost of batteries is likely to require either direct subsidy or tax advantages to be devised to make this option attractive). This is an important area of policy and it is likely to get renewed focus as transport carbon emissions are declining much more slowly than required to meet the Paris Agreement requirement. Electrification and capacity increase of the Felixstowe-Nuneaton route would see the substantial number of existing freight movements (20 trains/day) increase to around 60 trains/day, with not only major environmental benefits, but also relief to the problematic cross-London parts of the network.[10]

10. 'Creating an Electric Freight Future, Julian Worth', *Modern Railways*, April 2018.

Strategy for freight network development

Freight flows continually change and evolve over time: the challenge is to identify a rail network strategy that works well for a wide range of options for freight terminals and railfreight volumes, rather than rely on a single central forecast. This means that freight-only main lines, while not to be ruled out, need to have very long-term secure levels of freight demand (of the type that justified the Betuweroute line for freight out of the huge Rotterdam port in the Netherlands[11]). The better approach in the British context is one in which investment is targeted towards management of the mix of traffics on existing lines to get best value and accommodate demand growth. Even though this leads to some significant investment decisions, the beneficiaries are both passengers and freight and the spread of project benefits is wide.

We develop the national network strategy in Chapters 6 to 9, covering both passenger and freight flows. Overall, our approach is strategic, with an intention to prioritise freight over a small number of selected long-distance corridors and progressively discourage it along routes where its continuing accommodation is very costly. Here we summarise the principal issues arising for freight across key segments of the national railfreight network, and where planned changes ahead are known – for instance from HS2 – the implications for the railfreight sector are developed.

West Coast Main Line: London to Crewe

HS2 Phase 1 releases extra capacity for freight, potentially increasing by 50% (to 3tph from 2tph today) between London and the West Midlands. Exploiting this increase is limited by the difficulty of getting more freight trains across the North London Line (and by other routes) to reach the south end of the WCML at Willesden. It is possible that investment in junctions to allow faster progress of freight trains through critical sections could ease this problem.

A step change in network capacity would come once the Felixstowe to Nuneaton (F2N) scheme as planned is fully completed and HS2 is extended, as provided for by Phase 2a. Then intermodal traffic from the Felixstowe route will be able to join the West Coast route at Nuneaton (rather than at Willesden, London) and on the WCML northwards to Crewe which will be freed of a large proportion of its intercity passenger trains that will transfer to HS2. A corollary is that the demand for freight paths over the southern section of the WCML between Willesden and Nuneaton would be reduced.

11. The closest British equivalent arises at Felixstowe. Here the long-term plan would sensibly be the creation of a freight-prioritised (rather than freight-only) cross-country route as shown in Figure 4.2.

So, a key opportunity arises – nine years hence if the F2N project is committed to completion by 2027, contemporaneously with HS2 – to expand railfreight on the national network and reduce the number of heavy goods vehicle (HGV) movements on congested roads. The specific opportunities arise over the southern section of the West Coast Main Line which runs parallel with the M1 motorway and include:

- a pro-active approach to siting a new strategic freight interchange in the Wembley/Willesden area which would have the benefit of knowing that the adjoining rail network (the WCML) would be able to handle the resulting additional railfreight flows – and provide London with a major multi-modal freight terminal;

- new freight flows that cannot be accommodated onto the southern section of the Midland Main Line given the intensity of post-Thameslink passenger train movements;

- growth in Channel Tunnel traffic (which also feeds into the route at Willesden having travelled via Bromley and Kensington Olympia);

- the future East West Rail line could be used for freight traffic[12] from Southampton to North West England/Scotland, avoiding congested junctions in the West Midlands (at Coventry especially);

- continued growth of the logistics centre at Daventry (just South of Rugby), currently served by 6m sq ft of warehousing, but with a further 7.7m sq ft on the way, with the scope also to route intermodal trains to South Wales via East West Rail and Oxford and the Great Western Main Line rather than via the West Midlands, and potentially to add other new flows – for instance to South West England.

Greater Manchester

In many cities, significant volumes of freight traffic continue to pass through major central stations, placing limits on the expansion and punctuality of passenger rail services. In the case of Manchester, freight flows to/from the major freight terminals at Trafford Park approach from the east and pass through Piccadilly, Oxford Road and Deansgate stations. Especially if (but not only if) these freight flows – all of which are from the south and the West Coast Main Line – are to increase in future years, their routing needs to change to approach Trafford Park from the west and avoid traversing the city centre. This might entail building a short freight only link between the route through Runcorn and the Hunt's Cross-Widnes line.

12. This would be in addition to its currently specified passenger-only role.

West Coast Main Line: Crewe – Glasgow

Better diesel locomotives, use of electric locomotives and timetabling that flights together trains with similar performance characteristics can all help ease the pressure on route capacity over this lengthy trunk railway that is very largely provided with no more than double-track. Longer freight loops (they are only typically 400–550m today) with higher speed entry/exit provision are, realistically, essential at one or two locations to promote service reliability on this busy mixed traffic route. A sensible objective would be to plan to accommodate 2 flighted Class 4 freight paths each hour (implying that the extended freight loops themselves need to be double-tracked, or created as longer 'crawler lanes' for the approaches to Shap and Beattock, or four track sections of route). Freight companies must be incentivised to electrically-haul their trains, because the long gradients over the two summits of Shap and Beattock can then be negotiated with less adverse impact on line capacity. Some investment appears inescapable, especially since demand for passenger services is already growing strongly over this route.

Felixstowe-Nuneaton (F2N)

Completion of the upgrade of the cross country route via Ely and Nuneaton should be given priority for completion by 2027, to allow at least 2 and probably 3 freight trains per hour. This is likely to mean that significant work is needed at Leicester where this route effectively crosses the Midland Main Line through the current station: we note the advantage of electrifying this route, as a priority, above. Network Rail has indicatively costed the capacity elements of such a scheme at £1 to 1.5bn in their February 2018 Strategic Business Plan.[13]

North London Line

This is where there is perhaps the most critical choice between passenger/freight capacity demands occurs on the national network at present. The pressure to move to 'tube style' frequencies for this busy passenger route (TfL wishes to increase frequencies by a further 2tph from 6tph in the peak today) interacts strongly with long term growth in intermodal traffic. It seems likely that the pressure to relieve overcrowded Overground passenger services will be a decisive factor.

Some of the freight flows are to/from Felixstowe so if the F2N project proceeds as suggested, that will relieve some of the demand pressure on this line. Other freight serves a range of London area terminals and the port of Tilbury (London Gateway railfreight flows are, to date, few in number).

13. Network Rail, *Freight and National Passenger Operators Route Strategic Plan*, February 2018, Appendix C1.

More freight paths for these destinations might be created if junction speeds for freight trains are improved on the line between Gospel Oak and Barking, used to reach the western part of the North London Line at Willesden. In the longer term, if for example London Gateway freight flows were to increase significantly, a solution could be to build a new tunnel to link the Gospel Oak route to Chalk Farm to provide access onto the West Coast slow lines for freight trains.[14]

A more strategic approach to freight routes to/from the Channel Tunnel

At present, capacity for 35 freight trains per day is reserved on the West London Line route between Battersea and Willesden. It remains a requirement under the agreements put in place between Eurotunnel, SNCF and British Rail in the late 1980s that this capacity be provided (along with paths from Folkestone to Battersea/Clapham Junction). As pressure builds to expand Overground services via Kensington Olympia (and perhaps even introduce direct trains from the South East to West London on this route), a better approach might be to consider a new Thames crossing (see Chapter 8).

East Coast Main Line

At least one extra path per hour might, in principle, be created from the combination of HS2 released capacity and further upgrading of the 'Joint' line between Doncaster and Peterborough via Lincoln. This is a back-up route to the ECML and, while improved and used for freight traffic, is slower and not electrified. Its increased use for freight is likely to require a new flyover at Werrington near Peterborough to allow access to it without blocking the busy East Coast line. The extra freight capacity would be particularly useful for trains between East Anglia and Yorkshire/the North East.

Midland Main Line

No further freight capacity should be allocated on the Midland Main Line between London and Leicester. This may seem a severe step but, as is now clear, the practical requirements of running a metro-style Thameslink service from St Pancras (Low Level), coupled with an East Midlands Trains service expanding to 6tph, severely limits the timetable options south of Bedford. The Southern part of the route, particularly from Luton to Cricklewood, is now an integral part of the high frequency Thameslink project (expected to carry 16 commuter trains per hour in the peak to which will be added 8 trains per hour from the Great Northern route).

14. As examined by the Strategic Rail Authority in the London East-West Study of 2000 that centred on Crossrail options.

Growth in demand at the existing construction terminals on the Midland Main Line (MML) might have to be addressed by operating more trains late in the evening or at night rather than in daylight hours, or, more radically, there might be an initiative to create a new terminal or terminals on the West Coast route in the Willesden/ Wembley area which, as we have seen, will be easier to serve by rail and lead to a switch away from the southern part of the MML.

Great Western

The section between Reading and Didcot is heavily used by freight trains to/from Southampton. Over time, it would make sense to four-track the Didcot-Oxford route and rebuild Oxford station to accommodate the higher traffic levels. Some intermodal freight accesses the Great Western route via the North London line and the forthcoming Crossrail service is being designed to accommodate this. However, once again because of the pressure arising from 'metro' style passenger operation (in this case, Crossrail, on the Relief Lines) it is highly unlikely that new paths can be found for growth and an increase in late evening and night operation may be needed.

On the Berks & Hants line that serves the south west, there is a mix of heavy aggregates trains from the Somerset quarries and 110 mile/h limited stop passenger trains (to be operated by new Class 802 trains). Measures which assist the accommodation of both types of service will be needed in future as traffics grow and if the ambition to speed up journeys between London and Devon/ Cornwall is to be realised (see Chapter 8).

Trans-Pennine

Sufficient capacity to allow at least one intermodal train per hour across one of the North Trans-Pennine routes should be provided. Such a trans-Pennine capability needs to be addressed as part of the studies that Transport for the North has in hand. The multiplicity of potential origins and destinations for freight, particularly intermodal, on each of side of the Pennines (Liverpool, Manchester city region, the Leeds area, Teesport, Hull and Immingham) mean that it would be sensible to consider this from a strategic perspective and accept that this is not about a certain, single flow on the corridor but more about the large range of possible origins/destinations. Choosing the best solution will be for TfN, but is likely to involve finding a way of creating the capability while avoiding the city centres of both Manchester and Leeds.

One particular approach that would achieve this aim also illustrates effectively the aim of bringing wider passenger based benefits. This would create a trans-Pennine freight route using various lines of the former Lancashire and Yorkshire Railway, from Liverpool via Ormskirk, a new/re-instated chord to Lostock Hall and thence to Burnley, Hebden Bridge, Mirfield and Wakefield from where routes southwards towards Doncaster, eastwards to the Humber and northwards to York can be used. Besides the works near Lostock Hall, there would need to be a re-connection of the two end-on branches at Ormskirk and an upgrade of the line to Preston, and this would support a valuable extension of the Mersey Electric network and an additional Liverpool-Preston route. Timetables on the Calder Valley route East of Hebden Bridge may need to be adapted to accommodate this, but this should not be an insuperable problem.

5.0 **Framing a national strategy**

Capacity, connectivity, productivity, regional economic disparities, international trade, carbon reduction and air quality all drive the need for a long-term rail strategy for Britain.

Some early choices about how high-speed rail is developed in Britain have centred on whether it is conceived of as a free-standing or integrated system. The choice has in fact been made that it is to be an integrated system, meaning that individual high-speed services can and will operate over the existing rail network and then onward over high-speed lines. This is one reason why any strategy covering high-speed rail must also consider the wider rail network.

Another reason is that the introduction of lines such as HS2 allows a re-consideration of what use is best made of railway lines that parallel the new high-speed infrastructure. This brings into play consideration of travel markets over shorter distances than high-speed rail itself addresses, and the question of freight as well as the opportunities for new long-distance services for cities that are currently poorly served by rail.

So, this ***Beyond HS2*** strategy is not just about high-speed rail. Indeed, with end to end journeys in mind we also embrace the prospects for related transport modes as will be seen in the 'tool-kit' of candidate measures. In geographic terms we restrict the scope to covering mainland Britain.[1]

We start by exploring key technical parameters that will in practice determine the HS2 service plan (as well as the detailed planning of its infrastructure).

1. Recent discussions on a bridge link between Scotland and Northern Ireland have had a mixed reception. See *The Herald*, 'Link between Scotland and Ireland would be a 'bridge too far', say engineers', 2018.

HS2: Integration with the national rail network

High-speed rail systems around the world share a common output (travel speeds in excess of 250–300 km/h – a definition we use in this report), but have differing design features, related fundamentally to whether they are intended to act as free-standing systems (typical of the Japanese and Chinese networks) or integrated with existing rail networks, so that high-speed trains can operate over both new high-speed and existing tracks (as in France and Germany, for example).

As HS2 has progressed into the initial stages of procurement, a key decision has been taken that there will be a single fleet of rolling stock – at least for the first phase of the project in 2026/7 – and this fleet will need to be capable of operation over both HS2 and existing (electrified) railways. A long-considered alternative – having a mixed fleet of trains, with one 'captive' set of trains to be used on the entirely new London-Birmingham route built with a larger cross-section (European) gauge[2] and another set built to the UK gauge to serve everywhere else – has been ruled out.

The full significance of this decision will not be known until the choice is made on Phase 2 rolling stock (for 2033 onwards), when a larger proportion of the set of HS2 services could have larger gauge trains: (additionally) those to Manchester and Leeds, but still not those operating beyond the new HS2 infrastructure (to Liverpool, Stoke-on-Trent, Sheffield, Newcastle, Glasgow and Edinburgh).

The question remains whether the Phase 2 rolling stock decision, when it comes to be taken, will be the same as that for Phase 1: a unified fleet of UK gauge trains.

This has implications for how the western and eastern leg of the Y shaped network is constructed. Since there is no realistic likelihood of changing parts of the existing rail network to enhance gauge, the only services that could potentially benefit from high-speed bi-level trains are those between London (Euston)/Birmingham (Curzon Street) and Manchester/ Leeds (but only those Leeds trains that do not serve Sheffield).

For the eastern limb, the more substantial interaction with the existing network means it is relatively unlikely to present a case for the larger (European) gauge that can accommodate bi-level vehicles. The western limb of the Y-network might be a stronger case for enhanced gauge if a direct new high-speed line into Liverpool is added into the existing plans. But, even then, western limb HS2 trains to Stoke-on-Trent, Preston, Glasgow and Edinburgh would all need to be those built to UK-gauge.

It follows that for the eastern limb of the Y-shaped network, at least, the question will arise of whether to commit to the use of UK-gauge trains from the outset and whether a useful saving could be made on construction costs.

2. The larger gauge offers greater carriage width than UK gauge – but seating formats are unlikely to be changed (e.g..2+1 in1st class; 2+2 in standard) – and the prospect of accommodating bi-level trains (there are TGV variants of this type operating at high-speed in France and they offer approximately +40% capacity in comparison with conventional single-deck trains).

Planning reliable HS2 services

The HS2 service plans developed for project appraisal purposes achieve very fast end-to-end journey times, with judicious elimination of intermediate stops for selected services. To maintain service reliability, generous layovers are provided at HS2 terminal stations. These provisions – at around 25–30 minutes – are in stark contrast to those allowed on (say) Japan's high-speed network, where turnrounds of 7 minutes are more typical – but may be seen as critical to achieving high levels of service reliability and thorough internal train cleaning. The experience with HS1 high-speed commuter services is a relevant precedent. Turn-round time assumptions have an effect on fleet size (especially for the short London-Birmingham route which has a journey time of only 49 minutes) and potentially also on how many platforms need to be provided at HS2 terminus stations.

The HS2 services that will be of most concern to the operational integrity of the high-speed system are those that inter-operate over the existing busy rail network. Timely presentation times, for example, of Glasgow-originating trains that are planned to use the existing network as far south as Lichfield (285 miles on the existing network) or one year later, from Crewe (243 miles) or Wigan (from 2033, and still over 210 miles on the existing network) are of concern. Such services merit terminus layover/turn-round times of 25–30 minutes; captive shuttles between London and Birmingham do not. Terminus arrangements should be planned with these distinctions in mind. And ideally, main line routes over which HS2 services run will be equipped with digital (ETCS[3]) train control systems.

HS1 Operational performance

On the subject of high-speed/classic network interactions and operational performance levels, the experience with HS1 is germane. The majority of trains using HS1 are not Eurostar's international trains but South Eastern's high-speed domestic services across Kent. On HS1 the average delay per train path from HS1's infrastructure was only 5 seconds in 2017. This is undoubtedly one of the reasons why the South Eastern high-speed commuting service is so popular, with over 10m passengers/annum and continuing growth, despite a 30% fares premium.

Ebbsfleet and high-speed commuter service
Photo: Greengauge 21

3. ETCS – the European Train Control System – sets out levels of industry standards for digital signalling and train control systems.

Phase 2b plans envisage 18 trains/hour operation over the 'stem' of the HS2 Y-shaped network. Such a high frequency has not been achieved on any high-speed rail network to date, and HS2 has an intermediate stop on the stem section of the route for all trains at Old Oak Common, which adds to the performance challenge. But none of the existing high-speed rail networks have fully automated train control systems (of the type increasingly common on new Metro systems) which would probably be a pre-requisite for higher frequency operation over HS2. Current plans (for Phase 1 at least) envisage an ETCS Level 2 application with in-cab signalling and this does not support automated train operation – but could be upgraded at a later stage so that it does.

A more cautious assumption would be that a maximum of 16 trains/hour would be operated over the stem of the Y. Even this is a higher frequency than existing high-speed applications elsewhere. Then it would be practicable to have say 4 trains/hour (at fifteen-minute intervals) stopping at Old Oak Common through the day (potentially increased during morning commuter peak hours) with the remainder passing through non-stop and saving around 4 minutes' journey time.[4] This is a level of service at Old Oak more consistent both with likely demand levels and with the level of provision planned at other intermediate HS2 stations such as Birmingham Interchange.

The two limbs of the Y network have some spare capacity (on current appraisal assumptions for HS2 service plans): potentially 2 trains/hour in each direction over the Phase 2a route between Lichfield and Crewe and 4–5 trains/hour in each direction over the Phase 2b eastern limb . Different ways by which this spare HS2 route capacity could be used were outlined in 2017, along with the capacity released on the existing network following completion of Phase 2 of the scheme. The candidate uses of Phase 1 released capacity on existing lines were first explored by Greengauge 21 adopting a Swiss-style regular interval timetable approach in 2011.

4. This is because, with trains operating with 3-minute headways, the fourth train in a batch of four running at 3-minute intervals could make a station call, while the previous and next three trains run non-stop provided that there is a double length interval after the fourth train in the batch: in effect four batches of 4 trains each hour (= 16 trains/hour). We consider the role of Old Oak Common HS2 station further in the next chapter.

What these earlier studies showed is that there is scope:

1. to add further destinations to the set of places served directly by HS2 (an example being Stoke-on-Trent, now added to Phase 2a plans, with the decision to proceed with the Crewe Hub investment in a way that allows HS2 trains to destinations such as Liverpool and Preston to be divided and joined at the hub station, releasing a train path to London);

2. with additional connections to HS2 (some of which are now under consideration, as described in Chapter 7), additional places could be served by trains using HS2 (an example is Leicester); and

3. to transform the timetable on the existing main lines from which HS2 services will be extracted, with the potential for:

    a. more commuting capacity into major cities
    b. more railfreight services
    c. more inter-regional trains and
    d. new direct services from a variety of locations including those currently lacking such connections to London.

HS2 design speed and energy/carbon impacts

The top-speed of the HS2 infrastructure – 400km/h – exceeds that of existing high-speed rail lines elsewhere, and the first train fleet order will specify a maximum capability of 360km/h. It is not uncommon to allow for some stretch in top speeds to allow for future technological developments. And much of the HS2 alignment is not intended to allow 400km/h operation in any event. Professor Andrew McNaughton of HS2 Ltd explained that 250 mile/h (400km/h) operation of HS2 had not been taken as a fixed design standard at a Transport Select Committee hearing (extract overleaf).

Transport Select Committee transcript extract November 2011

Q437 Chair: Were you instructed that [400km/h] had to be the maximum speed?

Professor McNaughton: No, we were not. The original remit from the previous Secretary of State was a high-speed line of similar standards or similar type as High Speed 1, in other words, that it was to European standards and at least 300 km/h.

In developing those corridors, it became apparent to us that some were more amenable to higher speed than others. In developing for each one the balance of journey time, cost and impact on sustainability, environment, people, etc., we took each route in turn…. The [..] actual speed at any point on the route is always a balance between cost and journey time and impact. Even on the route that we recommended to Government […] by no means all of it is designed for that top speed.

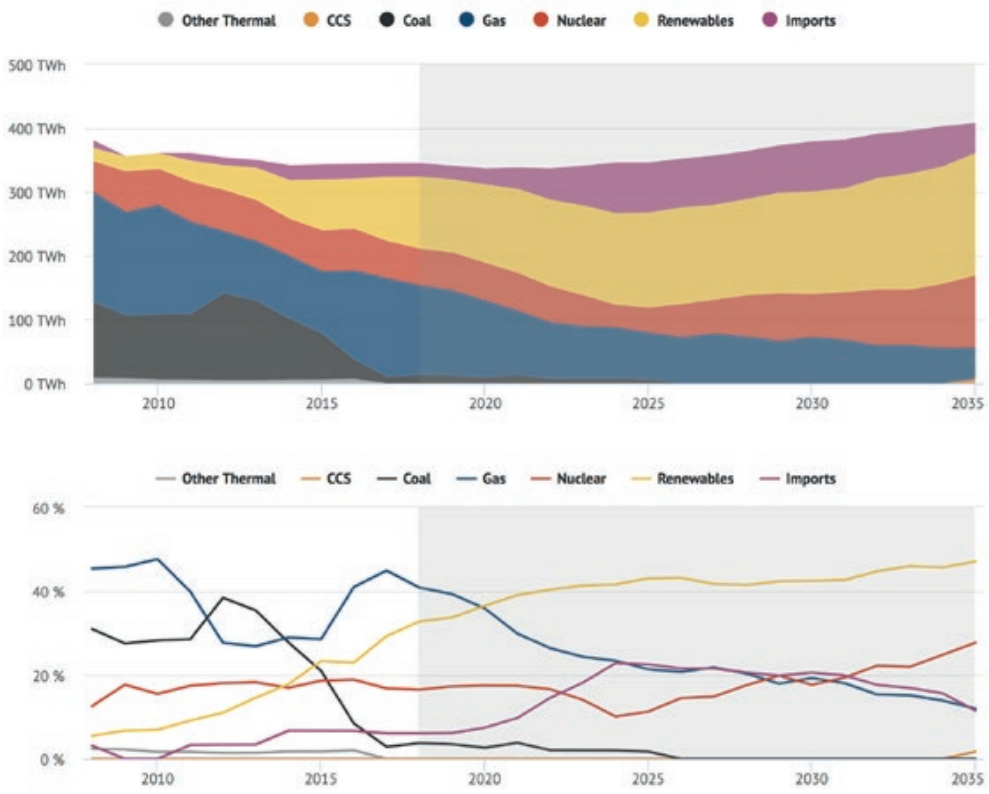
The reason we went initially for 350 km/h to 360 km/h was partly because each of the routes we looked at, including motorway corridors, had potential for that sort of speed while retaining suitable sustainability impacts. That technology is widely available now, all the major manufacturers produce technology for those speeds, and around the world all our colleagues in every country are designing an alignment for at least that sort of speed.

We took it a little bit further on to the 400 km/h (250 mph) for two reasons. One is because we learned very strongly from people […] like Guillaume Pepy [head of SNCF] in France, that they had wished that they had not designed to the limit of the day because the technology continues to advance. They warned us very clearly not to design to the limit and always leave something in hand either for future generations or simply because engineering systems work better when they are not running on the limit. There are examples around the world where people have run things on the limit and they go poorly in the end. But we did not, dogmatically, at any time design to that top speed. That was where it was sensible, practical and gave what we considered in our judgment an acceptable balance of minimising journey time and, therefore, benefits to the cities that High Speed 2 would serve, against the cost and sustainability impacts.

It could be argued that there would be capital cost savings from reducing the top design speed of 400km/h. But the factors that Professor McNaughton outlined in answer to the Transport Select Committee would suggest a number of other factors would then need to be considered, and these would offset the savings achievable.

The question of the energy and carbon impacts of differing operating speeds is another important issue. There is an environmental case to align the timing of adopting higher operating speeds (which increase electrical power levels) with the rate of progress of decarbonising electrical power generation[5] – on which it can also be noted that the UK has made substantial progress over the last two years (see Figure 5.1 below).

Figure 5.1: **Recent and projected trends in UK electrical power generation**



Source: energy and emissions projections published by the UK Department for Business, Energy and Industrial Strategy (BEIS).

5. Greengauge 21, *The carbon impacts of HS2*, September 2012.

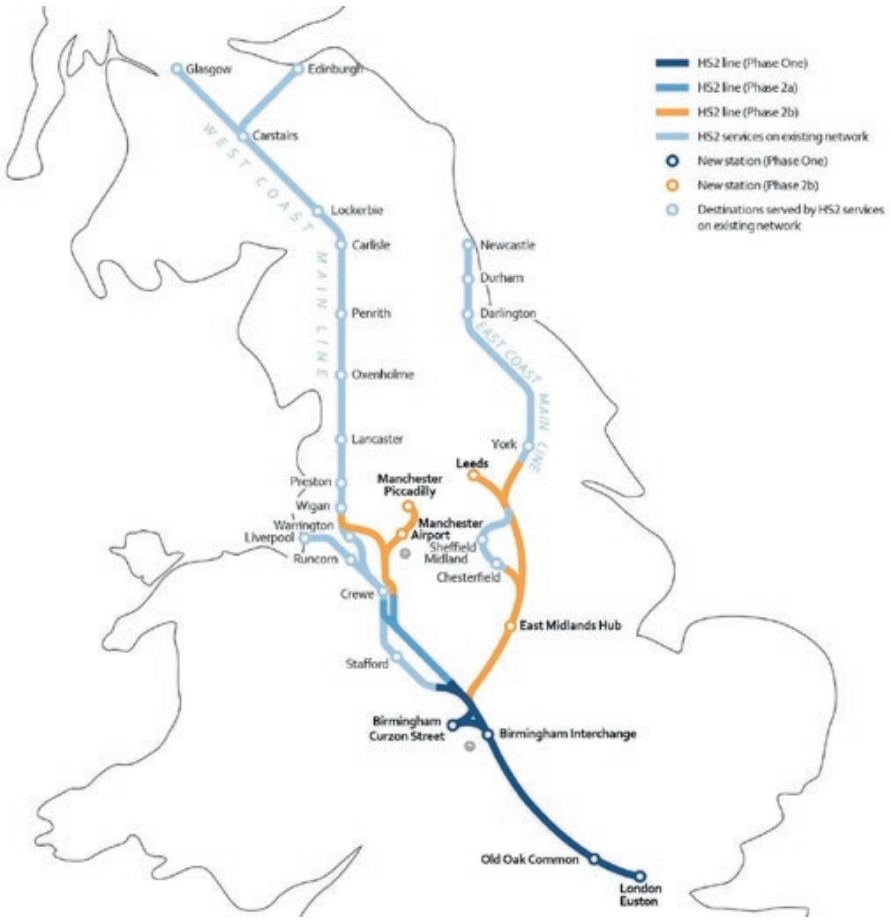
HS2: assumptions and outstanding decision areas

Our assumption in this report is that HS2 Phase 1 will be built and the whole of Phase 2 will be delivered as well; and that Government will hit its carbon targets which will allow the sustainable use of electrically powered high-speed ground transportation systems that will reduce dependence on car-based travel.

But in taking the HS2 infrastructure and its full high-speed operation as a given, there remain considerable choices on HS2 service patterns, on operating rules (turnrounds and line-speeds); and on options for connecting Phase 2 HS2 with the existing rail network, some of which are currently under study.

HS2 services, as planned, will reach widely across Britain, well beyond the limits of the new high-speed infrastructure (see Figure 5.2). The new infrastructure can support service developments in addition to those that have been assumed in project appraisals to date. These wider service opportunities are of great importance when it comes to national network planning to meet connectivity aims – but are not the only relevant investments. In chapters 6 and 7, we explore the limits of what HS2 can support, and thus to be clear about what else is necessary. We do not offer a definitive or general view on electrification, pending completion of industry studies into ways of reducing its costs to levels that can restore its viability.

Figure 5.2: **HS2 phasing and services: current plans**



Source: DfT HS2 Phase 2b Strategic Case, 2017

The Case for electrification of existing lines

The Control Period 5 (2014/19) electrification programme ran into serious difficulties, with major overspends against original, preliminary budgets and timescale over-runs too. Major electrification schemes have been cut back on both the Midland Main Line and Great Western Main Line projects, and train fleets will be very largely bi-mode (diesel and electric). It is not yet clear whether the trans-Pennine electrification scheme (Manchester-Leeds-York) will survive intact, but it has the advantage of being an 'infill' project where the major stations at Manchester, Leeds and York are already electrified.

Some of the electrification cost over-runs are due to errors and poor planning as an NAO investigation discovered. But the adoption of newer standards, with much increased clearances between overhead 25kV lines and adjoining structures, meant that existing stations and bridges and other structures that could have been left unchanged under previous design standards had to be rebuilt, or taken down and replaced. No difficulties had arisen with the now tried and tested electrification systems built to the original standards and the safety performance is exemplary. Until the situation is addressed, electrification of existing lines will be associated with seemingly unnecessary total route re-construction.

All of the currently planned HS2 service extensions are over existing lines already electrified, except the planned loop through Sheffield. Use of bi-mode trains (none exist to date that can achieve HS2's design speed) would seem to be unlikely. The cost of electrifying lines necessary to accommodate the HS2 service should be attributed to the HS2 project.

High-speed rail development beyond HS2

Ministers sometimes speak of HS2 as if on its own it forms a truly national high-speed network but, as we saw in Chapter 1, its benefits leave large swathes of the country untouched, as would be expected from a single north-south line (albeit with two northern branches).

The outline concept for HS2 was first provided by Greengauge 21 in June 2007[6]. It was seen as the first stage of a national network as subsequently published in the report Fast Forward of September 2009.[7] The report set out a comprehensive network of new and upgraded routes that would link all Britain's major cities – helping to ensure a competitive and sustainable Britain. The network we envisaged at that time is illustrated in Figure 5.3.

6. Greengauge 21, *HS2 Proposition*, June 2007.
7. Greengauge 21, *Fast Forward: a high-speed strategy for Britain*, September 2009.

Figure 5.3: **Fast Forward: a high-speed network for Britain**

Source: Greengauge 21, Fast Forward, September 2009

The Fast Forward network envisaged two cross-connected north-south lines, with a speeded-up Great Western corridor and a hub station at Heathrow. It embraced the idea of upgrading existing lines/building medium speed (200km/h+) lines as part of the overall concept (shown in green in Figure 5.3).

Welcoming both Greengauge 21's report and also a high-speed rail positioning statement from the Northern Way[8], HS2 Ltd Chairman David Rowlands said:

8. The Northern Way, *Transforming Our Economy and Our Connectivity – High Speed Rail for the North*, 2009.

> **"These are useful contributions to the much more detailed work which HS2 is doing on identifying a buildable route with station options from London to the West Midlands, including possible connections to Heathrow and High Speed One. We will be submitting a report to Ministers at the end of this year, which will also include a comprehensive business case covering the costs, benefits and environmental impact. It will also consider broad route options beyond to Scotland."**[9]

HS2 Ltd duly published its plans for the Phase 1 route "London to the West Midlands and potentially beyond" in March 2010[10] complete with through running connections to HS1 and to Heathrow Airport. But both of these connections were 'trimmed' from the project as the project passed through Parliament on the grounds that they offered weak business cases, a view countered unsuccessfully by extensive evidence from Greengauge 21 and others.[11] The outcome is that HS2 has no onward links (only interchanges) with the existing national rail network in the south of the country.

The adoption of the Y-shaped network, however, ensures that there is a plan for high-speed rail to serve Yorkshire and the North East as well as North West England, an arrangement that would have taken two new high-speed lines under Greengauge 21 and preliminary Network Rail[12] plans of the time. Some nine years on, many studies have been carried out – into HS2, and variants and alternatives to it, providing a huge array of appraisal evidence that supports the planning choices made.[13]

Our aim now is to identify how best to build on the connectivity and capacity gains that HS2 provides. Should there be further high-speed rail schemes, beyond HS2 – either in the form of new build or upgrades to existing lines? Or are other types of new railway infrastructure needed to expand the advantages of rail more widely?

9. http://assets.hs2.org.uk/sites/default/files/statement_by_high_speed_two_greengauge21_%26_northern_way_reports.pdf, 16 September 2009.

10. Cmnd Paper 7827, HMSO, March 2010.

11. See, for example, Greegauge 21, *HS1–HS2 Connection: a way forward*, April 2014 and *The Heathrow Opportunity*, February 2010.

12. 'Written evidence from Network Rail (HSR 186)', https://publications.parliament.uk/pa/cm201012/cmselect/cmtran/1185/1185we42.htm, June 2011.

13. DfT publishes regular updates to the HS2 Strategic Case; it also has commissioned Atkins to asses a series of alternatives to HS2 elements, for instance those that involve upgrades to the existing railway instead of new-build.

Evidence on connectivity: cities and economic sub-regions

To help develop this *Beyond HS2* strategy, we examined how well Britain is connected. Direct connectivity is often preferable – especially in the absence of frequent and reliable connecting services – as noted in Chapter 3. We examined the direct connectivity of 'economic sub-regions' across Britain – with London, and with other major British cities comprising the Scottish and Welsh capitals, the English Core Cities[14] and Glasgow. These 12 major British cities are important economic growth centres as well as important rail hubs. We took "economic sub-regions" to be the Local Economic Partnership areas in England; the two city regions and the more rural sub-national areas in Wales; and, in the absence of defined "economic sub-regions" in Scotland, the areas covered by the Regional Transport Partnerships. As part of our analysis, we also looked at the direct connectivity of the individual local authorities that make up the 'economic sub-regions'.

Our full analysis is at Annex A and in England shows the Local Economic Partnerships in their Sub-National Transport Body groupings where they exist formally or are emerging. Figure 5.4 shows the direct rail connectivity of the 12 major cities with each other and Figure 5.5 provides an example of one economic sub-region's (the Leeds City Region) connectivity with major cities across Britain. This analysis is then distilled in Figure 5.6.

Only London has at least hourly direct rail connectivity with all the major cities identified. Cardiff is the major city least well directly connected, having hourly connectivity only with London and five other major cities.[15] There is an arc of weak (less than hourly) direct connectivity stretching from Glasgow to Newcastle, Leeds, Sheffield and Nottingham/Derby; no direct connectivity between Liverpool and Edinburgh, Glasgow or Bristol; and like-wise none between Cardiff and Edinburgh, Glasgow, Liverpool, Newcastle, Leeds or Sheffield.

A number of English "economic sub-regions" have less than hourly direct rail connectivity with London. The Humber (north-bank – including Hull), Cornwall and Gloucestershire have services about every two hours and the Marches less than a train every two hours. While Greater Lincolnshire benefits from an hourly service at Grantham on its western edge, London services penetrate to Lincoln less than once every two hours and not at all to Grimsby and Boston. Commenting on the publication of the Beeching Plan, Modern Railways noted in 1963 that:

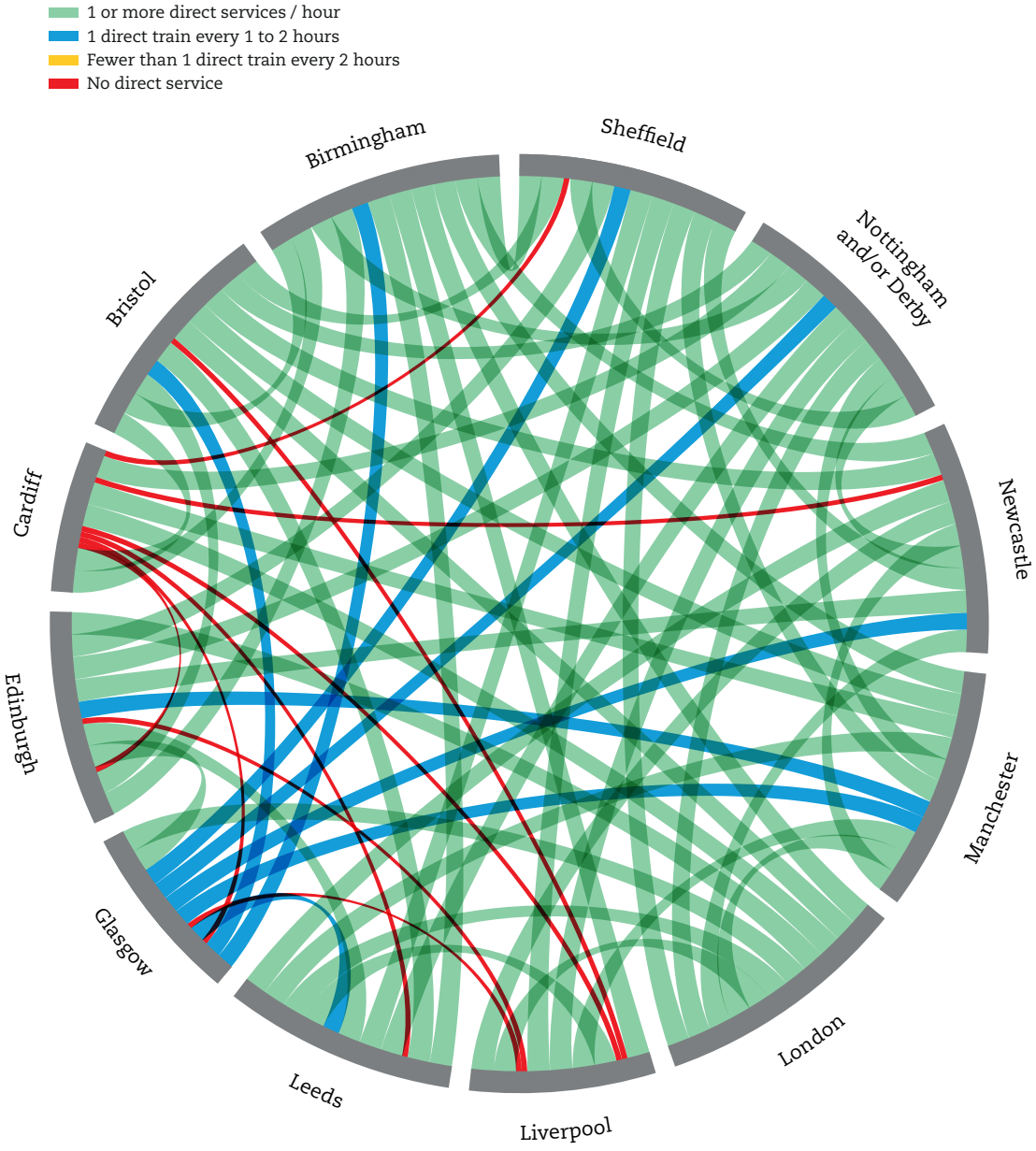
> **"bluntly to inform a town as big as Grimsby that it is to lose its direct route to London without a word of clarification on how it is to be served in future is a needless affront."**[16]

14. The English Core Cities comprise Birmingham, Bristol, Leeds, Liverpool, Manchester, Newcastle, Nottingham, and Sheffield.

15. While Cardiff is a relatively small major city amongst those studied, it is fast-growing and – in rail terms – forms the gateway to the whole of South Wales and West Wales.

16. Modern Railways, Dr Beeching Prescribes, Vol. XVII No. 176 May 1963

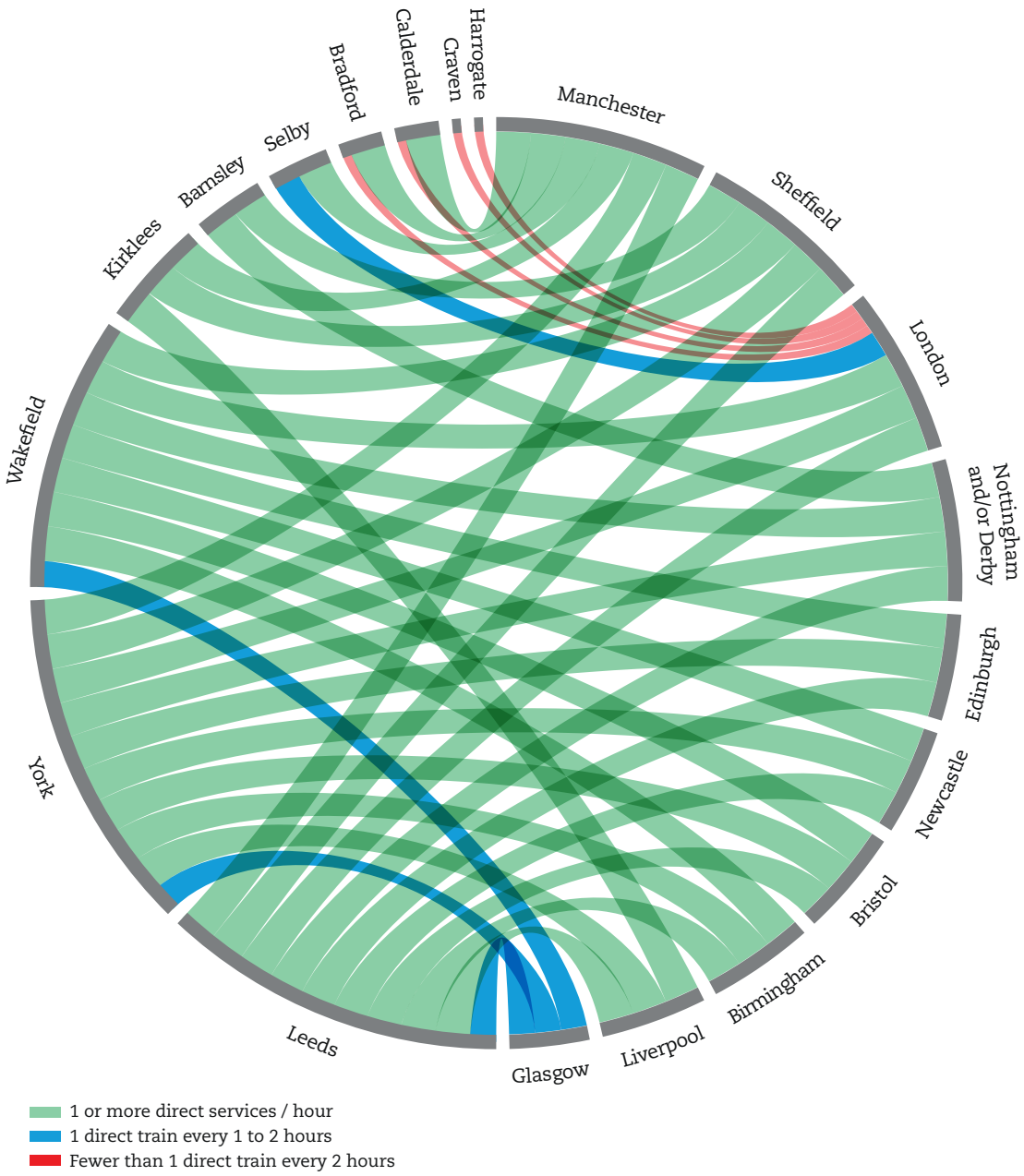
Figure 5.4: **Major city to major city direct rail connectivity**



Fifty-five years on in 2018, it takes around three hours by train from Grimsby to London (a journey of around 150 miles) with a choice of an hourly connecting service (or maybe a drive) to Doncaster or every two hours with a change at Newark. But it is not only some of the less urbanised or peripheral economic sub-regions that have infrequent direct London connectivity. Large 'second' cities like Bradford in the Leeds City Region and Sunderland in the North Eastern LEP are served by less than one direct train every two hours.

In Scotland, north of the central belt, there is just the one direct London service a day to/from Inverness and two to/from Aberdeen and, in Wales, there is one daily London train serving West Wales, none serving Mid-Wales and less than one every two hours serving North Wales.

Figure 5.5: **Direct rail connectivity between Leeds City Region and other major cities**



Note: Cardiff is not shown as there are no direct rail services with the Leeds City Region.

It is also important to draw out some salient points about how well economic sub-regions are connected to major cities other than London:

- In the North, the Humber LEP has direct connections on the North Bank to just three (Leeds, Manchester, and Sheffield) and this falls to two on the South Bank (Manchester and Sheffield). Sunderland has at least hourly direct connectivity only with Newcastle, and Bradford only with Leeds and Manchester.

- In the Midlands, Worcestershire has hourly direct links only with Birmingham and likewise the primary connectivity of the Marches is with Birmingham, together with direct connectivity with Manchester and Cardiff. Lincoln has direct hourly connectivity only with Nottingham and Sheffield.

- Across the Economic Heartland, only Oxford and Peterborough stand out as being well connected to cities other than London. Growth areas such as Northamptonshire, Cambridge, Stansted and to a lesser extent Milton Keynes are all weakly connected to major cities, other than Birmingham.

- On the other hand, with the benefit of the Cross-Country network much of the South-West benefits from hourly services with a range of major cities other than London. The exceptions are reduced frequencies at the end of the network in Cornwall, and Dorset which has direct hourly links at Bournemouth only to Birmingham and Manchester, while Swindon and Wiltshire have hourly direct links only to Bristol and Cardiff.

- Well connected to London, the East of England (including Hertfordshire) is sparsely connected with other major cities – at Watford to Birmingham, at Stevenage to Leeds and at Norwich to Nottingham, Sheffield, Manchester and Liverpool.

- South of the Thames, Cross Country services provide direct, if sometimes infrequent, connectivity to a range of major cities for the Thames Valley (Berkshire), M3 and Solent LEP areas, but London is a barrier for any such connectivity for the Coast to Capital and South East LEPs (i.e. from Sussex, Surrey and Kent).

- In Wales, Swansea City Region is less well connected than Cardiff but has hourly direct connectivity to Manchester, in addition to Cardiff (and London). North Wales has hourly direct (but slow) connectivity only with Manchester, with less frequent direct links to Cardiff and Birmingham. Mid Wales is limited to two-hourly connectivity with Birmingham alone.

- The North-East of Scotland and Tayside, like Cornwall to the far south-west, have direct, if infrequent, services through the Cross-Country network to a range of major cities other than London. The Highlands has infrequent direct links with Edinburgh and Glasgow and a once-a-day service to Newcastle (and London) and no other major city outside Scotland.

In chapter 2 we looked at GVA per head across the country. Often it is the local authority within an economic sub-region that is best connected with London and the other major cities that is performing best or amongst the best on GVA per head within its sub-region. For example, within the Leeds City Region it is Leeds that comes top on GVA per head and well-connected York also performs well on the same indicator. It is, however, not a consistent correlation. Wakefield, a secondary centre in the Leeds City Region, is relatively well connected to major cities, as Figure 5.5 shows, but it performs much less well on GVA per head than either Leeds or York. Major airports and prominent centres nearby are important drivers of GVA too – for Solihull in Greater Birmingham and South Manchester (Trafford) as well as places in proximity to Heathrow and Gatwick.

It is former industrial areas, and coastal and other peripheral locations that are struggling to restructure economically that perform least well on GVA per head and social mobility and where improved connectivity in combination with community-based and properly funded local initiatives in skills development and business innovation will be factors in their future success.

Direct rail connectivity between Britain's major cities and its economic sub-regions – a summary

- There are some distinct shortfalls in connectivity between major cities, notably for Cardiff, between Glasgow and cities east of the Pennines, and between Liverpool and Scotland;
- Large second cities such as Bradford and Sunderland have poor direct connectivity both with London and other major cities in Britain;
- Economic sub-regions in England along the East Coast from the Humber to Essex and also down the Welsh border have limited direct connectivity with major cities - and with London in the case of the Humber, Greater Lincolnshire and the Marches;
- Growth areas across the Economic Heartland are well connected with London but very much less so with other major cities;
- There is no direct cross-London connectivity between Sussex and Kent and major cities north of London;
- Wales has poor direct connectivity with England's major cities and no direct connectivity with Scotland. Few cross-border services penetrate north of the Central Belt in Scotland.

We summarise these conclusions on connectivity in Figure 5.6.

Figure 5.6: **Weaknesses in city to city direct rail connectivity**

Towards our *Beyond HS2* Strategy

Building on the analysis in this and the previous chapters, we now move on to drawing out conclusions on the services that should operate across the HS2 network in Chapter 6; and in Chapters 7 and 8 we set out conclusions from regional levels of assessment, both in terms of further high-speed rail proposals and other strategic schemes. And then in chapter 9 we explore peripherality and the investments that are needed to help reconnect those places left behind not only economically but also in terms of social mobility.

To help reach our conclusions, we used a 'toolkit' to address the capacity, connectivity, productivity, regional economic disparities, international trade, carbon reduction and air quality challenges.

The Toolkit: possible measures to use 'beyond HS2'

In looking *Beyond HS2*, we are taking HS2 as a given plan, and considering what else is needed to create a national rail strategy. Some of the measures available can (and in some cases, should) be implemented before HS2 is complete (scheduled for 2033). The toolkit is illustrated opposite, in broadly declining levels of cost. Measures can, of course, be combined.

One of the toolkit measures requires some explanation. We have included 'high quality interurban bus' in the toolkit of measures because we found in recent research that there are many such services in existence; they are just not well known outside the areas they serve, and they are not well integrated with the national rail network. In relative terms these are problems easily soluble, and our research[17] has a ten-point action programme to address this weakness. The interurban services we have in mind typically operate with fully wheelchair-accessible new vehicles, offering free wi-fi and high standards of seating and good luggage provision.

17. Greengauge 21, *The Interurban Bus Network*, March 2018

The Toolkit

(a) Infrastructure

New build (high-speed).

- new lines;
- added connections HSR-existing network.

New build (conventional speed)

- cut-offs;
- missing connections;
- estuarial crossings;
- airport access;
- freight lines;
- closed line re-openings;
- strategic freight interchanges.

Upgrades of existing routes (journey times, capacity, reliability and resilience, electrification, re-signalling stations and junctions).

Metro rail & LRT schemes for metropolitan areas and facilities for limited-stop interurban express bus.

Digital train control systems.

New stations, multi-modal & rail-rail/metro interchanges and enhanced station access.

(b) Services

- Train lengthening;
- (HS2) bi-level vehicles;
- Tilting trains to enhance journey times;
- Connecting standard interval timetables;
- New direct through rail services;
- High quality interurban bus;
- Integration across the modes.

Summary

We conclude from this chapter that there are a number of important issues and assumptions that need to be considered in framing a national strategy:

- HS2 will form part of an integrated national network rather than a free-standing operation (a decision already taken by Government);
- The two phases of HS2 infrastructure should be taken as a given, but not its train service plan or the connections needed to support through services onto the existing network (neither of which are as yet settled);
- Having reviewed key technical assumptions, we suggest the question of the value of providing for the larger EU-gauge for the whole of Phase 2 needs to be considered;
- We will adopt a cautious assumption of a lower Phase 2 maximum train throughput on HS2 of 16 trains/hour (rather than the 18 tph in HS2 Ltd assumptions);
- HS2, even in its fullest form, should not be regarded as the limit of what would be valuable (and value for money) in terms of national high-speed rail infrastructure;
- High quality rail connectivity is well correlated with the highest-performing cities and sub-regions (GVA/head);
- There are some distinct short-comings in rail connectivity impacting economic sub-regions across the nation;
- In *Beyond HS2*, we will examine the rich variety of measures available (described as a 'tool-kit') to address the policy aims identified in Chapter 1.

6.0 **HS2 services and corridors**

A key part of the ***Beyond HS2*** strategy is an examination of the services that HS2 will support when it is operational. So far these have been developed for the purpose of making economic assessments of the HS2 investment case, and they remain uncommitted and open to adaptation as the actual service plan is developed and finalised.[1]

In this chapter, we examine the pattern of 'planned' London/Birmingham – North of England/Scotland services, as set out by Department for Transport/HS2 Ltd in the HS2 investment case and raise questions about the best use of the eastern arm of the 'Y' network.

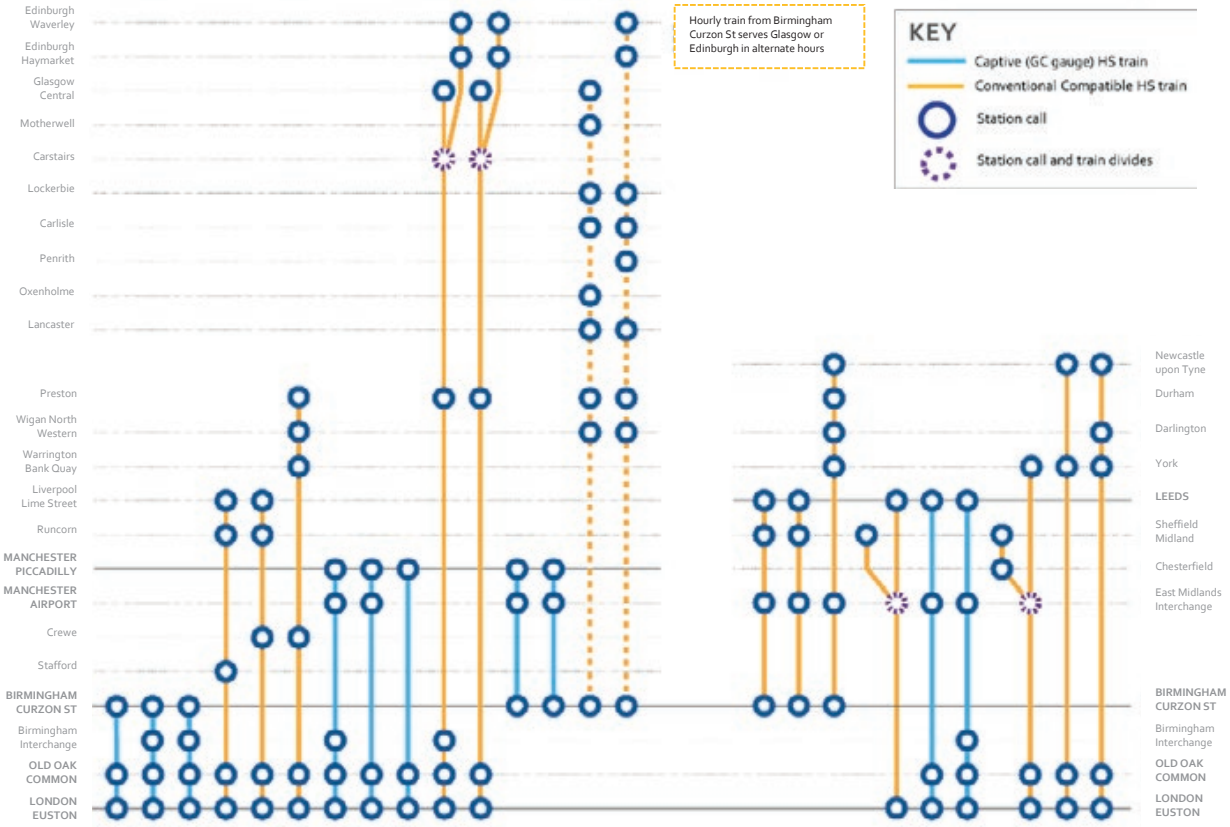
The currently assumed service plan used in economic appraisals for the full HS2 network (Phases1, 2a and 2b) is shown in Figure 6.1. Annual passenger numbers of over 85m are expected.

All services shown are hourly, except the Edinburgh and Glasgow – Birmingham services (shown with a dashed line) which are each two-hourly. Some services divide or join en route: at Carstairs (London – Glasgow/Edinburgh); and at Toton (to split off a portion for Sheffield). In the Phase 2a consultation,[2] there were optional plans to divide/join trains at Crewe (London-Liverpool/Preston) which allows an additional service to run via Stoke-on-Trent, without increasing the number of services to/from London, and these have been recognised as beneficial and are reflected in the plans for Crewe Hub.[3]

1. High Speed Two (HS2) Phase Two Economic case advice for the Department for Transport, HS2 Ltd, July 2017.
2. See House of Commons Library Briefing Paper *High Speed 2 (HS2) Phase 2a* (CBP07082), 19 January 2018 (researchbriefings.files.parliament.uk/documents/SN07082/SN07082.pdf).
3. See HS2 Crewe Hub consultation: government's response, March 2018 (www.gov.uk/publications).

The service plan shown in Figure 6.1 has eleven hourly London services from the western limb and six from the eastern limb: a total of 17 trains/hour, well beyond the highest service frequency achieved to date on a high-speed line, and – as noted in the last chapter – one more train/hour than we judge is appropriate[4] – at this stage – to plan for.

Figure 6.1: **Scheme Service Pattern – the Full HS2 Network including Phase 2b**



Source: Figure 24, High Speed Two (HS2) Phase Two Economic case advice for the Department for Transport, HS2 Ltd, July 2017

4. And one fewer than the claimed line capacity of 18 trains/hour. See previous chapter for the 16 trains/hour operating assumption.

A more cautious plan provides for 16 trains/hour, four of which would stop at Old Oak Common through the day – see Table 6.1.[5] The blank columns denote periods which create a 6-minute service interval, which should be sufficient to allow a non-stopping train (such as Train E in Table 6.1) to pass Old Oak non-stop and uninterrupted, following Train D which will have made a station call at Old Oak. HS2 Ltd's assumption is that if any trains stop at Old Oak Common – all must stop[6] – and with 18 trains/hour this would seem inevitable. But much lower frequencies are planned for other intermediate stops (5/hour at Birmingham Interchange, for example). A revised stopping pattern through Old Oak Common as would become possible with a slightly reduced train throughput could speed-up 75% of HS2 London journeys by about 4 minutes and also should make it an easier-to-use interchange for passengers (in each direction, HS2 trains would all depart from the same platform, every 15 minutes).

Table 6.1: **Potential service pattern HS2 trunk line (indicative only)**

	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
Departure time (minutes past the hour)	00	03	06	09	15	18	21	24	30	33	36	39	45	48	51	54
Stops at Old Oak Common?				yes				yes				yes				yes

Note: departure times refer to HS2 trains leaving Euston. A similar pattern would apply southbound.

Northbound services originating at Birmingham Curzon Street HS2 station make use of the two limbs of the Y-shaped network, with four trains/hour operating over the western and eastern limbs in addition to trains originating at Euston. This still leaves further capacity for additional services, and DfT has published a report which suggests this might allow an additional 2 trains per hour on the western limb north of Birmingham and an extra 4 trains per hour on the eastern limb.[7] This would take utilisation of both the eastern and western limbs of the 'Y' up to 13 trains/hour. We will consider these two limbs in turn, noting the need to share HS2 Ltd's assumption, made from the outset, that it would be wrong to plan on introducing any service knowing that it would need to be withdrawn at subsequent stages of the project's roll-out.

5. In the peak periods (peak direction of travel) in addition to trains D,H,M,Q calling at Old Oak Common, trains C,G,L,P could perhaps also make station calls – this would be potentially of greatest value in the morning peak period when transfer to Crossrail is likely to be most attractive.
6. Although in one direction, there is one train shown in HS2 Ltd's plans as at Figure 6.1.
7. See Department for Transport, *HS2 Released Capacity Study: Summary Report*, July 2017.

Western Arm

The western arm service plan shown earlier in Figure 6.1 has eleven trains/hour.

Changes are possible, or even likely, specifically:

1. The adoption of Carlisle (or Preston) as the chosen splitting/joining point for HS2 London-Scotland services rather than Carstairs (which has minimal demand catchment). This would increase train path volume over the West Coast Main Line (north of Carlisle or Preston) but not over HS2 itself; a 'flighted' timetable on the WCML would be a likely consequence;

2. As the northern section of the West Coast Main Line is improved to shorten journey times towards the agreed target of 3 hours (see next chapter), the growth in demand could, over time, result in the planned use of half-length HS2 trains[8] to serve Edinburgh and Glasgow being short of seating capacity. Using full length HS2 sets would require some investment at terminals in Glasgow and Edinburgh for which Transport Scotland has initial proposals, and it would potentially mean an additional two trains/hour over HS2's western limb and onwards to London;

3. The creation of a new route into Liverpool (possibly via Warrington as part of the idea to use the Manchester branch of HS2 to create some of the Northern Powerhouse city to city connectivity ambitions) with new terminus platforms in Liverpool would potentially accommodate full-length trains to run on the London-Liverpool route. At least in peak periods, the scale of demand from Liverpool and Warrington could preclude the idea of using half-length and joining/dividing HS2 trains at Crewe. This in turn would also increase the number of train paths to be operated over the western limb (and through to London);

4. Further route electrification could create the opportunity to extend HS2 services or introduce new ones. In the case of some service extensions (say Preston-Blackpool) this would have no impact on HS2 line capacity; but if (say) Crewe-Chester were to be electrified, a good case would exist to introduce a Chester-London HS2 service[9].

8. At 200m, half-length HS2 trains are significantly shorter than the trains they would replace – the Pendolinos which are 253m long. Two 200m trains/hour (as per Figure 6.1) allows for capacity growth over today's capacity levels.

9. At 200m, half-length HS2 trains are significantly shorter than the trains they would replace – the Pendolinos which are 253m long. Two 200m trains/hour (as per Figure 6.1) allows for capacity growth over today's capacity levels. Another option that might work better is to have 267m and 133m sets that can be better matched to the inevitably imbalanced pattern of demand for portion services.

It is, therefore, hard to escape the conclusion that, on current pans, after the phased implementation of HS2 is complete in 2033, there could be demand for perhaps two additional hourly HS2 paths over the western arm – consistent with its assessed spare capacity – and onwards to London. If this were the case, instead of 7 paths being available for London services over the eastern arm services (6 are shown in Fig 6.1, with one of the 18tph to London paths remaining unused), there would be only five train paths/hour available, and only three if the overall path maximum is taken as 16 trains/hour.

Eastern Arm

The Figure 6.1 service plan has three London trains/hour serving Leeds and three York/Newcastle, complemented by two Birmingham trains/hour from Leeds and one/hour from Newcastle. Sheffield has two trains/hour to London (dividing or joining at Toton) one of which is shown as calling at Chesterfield, and 2 trains/hour to Birmingham, but these don't call at Chesterfield.

It may be worth considering whether an alternative, shorter and therefore less costly, approach to Sheffield (Midland) via the Woodhouse-Darnall corridor – as considered when a Sheffield alternative station at Victoria was under consideration – would be better value. Sheffield-London HS2 times would be significantly quicker than the 1h27 minutes journey time with the approach via Chesterfield[10], although a reversal would be needed for the two Sheffield – Birmingham HS2 trains which start in Leeds.

The HS2 eastern arm services bring substantial journey time savings from London to Leeds (reduced by 38% from 2h11 minutes to 1h21 minutes[11] but only half this scale of journey time reduction (19%) for London-Newcastle (reduced from 2h50 minutes to 2h17). Work by DfT's consultants, Atkins, looking into the alternatives to HS2, showed that with what it called 'an agreed list of 'committed' schemes' (see Table 6.2), the journey times for London-Newcastle via the East Coast Main Line could be only 7 minutes slower than via HS2.[12]

10. And Chesterfield will continue to get good services over the Midland Main Line because of the need to continue to serve Derby.

11. DfT HS2 Phase 2 Strategic Case, Moving Britain Ahead, July 2017, p5.

12. See Department for Transport and HS2 Ltd, *HS2 Phase 2b: strategic alternatives*, November 2016, Tables 1–3.

Table 6.2: **East Coast Main Line agreed list of assumed 'committed' schemes**

1. Kings Cross throat works including possible reopening of Gasworks tunnel (not Copenhagen tunnel)
2. Power enhancement to Hertford Loop
3. 4 tracking Huntingdon to Woodwalton and reversible signalling over Stilton Fen 2 track
4. Speed improvements at Peterborough
5. Grade separation at Werrington
6. Shaftholme junction line speed increase
7. York station (northern) throat works
8. Northallerton to Newcastle freight loops
9. ERTMS
10. Thameslink

Source: Atkins Strategic Alternatives to HS2 Phase 2b ISSUE 2.0, November 2016, p19

The so-called committed schemes listed in Table 6.2 have not all, in fact, been agreed and committed as yet – but they are reasonably well advanced through the planning stages, and so as assumptions for (say) 2033, they were no doubt considered to be a reasonably central estimate of outturn infrastructure enhancements on a route which has been the subject of a programme of progressive improvements through several decades.

Much of the motivation behind these investments is the aim to accommodate additional services on the East Coast Main Line. They support better journey times by easing timetable pathing constraints and localised speed uplifts, and ERTMS (specifically, one of its components, ETCS, the train control system) would allow for the operation of the new Azuma train fleet at its design speed of 140 mile/h where track geometry permits.

The largest time saving from the eastern arm of HS2 comes from faster connectivity for cities in the north with Birmingham. If there are insufficient paths available over the stem of the HS2 'Y' network available to accommodate all of the potential demand flows to London, then it would seem most sensible to provide for faster London services for North East England by upgrading the East Coast Main Line rather than operation over a hardly any quicker (because longer) HS2. While this might not achieve exactly the same journey time improvement that HS2 offers, it comes very close, and North East-London service speed-ups could potentially be delivered sooner. No other sub-group of planned HS2 services could benefit from another route enhancement to an equivalent extent. Enhancements to the East Coast Main Line could happen progressively through the 2020s and the investments could support other service enhancements besides those for London-North East England services. There are significant capacity constraints on the ECML, and arguably the most pressing is in North East England (Darlington-Newcastle) where investment is needed regardless of which routing is adopted south of York by fast London services. Implementing HS2 does not remove the need for investment in the northern part of ECML.

There is a two-edged nature to the investment policy decisions, since south of York, HS2 and the East Coast Main Line run in parallel and inevitably the case for investing in one route is affected by decisions made on the other. Whatever is decided needs to form a committed part of a wider strategy so that the wider economic benefits can be secured from ECML enhancements alongside those from HS2.

A good combination of route capacity utilisation could be to retain the Leeds – London services on HS2 as planned while enhancing the speed of Newcastle – London services on an upgraded East Coast Main Line. Removal of Leeds-London services from the ECML would still provide valuable capacity release.[13]

This would leave the eastern arm of HS2 under-utilised on current plans, but there is a consequential opportunity. There would be no shortage of capacity to operate a range of other services over the HS2 eastern arm, provided they leave the HS2 route at Birmingham rather than continuing to London. As configured, HS2 can only accommodate a few of the wide mix of city-to-city cross country flows in the North East – South West direction, and this is an area of connectivity short-comings as was shown in Figures 5.4 and 5.6. The eastern limb can be re-purposed to provide a way to spread the advantages of HS2 much wider, creating a higher speed 'X' out of the 'Y' network as we show in the next chapter. This also helps achieve optimum utilisation of the HS2 network, which is not achieved on current plans – and the North East would not only have a faster London service but also HS2 trains which can provide a significant connectivity gain for travel to Birmingham and beyond to Bristol and Cardiff.

13. If Newcastle-London services are also switched to HS2, there is possibly a risk that the southern part of the ECML would be downgraded, and the investment stream (the 'ECML Connectivity Fund') turned off.

Conclusion

The nature of a 'Y'-shaped network is that the stem of the 'Y' is under greatest pressure (into London) while there is some spare capacity on the two arms.

To the west, there is scope to add a key new destination for HS2 services (Stoke-on-Trent) without increasing these pressures, and further opportunities may arise as extensions of already planned HS2 services (for example northward extensions of London services from Preston to Blackpool or to Lancaster, and the main line stations of Cumbria (Oxenholme, Penrith and Carlisle)).

In the longer term, the likely need for additional London HS2 service capacity from Scotland and potentially Liverpool is foreseeable. This will add pressure to the Birmingham-London section of HS2, even if the safer assumption of a maximum throughput of 16 trains/hour (rather than 18) isn't adopted, as we suggest it should be.

To the east, the question of getting the right balance between investing in HS2 and the East Coast Main Line has been highlighted. The scope to route services from the North East to London over an upgraded East Coast Main Line rather than HS2 has been identified as achieving the best balance. It could:

1. Help ensure that investment continues – and is indeed accelerated – on the East Coast Main Line, so that places that do not benefit directly from HS2 can get more services and better connectivity;

2. With HS2 London services from West Yorkshire on HS2, still achieve valuable capacity relief on the ECML for additional services that are currently 'squeezed out';

3. Allow a re-purposing of the eastern arm to enhance cross country connectivity from east of the Pennines to Bristol and Cardiff and beyond;

4. Allow the creation of a more valuable and efficient high/higher-speed, X-shaped, network rather than a 'Y'.

The overall implications are for an enhanced business case, with new services on HS2, and others achieving close to equivalent outcomes via the East Coast Main Line, on which route further investment would be made, benefitting a very wide catchment. A revised approach to Sheffield would both save capital outlay on the existing railway and speed up Sheffield HS2 services (significantly). A revised stopping pattern through Old Oak Common could speed-up 75% of HS2 London journeys by 4 minutes and make it an easier-to-use interchange for passengers.

7.0 Scotland, the North of England and the Midlands

In this and the next chapter, we examine the ambitions for improved rail services that have been set regionally and locally by city and city region authorities and others in terms of regional connectivity and capacity. We reflect the full set of objectives identified in Chapter 1.

We look at the North and the Midlands, cross-border routes and Scotland, and the existing spine railway corridors along the west and east coasts. We draw on an important set of Route Studies carried out, in consultation with stakeholders, by Network Rail under its Long Term Planning Process (LTPP, time horizon: 2043). We consider the long distance Cross Country network of services and, building on our findings in chapter 6, conclude on the best use of HS2's Phase 2 eastern arm by distilling implications from each of these regional and route-based studies.

Network Rail Routes 2017

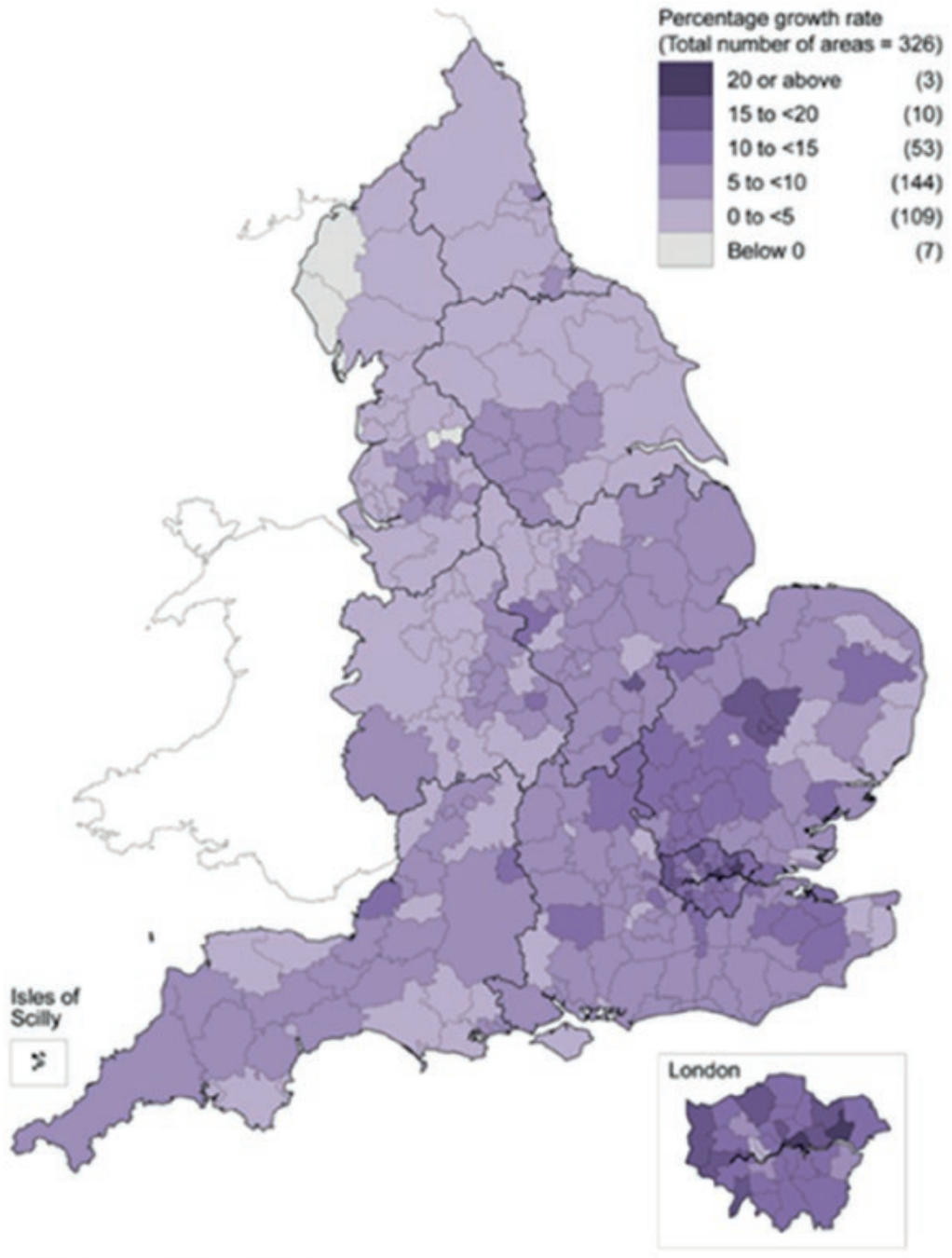
The Network Rail Routes map poorly onto the geography covered by Transport for the North and Midlands Connect.

Within England, the routes are a series of radiating sectors of a circle centred on London. This reflects railway geography, but it means that Route-based plans function well at a corridor level, but lack focus on east-west connectivity in the North, Midlands, East Anglia and the South-East.

Source of map: Network Rail

Our aim is to identify and draw out regionally based proposals that should form part of the wider national strategy, and where necessary provide a challenge to current thinking. In doing so, we recognise varying economic prospects across the country – as reflected in Figure 7.1[1]. We also believe that decisions on transport connectivity can help change the 'continuity' assumptions behind such projections.

Figure 7.1: **Variation in the outlook for economic growth to 2030 across England**



1. This diagram from Office of National Statistics dates from 2014. Much has changed since then, but the evidence suggests that, in general, stronger performing areas have become relatively stronger still.

The advent of HS2 has acted as a stimulus for considering new lines. The advantages that HS2 will bring has been seen most clearly in relation to better connectivity with London and the regional economic benefits that flow in response. Partly prompted by a set of reports produced by the Chairman of HS2 Ltd, Sir David Higgins from 2014 onwards[2], other connections have been recognised as having great importance too. This thought has, in practice, driven much of the work of the two most advanced English regional bodies, Transport for the Northern (TfN) and Midlands Connect, over the last three years.

Connections with HS2 in the North and the Midlands

At the Conservative Party conference in October 2017, chancellor Philip Hammond announced 'a further £300m to future-proof the railway network in the north, ensuring HS2 infrastructure can link up with future Northern Powerhouse and Midlands Rail projects while keeping open all options for services through Manchester Piccadilly'. This was confirmed in the Autumn Budget.

In answer to a written Parliamentary question on 'the eligibility criteria' for the planned £300m infrastructure funding, Rail Minister Paul Maynard said in November 2017 that this would be used to ensure that:

"HS2 infrastructure can accommodate future Northern Powerhouse Rail (NPR) and Midlands Connect services. This includes connections:

- in the Leeds area, enabling trains from for example Sheffield and the Midlands to travel via Leeds and on to York and the North East;
- to the HS2 Western Leg line to connect Liverpool to Manchester Airport and Manchester Piccadilly stations;
- in the Manchester area to enable Northern Powerhouse Rail services from Liverpool to continue from Manchester Piccadilly station east towards for example Leeds; and
- to enable services from East Midlands to the North to travel via HS2, for example between Leicester and Leeds.

These uses of HS2 infrastructure could be reflected in the Phase 2b hybrid bill if practical and affordable propositions can be developed that deliver value for money for the taxpayer whilst ensuring significant benefits for passengers."

2. See HS2 Ltd Chairman's reports, 21 November 2014.

Transport for the North and the North of England

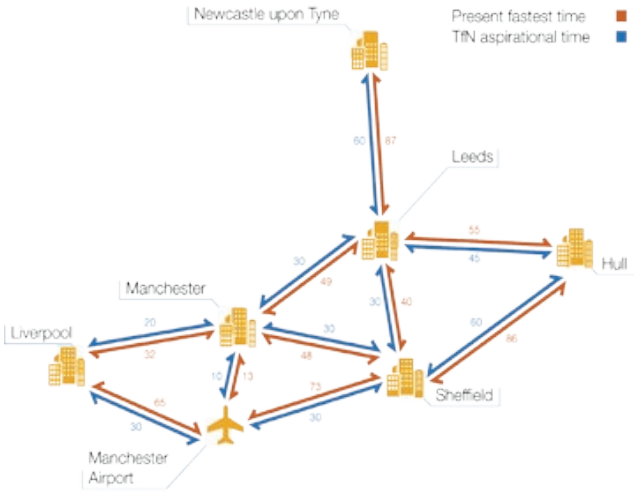
The North of England comprises three geographic regions (North West England; Yorkshire and the Humber and North East England), with a population of 16 million, an economy worth £317bn Gross Value Added, 7.5 million jobs and £50bn goods exported per annum.

Transport for the North (TfN) became the first sub-national transport body in April 2018. It has responsibility for developing a strategic transport plan, a first draft of which was published in January 2018.[3] The plan is aiming for an additional 850,000 jobs and £92 billion additional Gross Value Added, over and above 'business as usual' trends by 2050.

For the last 30 years, the North's economic output per person (measured as GVA) has been consistently around 25% below the average for the rest of England, and 10-15% below the average for England excluding London.

A key aim since 2014 has been to create much better rail connectivity between the major cities of the North (see Figure 7.2). This is intended to support the 'Northern Powerhouse, providing economic strength by enabling the main cities of the North to act together, and to provide a counter-balance to the pull of London and the South East'.

Figure 7.2: Target rail journey times, North of England major cities and Manchester Airport



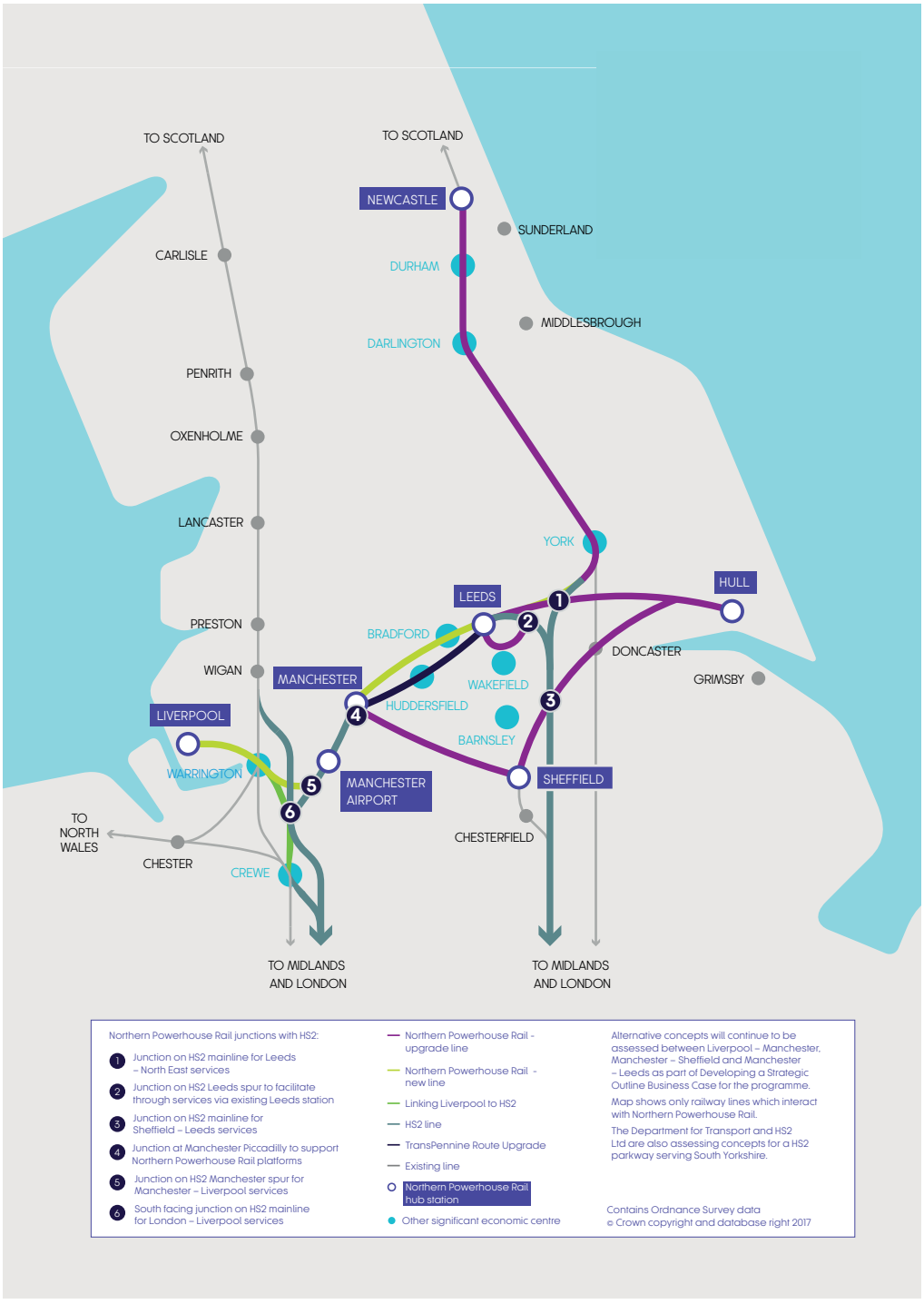
Source: *The Northern Powerhouse: One Agenda, One Economy, One North*, March 2015.

This diagram shows the faster connections between major cities (and Manchester Airport) sought across the North of England. It was adopted by Transport for the North as a set of conditional outputs for 'Northern Powerhouse Rail' (NPR) – namely rail journey times to be achieved subject to developing suitable business cases. The times shown in Figure 7.2 are all faster than are achieved on today's railway.

3. See *Transport for the North, draft strategic plan for public consultation*, January 2018.

The modified route now planned for the eastern limb of HS2 (Phase 2b) provides for one of the key city pairs (and in fact the busiest in terms of demand) the sought-after 30-minute journey time between Sheffield and Leeds. This would be achieved with some new junctions linking HS2 to the existing network (numbered 2 and 3 in Figure 7.3, which is taken from TfN's draft Strategic transport plan of January 2018).

Figure 7.3: **Emerging vision for Northern Powerhouse Rail Network**



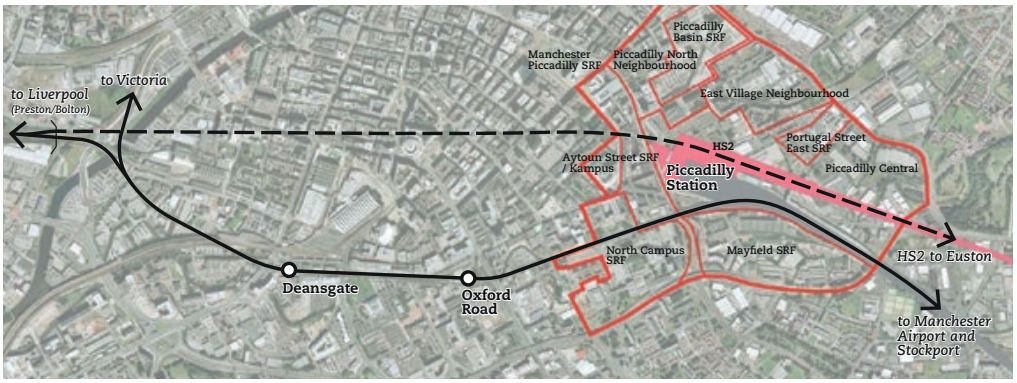
Achieving the critical[4] Manchester-Leeds 30-minute journey time would need new sections of route to be built, as part of Northern Powerhouse Rail. TfN's current presumption in favour of a route that serves Bradford en route will likely add to the extent of new alignment needed and to its capital costs compared with a more direct route. Electrification of the existing Leeds-Manchester railway, with limited localised improvements in the meantime, assuming it is taken forward (this is the TransPennine Route Upgrade), is likely to reduce journey times by about ten minutes, so that journeys between Leeds and Manchester would be speeded up and take 40 minutes (compared with a time of 51 minutes today).

Liverpool–Manchester

The target Liverpool-Manchester journey time is 20 minutes between the two city centres. TfN's preferred approach to achieving this is to add a new high-speed alignment westward from the Manchester Phase 2b branch of HS2 (Junction 5 in Figure 7.3). This would go to Liverpool, with an additional connection that will also allow HS2 services between London and Liverpool to join the new quicker route into Liverpool (new Junction 6). But the resulting route between the two northern cities is indirect and is acknowledged as unlikely to deliver the target 20-minute journey time, although it would ensure greater use of the planned Manchester branch of HS2, and it would allow expansion of railfreight over the critical Crewe-Weaver Junction section of the WCML, which would be needed to make use of the suggested freight chord at Widnes, noted earlier on p64. As we will show, there may ultimately be a better way to achieve these objectives.

The layout of the planned HS2 station at Piccadilly is conveniently alongside the existing station and ideally placed both for local rail and Metrolink access (coloured pink in the diagram below, alongside the existing Piccadilly platforms). Using the planned HS2 route into Manchester means that trains from Liverpool, if TfN's draft plan is implemented, would approach the station from the east. This means that to create the through Liverpool-Manchester-Leeds high-speed route, trains from Liverpool would need to proceed onwards to Leeds either by means of a newly constructed tunnel (broadly westwards from Piccadilly under the city centre before looping back to the north east) towards Leeds/Bradford or would need to reverse at the station (Junction 4 in Figure 7.3 covers this particular challenge).

4. Critical because: (i) these are the two largest northern city economies, only 36 miles apart (43 miles by motorway or railway), with rail journey times today generally around 51 minutes, so inhibiting the full agglomeration benefits the two city economies can bring each other, and (ii) because so many of the key longer distance movements across the north by rail involve using the Leeds-Manchester corridor.



Base map source: see March 2018 City Council paper at http://www.manchester.gov.uk/downloads/download/6117/hs2_piccadilly_srf.

If the business case for this part of Northern Powerhouse Rail turns out to be weak, there are other solutions that could be considered, either as an alternative, or as a subsequent phase of development. One that could deliver the target 20-minute journey time would be delivered if the existing route via Newton-le-Willows, which has a largely straight as well as direct alignment, is upgraded for 125 mile/h operation, with provision made for new separate tracks over the sections of route where there are stations that need to be served by local stopping trains (west of Newton-le-Willows and a short section within Greater Manchester)[5]. The western part of this approach reflects thinking by the '20 miles more' campaign group that wants to see an HS2 extension into Liverpool.

Given the volume of services using the Castlefield Corridor in Manchester, there would need to be a new tunnelled route (approximately 2 miles long) built from the Ordsall area to Piccadilly. This would provide a faster route to Liverpool and has potentially three strategic advantages:

- It allows for more direct onward routes to destinations east of the Pennines (Sheffield/Nottingham as well as Bradford/Leeds for Hull and Newcastle,)
- Very substantial relief can be given to the Castlefield Corridor across central Manchester, with all inter-regional trains that might entail longer station dwell times able to use new, longer low level HS2/NPR platforms at Piccadilly instead of platforms 13/14[6]
- It would mean that HS2 trains from London and Birmingham could serve Manchester and then continue northwards to Preston, Carlisle and Scotland – potentially adding to the value of the HS2 Manchester branch and providing valuable routing options for HS2 services.

5. See Hall, Thrower and Wray, Town and Country Planning, April 2014, pp172–179 for this proposal.

6. Rather than services from Liverpool only, longer distance trains from Glasgow, Edinburgh, Windermere, Barrow-in-Furness, Blackpool, Chester and North Wales could use a new Ordsall-Piccadilly link. This holds the prospect of major relief to the Castlefield corridor which can then be focussed on more local services over lines from Warrington, Newton-le-Willows, Southport &Wigan, Bolton & Blackburn, Burnley & Rochdale, Stalybridge & Ashton-under-Lyne, and the full set of south of Manchester commuter routes from Hadfield/Glossop, Buxton, the lines through Stockport and Manchester Airport.

The Castlefield corridor lies at the heart of the North's rail network and as demand grows it will be unable to accommodate the mix of longer distance cross-Manchester and Manchester City Region services it carries today. If longer distance services from the west and north west are able to access the Piccadilly Hub using its new platforms, then Greater Manchester City Region train services could be significantly expanded on the existing lines which have multiple central Manchester stations, including an upgraded Oxford Road. Plans to accommodate NPR within the expanded Piccadilly station would be unaffected other than the removal of the need to consider reversing through trains in the new platforms.

While this might provide an excellent long-term solution, its existence should not delay progressing Northern Powerhouse Rail which is progressing through business case development under a joint Transport for the North/Department for Transport team. Provision for its future adoption should be made, however, in the designs for Manchester Piccadilly station's expansion plans.

In the meantime the Castlefield corridor will need attention well before NPR plans are likely to come to fruition (which might not be until 2036–45[7]), as we discuss below when we come to consider rail access to Manchester Airport.

The North's Key Corridors and Stations

The other northern city-to-city connection connectivity improvements remain the subject of further studies. As TfN's Long Term Rail Strategy Update, which concentrates on development through the 2020s, makes clear[8], the Sheffield-Manchester corridor will be examined as an upgrade prospect, and only if this proves unworkable will consideration be given to a new 'south' trans-Pennine route. The approval of a Transport & Works Act order in February 2018 allows for the creation of passing loops at Bamford and Dore, allowing the number of fast trains/hour on the route to increase from two to three,[9] but this is just a step towards the full route upgrade needed.

Greengauge 21's Fast Forward network of 2009 included a new east-west trans-Pennine rail link. Its function was to provide transformed connectivity within the North and also to provide a means to operate a set of fast longer distance cross country services (for instance from East Anglia to North West England). Attention still needs to be given to the 'south' trans-Pennine corridor (Sheffield-Manchester, which has a very poor road capability) as well as the busier M62 corridor between Leeds and Manchester.

7. See *Transport for the North, Long Term Rail Strategy*, January 2018.
8. *Ibid*.
9. See Department for Transport, *Network Rail (Hope Valley Capacity)*, 13th February 2018 (www.gov.uk) .

Northwards and eastwards from Leeds there are constraints on the two-track railway through Garforth that could potentially be addressed by a new junction with the planned Phase 2b HS2 route (Junction 1 in Figure 7.3). In Leeds as well as other northern cities – Manchester and Bradford in particular – there is a pressing need to make better use of station capacity in the city centre, to improve the economics of local train services and to cross-connect satellite towns to provide better connectivity.

Creating city region networks

Of the largest cities in the North, Liverpool has the most developed city region rail network, based on the link and loop investment in the 1970s that led to the creation of the Merseyrail Electric network. In London, the solution to the inefficiencies created by the ring of termini around the centre was solved initially by the Underground, and then a century or more later by creating cross linkages that allow through running from the national rail network: Crossrail and Thameslink. In Europe these would be classified as regional express rail ('RER') or S-Bhan. We will simply refer to them as city region rail networks.

Bradford, Leeds and Manchester each need a better city region rail network. Instead of services that terminate at city centre stations, they would be cross-connected. If this was the only challenge, the solutions would be relatively straight-forward, although some relatively small-scale electrification schemes would be required. But the North also needs much better city-to-city connectivity at the same time. This creates the need and the opportunity for smarter planning solutions.

In Leeds, a key need is to expand rail access capacity to City station from the east – and potentially add a second city centre station for cross-city trains on a city region network that cross-connects routes to the east and west of the station. In Manchester, the key Castlefield corridor acts as a capacity constraint and requires both short/medium term and longer-term solutions. In the case of Bradford, the advent of NPR may point the way forward.

In the cases of Liverpool and Newcastle, there should also be further developments in city region network provision. This strategy embraces the extension of the Merseyrail Electrics network to Preston eliminating the train to train transfer at Ormskirk (as a by-product of a potential new strategic freight route), and an equivalent service extension to Wrexham would eliminate enforced train to train transfers at Bidston. In the North East, local authorities have been pursuing the addition of Ashington/Blyth to the local service network and this would form a very suitable complement to the much improved intercity connection that Newcastle will enjoy, and it too could be operated on a cross-city basis.

In the North East, it seems unlikely that all of the service aspirations on the section of the East Coast Main Line between Darlington and Newcastle – which include new higher-speed open access Edinburgh-London proposals and increased Trans Pennine Express services – can be accommodated alongside the InterCity East Coast and long-distance cross-country services, local commuter trains and freight. This is a section of route where examining upgrade options is likely to lead to a new section of line being needed for a capacity reasons, with the option of achieving shorter journeys times as a consequence. A solution needs to be implemented certainly no later than 2033.

For the NPR intercity developments to prove fully worthwhile, it will be essential that each of the major city stations – Liverpool, Manchester, Sheffield, Leeds, Hull, Newcastle, to which should be added others such as Doncaster, Preston, York, Chester, Warrington, Darlington and Carlisle – acts as a hub[10], designed to feed journeys from the regional or city region networks onto the HS2 and NPR intercity networks. This in turn means attention also has to be paid to services on these more local, regional networks, and to the capacity and ease of use of the hub stations[11], ensuring that there are attractive service frequencies, with fares integrated (in a way equivalent to those enjoyed across London's transport networks), excellent arrangements for access by the most sustainable transport modes, and a single, seamless network created in the minds of users.

There is no escaping the fact that transforming these stations to get them fit for today's purpose is challenging and likely to be expensive. But Britain has a good track record on this, blending historically valued buildings with contemporary design, and fashioning zones of prosperity in the immediate surrounds.

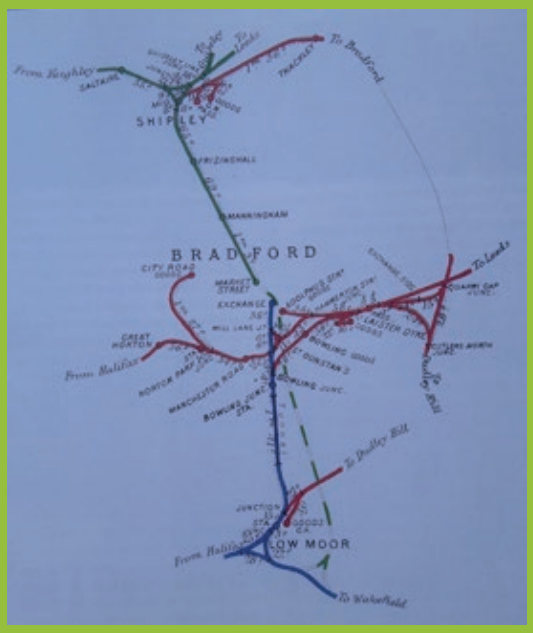
The case of Bradford is perhaps an extreme case (it has two unconnected city centre termini), but it could yet serve as a positive case study for the type of strategic investment that comes from looking at local/regional and inter-regional connectivity together (see panel). The way in which the Northern Powerhouse Rail outline plan in Figure 7.3 could be combined with the creation of a city regional rail network and the wider rail connectivity that Bradford has always lacked is shown in Figure 7.4.

10. See, for example, Growth Track 360, West and Wales Rail Prospectus launched (www.growthtrack360.com).

11. While each of the stations in question has been subject to investment programmes within the last 15 years, none of them has yet experienced the major make-overs and expansion enjoyed by major stations in London (Kings Cross, St Pancras, London Bridge, Blackfriars; or Paddington and Liverpool Street both of which have been superbly renovated and which will shortly enjoy the advantages that Crossrail brings too).

The Case of Bradford

The latest population figures produced by the Office for National Statistics (ONS) in June 2017 show that an estimated 534,300 people live in Bradford District – making it the fifth largest metropolitan district (in terms of population) in England, after Birmingham, Leeds, Sheffield and Manchester.



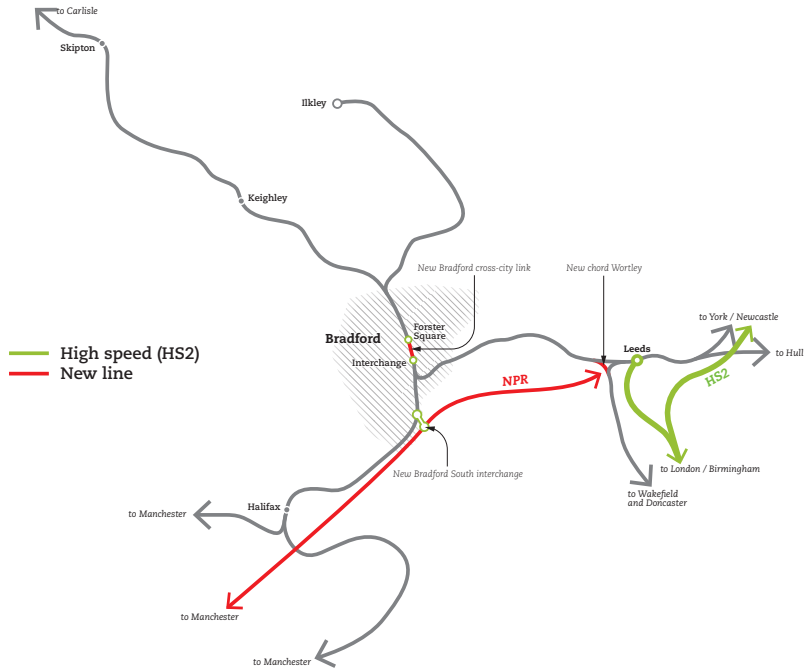
Transport for the North plans for a new high-speed Leeds – Manchester rail link might include an intermediate station to serve Bradford. This might be provided to the south of the city, rather than the city centre, to avoid unduly lengthening (and increasing the cost of) the trans-Pennine link. But even if such a scheme incorporates a station in central Bradford, the same problem remains: there are two stations in Bradford, on the northern and southern fringes of the city centre and they are both termini, with no inter-connection.

A cross-Bradford railway link received Parliamentary Powers in 1911 (see one such plan – dashed green line – in the diagram) but the First World War intervened and after 1918, railway company finance had weakened to such an extent that it was abandoned. It has been examined since, but found to offer poor value for money. But if there is a new high-speed east-west route with which it can intersect, the case for creating a tunnelled north-south rail route across the city centre would be much stronger. Its services would then not only serve Bradford city centre better and more efficiently, but would act as a key feeder to the NPR line – and the case for it serving a much wider Bradford catchment and its value for money would also each be strengthened.

Source: Railway Clearing House diagram, 1913

Note the differing colours reflect the several railway companies then existing, each with their own central termini. The dashed green line indicates a version of the planned cross-city rail link of the time.

Figure 7.4: **Connectivity for Bradford – Northern Powerhouse Rail (NPR), Cross-city link and Wortley Chord.**



Shorter-term, in advance of a new NPR trans-Pennine link, there is clearly much that can and should be done to improve the capability of the North's rail network that will feature in TfN's plans, building on the investment committed through the Northern and Trans Pennine Express franchises and bringing the 'Great North Rail Project'[12] to satisfactory completion. A way needs to be found to ensure that expected demand growth through the 2020s can be accommodated. And surely, it isn't the intention to wait until the 2030s and 2040s before a major spur to the North's economy can be created from the delivery of Northern Powerhouse Rail?

Manchester Airport Rail Hub

The Northern Hub and Ordsall chord allow greater use of the Castlefield Corridor (Deansgate-Oxford Road-Piccadilly) for cross-city services. But as these services intensify and take on more of an 'S-Bahn' or Thameslink style of operation, demand is expected to continue to rise strongly, and the corridor will become less well-suited for lower-frequency long-distance services (such as those to East Anglia, Scotland and Wales) which it also currently accommodates. In the longer term (2033 and beyond), we have offered a solution using a modified route for the Manchester-Liverpool part of NPR, with a central Manchester cross-city tunnel for these longer distance services.

12. This is: NW Electrification; the Northern Hub; and trans-Pennine route upgrade.

In the meantime, the most effective approach will be to focus on developing an effective pattern of cross-city rail services, getting better utilisation out of rolling stock and scarce city centre platform space by eliminating layovers and turn-backs, and using longer trains. And in the North West, this approach will need to overcome two practical problems:

- The capacity bottleneck at Manchester Piccadilly caused by the operation of Manchester Airport-Sheffield and Liverpool-Sheffield trains which need to cross all of the approach tracks, during which time no other train movements at the station are possible

- Limitations at Manchester Airport station, which is the southern terminus for a large proportion of Castlefield corridor services, and which, despite the addition of an additional platform, cannot accommodate lengthening of trains to provide more capacity.

The southern approaches to Manchester Piccadilly: multiple franchise operators and unimproved infrastructure.

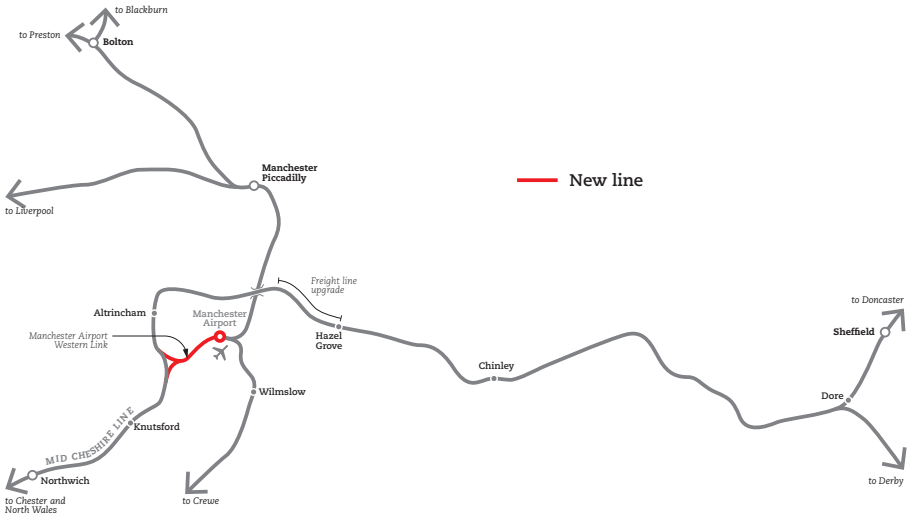
Photo: Jack Boskett/RAIL magazine.

A solution exists for these two problems – and one that can provide a much-needed connectivity boost across the north in the 2020s by opening up rail access to Manchester Airport from cities poorly connected presently.[13] This could help kick-start the economic boost envisaged as the Northern Powerhouse.

13. See Transport for the North, *Long Term Rail Strategy*, January 2018.

What is needed in the interim is implementation of the western rail link to Manchester Airport[14], an alignment that received renewed protection from encroachment by Manchester Airport in 2017. Together with an upgrade to an existing freight line, building this short link will allow:

- more capacity for Manchester Airport trains;
- the elimination of conflicting train movements at Manchester Piccadilly station throat;
- improved access to the North's single most important international gateway at Manchester Airport.



Using the planned connections to the Mid Cheshire line at a delta junction west of the airport, services can be introduced from Manchester Airport station to Chester & North Wales via Knutsford and also to Sheffield and beyond via Altrincham avoiding the need for these trains to go via central Manchester and a capacity-hungry reversal at Piccadilly. The Airport station would cease to be a terminus and the inefficiencies of train turn-round and layover can be overcome.

Radically improved new cross-airport routes devised with longer distance city-city services across the North would transform access to Manchester Airport. In place of separate, network capacity draining Manchester Airport-Sheffield and Liverpool-Sheffield services, there can be a single through Liverpool-Manchester Piccadilly-Manchester Airport-Sheffield route, using the loop created at the Airport with the western connection in place of a reversal at Piccadilly.[15] North Trans-Pennine airport services could run through to Chester/North Wales providing more city-city connectivity gains.

14. As suggested by, amongst others, the LEPs, local authorities and others in the West and Wales prospectus – see footnote 10.

15. Currently Manchester Airport – Sheffield – South Humber trains proceed northwards from the airport to Piccadilly station, where they reverse and cross all of the Piccadilly station approach tracks to head south again, to Stockport before turning east towards Sheffield.

Midlands Connect: West Midlands and East Midlands

The position reached by Midlands Connect is summarised in a recent Network Rail Route study:

> **"In order to support investment in the Midlands, the Midlands Connect partnership has identified the economic benefits that could be unlocked by improved links between the East Midlands and West Midlands. Analysis undertaken by the partnership has shown the potential for in excess of £500m in Wider Economic Benefits by improving services on three corridors: Birmingham to Nottingham, Birmingham to Leicester and Coventry to Leicester. The rail industry will continue to work with Midlands Connect on rail strategy, and unlock the identified economic prize."**[16]

The three corridors were selected from a wider set of corridors that Midlands Connect identified as part of its 'Powering the Midlands Engine' strategy, built around the principle of Strategic Economic Hubs and Intensive Growth Corridors (see Figure 7.6).

The Midlands Rail Hub forms a cornerstone of the Midlands Connect rail strategy, and further work is underway to develop its Strategic Outline Business Case: due to be complete early 2019. It offers greater connectivity for those passengers wishing to change onto HS2 services at Curzon Street:

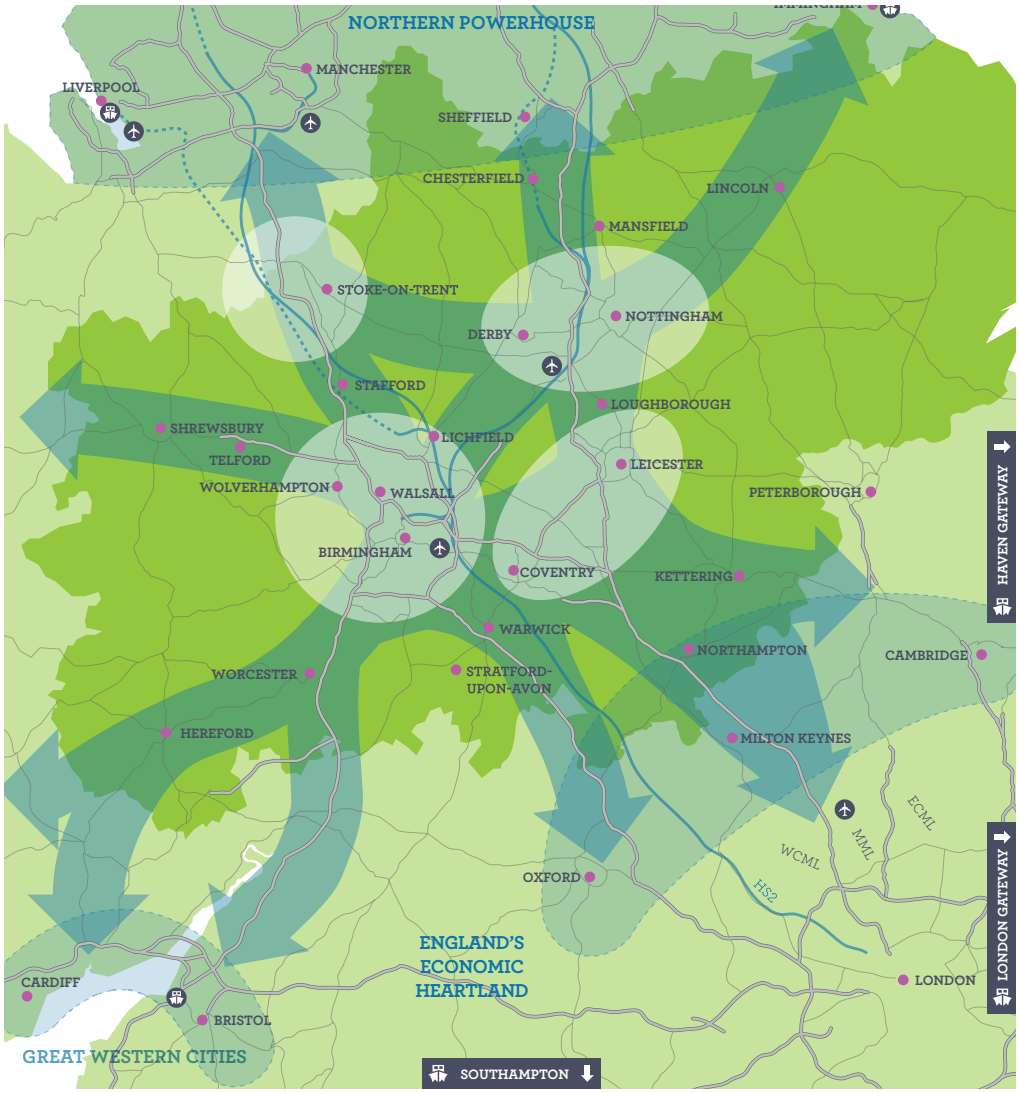
> **"The Midlands Rail Hub option links Birmingham Moor Street to the routes to Longbridge/the south west and Derby/Leicester which will improve access to the adjacent Curzon Street station from these corridors."**[17]

The key is that Moor Street (existing rail network) and Curzon Street (HS2) stations are adjacent, with plans for, in effect, a contiguous passenger concourse. Creating the hub at Moor Street requires the construction of new chord lines, and other investment on the Camp Hill railway line in south Birmingham. Much would depend on which services are selected for a switch from New Street to Moor Street. But what is apparent from preliminary work carried out to assess the wider economic (agglomeration) benefits of better connectivity to the high value location around the new HS2 Curzon Street station, is that benefits are likely to predominantly lie to the south/west of Birmingham and less to the north/east (see Figure 7.7).

16. West Midlands and Chilterns Route Study, Network Rail, August 2017.

17. West Midlands and Chilterns Route Study, Network Rail, August 2017, p42. The routes into Moor Street were selected through consultation with local authorities across the Midlands. They have a consequential benefit of freeing up network capacity at Birmingham New Street – a station that is reasonably near but not (as Moor Street is) adjacent to the HS2 terminus at Curzon Street.

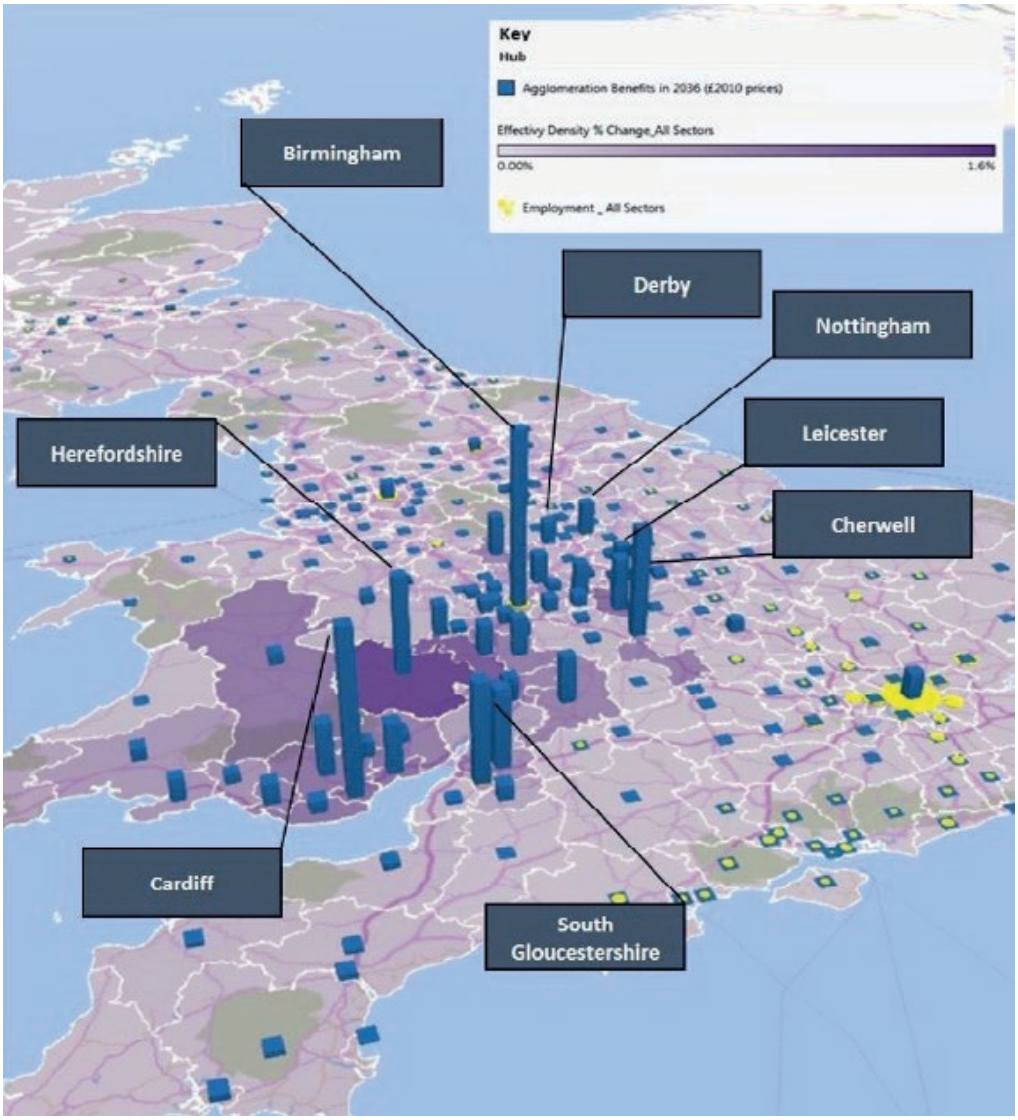
Figure 7.6: **The Midlands' Strategic Economic Hubs and Intensive Growth Corridors**



Source: Midlands Connect Strategy, March 2017.

This distribution of benefits pattern reflects specific service assumptions and others no doubt could be chosen. It would be expected that enhanced access to jobs and businesses in central Birmingham would dominate the generation of agglomeration benefits illustrated by the blue 'towers' in Figure 7.7. But it probably also reflects the fact that good connectivity to HS2 at Curzon Street is more beneficial for places to the south west of Birmingham which can gain access to fast HS2 services from Curzon Street to London, the East Midlands, Yorkshire and the North East. The same gain is not available for locations to the north/east of Birmingham (the East Midland cities of Derby/Leicester/Nottingham), where better access to Curzon Street would result in HS2 trips that 'double-back' on themselves. From places such as Worcester, Gloucester and Hereford, significantly faster journeys to London and other HS2 destinations would be possible if a good interchange can be fashioned at the Midlands Hub.

Figure 7.7: **Midlands Rail Hub Economic Benefits**



Source: Network Rail, West Midlands and Chilterns Rail Study, 2017.

In addition to the more southerly places that score highly in Figure 7.7, others that could benefit from better links to Curzon Street include the Black Country, Walsall-Hednesford and the Wolverhampton-Shrewsbury corridor. This catchment contains three of the ten worst performing local authority areas in Britain in terms of economic outputs (as shown earlier in Table 2.2). An examination of the new connections or chords needed to facilitate services from these places direct to Moor Street for convenient transfer to HS2 is required. It would most likely lead to an intensification of the cross-city Snow Hill-Moor Street line, with new connections to broaden its catchment west of Birmingham, but then it is appropriate for such a key cross-city link to be fully used as a city region rail route, perhaps with as many as 24 trains/hour ultimately.

From a Midlands' perspective, it is frustrating that the HS2 Eastern arm runs directly from the centre of Birmingham towards Nottingham, but doesn't reach it, serving nearby Toton instead – an HS2 station that is likely to be linked to Nottingham City Centre by tram and a journey taking about 35 minutes. This more or less negates the speed advantages of HS2 between the centres of these two cities (allowing for interchange penalties). As planned, the largest cities of the West and East Midlands would remain with effective centre-to-centre journey times little better than today's railway offers (which is a remarkably slow 1¼ hours).

Excluded from current consideration in the £300m HS2 connection fund,[18] is a junction from HS2 into Nottingham from the south that would make it possible to operate fast non-stop Birmingham-Nottingham trains over HS2. The absence of such a connection, assuming the northwards connection at Toton that **is** included in the connection fund is progressed and used, means that the Birmingham – Toton section of HS2 would be bound to operate at less than its full capability. We take up further the idea of connections to HS2's Eastern arm later in this chapter.

The West Coast Main Line (WCML)

Services on the west coast main line will be capable of a radical transformation once HS2 is open. Today it carries most of the nation's north-south railfreight as well as a set of high frequency intercity services and heavy commuter volumes into London, Birmingham, Manchester and Glasgow.

A study seven years ago set out how the released capacity from the first phase of HS2 could be utilised.[19] We also showed, in 2014, how the acceleration of the project to Crewe (Phase 2a) could be used to ensure that Stafford and Stoke-on-Trent enjoy a HS2 service rather than risk being neglected.[20]

In more recent work with West Coast Rail 250 (the stakeholder group covering the length of the West Coast Main Line), a review of the relevant LEPs' Strategic Economic Plans was carried out to help frame their perspective on the planned West Coast Partnership – the franchise that will take forward not just the existing West Coast franchise but also the early years' operation of services over HS2.[21] It summarised the significance of intercity rail service provision to the wider economic aims in the corridor as set out below.

18. See page [ ] for details of junctions included as part of the fund.
19. Greengauge 21, *Capturing the benefits update*, February 2011.
20. Greengauge 21, *Staffordshire a key HS2 beneficiary*, September 2014.
21. Greengauge 21, *Stakeholder Perspectives: the West Coast Partnership*, October 2017.

West Coast Rail 250/Greengauge 21: the role of longer distance rail

The intercity services in the West Coast Corridor play an especially important role for regional, city and local economies by:

- Connecting West Coast activity centres both with each other and with London – of great importance for business travel but also for the cultural and social life of this significant part of the nation;
- Connecting West Coast activity centres with Heathrow Airport – a task that HS2 is better placed to fulfil than the existing West Coast Main Line – again of great importance to businesses, especially those engaged in international trade (on this subject, the Coventry and Warwickshire LEP proposes an alternative solution of direct Heathrow access via Oxford, Reading and the planned new western rail access to the airport);
- Providing the critical national connections between London/the South East and the West Midlands, North and Mid Wales, North West England, South West Scotland and the central belt of Scotland: faster, safer and more reliably than road-based connectivity; more sustainably than by air services (where they exist);
- Offering opportunity with greater choice for accessing jobs and higher education, and improving productivity though broadening and overlapping of labour markets;
- Providing rail access to tourism and conference centres, and these include the major National Parks of North Wales (Snowdonia) and North West England (the recently designated World Heritage Lake District); traditional holiday resort locations such as Blackpool, Southport and Llandudno, each of which have active programmes to transition from summer week/fortnight family destinations to year round short breaks; major one-off attractions…and cities that have become major leisure destinations (such as Liverpool, also World Heritage); and, important conference destinations including Blackpool, Liverpool, Manchester, Glasgow and Birmingham…;
- Providing national transport access to remoter communities in places such as Dumfries and Galloway, West Cumbria, and the North Wales hinterland. The West Coast Corridor and its intercity rail connections are just as important to these areas as they are for the major cities.

Source: Source: Greengauge 21, *WCR250 report*, October 2017

The report also proposed a set of policies on the question of released capacity once HS2 is open in 2026/7:

- No West Coast station should lose direct London rail connectivity;
- Remaining Intercity services on the WCML should be both extended where practicable [to new destinations] and operated on a limited stop basis to provide key interchange stations on the WCML with a regular interval service;
- Sufficient 'clean' path capacity should be provided for fast intermodal freight traffic, allowing for expected growth;
- Additional capacity should be provided for commuter services on shared routes into the major cities.

Scotland and connectivity across the English border

In terms of connectivity between England and Scotland, there are important economic linkages and growing rail market shares along both east coast and west coast corridors. We examined stakeholder aims in the North of England across the border with Scotland in 2012 and they are summarised in the panel opposite. Network capacity limitation was recognised then as a key problem, and rather than see possible northwards extensions of high-speed rail as a stand-alone facility, stakeholders wanted to see what provision it could make for a wide mix of service types.

Little has been developed on the English side of the border in terms of firm plans since this stakeholder research was carried out six years ago (although TfN has identified in its draft Transport Strategy of 2018 a Sheffield-Manchester-Lancashire/Cumbria strategic corridor for study). But a number of new rail services have featured in franchise and open access operator plans on cross-border routes.

We reviewed various studies by HS2 Ltd (with DfT, Transport Scotland and Network Rail) undertaken between 2013 and 2016 into extending high-speed rail northwards beyond the limits of the HS2 infrastructure.[22] In our view, these studies were caught between over-ambitious options with full new HS2-style alignments (that might in part be designed for lower top speeds, but which would protect the facility to accommodate larger gauge trains) and upgrades constrained to be carried out only within the boundaries of existing railway land ownership. The more fertile middle ground – where existing route development may need to encroach on land not currently under railway ownership – was ignored, illustrative perhaps of a wider weakness in option development.[23]

22. Greengauge 21, *Linking North to South*, June 2016.

23. The issue arising perhaps because there is one Government body charged with new build (HS2 Ltd) and another with operating today's railway (Network Rail). What is missing is a single body to carry out strategic planning.

The views of Northern Stakeholders on Anglo-Scottish routes

Authorities across the north of England believe that high-speed rail is needed, and that it can play a valuable role in meeting projected demand for both freight and passenger travel. They want to see its design and development linked closely to the opportunities in northern England for economic recovery and growth. They want to see consideration given to the mix of services that could use any new line, while recognising the importance of achieving very attractive journey times for high-speed rail customers. They also believe that careful consideration should be given both to new-build and to upgrading existing lines.

They point out that there are rail capacity constraints in the north of England just as in the south, in part caused by the mix of intercity trains, local stopping services and freight trains and junction arrangements. High-speed rail should be designed to relieve capacity pinch-points and to provide a better alternative to road-based travel.

Where there is capacity available, HSR in the north of England should be able to accommodate fast inter-regional passenger services or freight trains where this does not compromise the provision of true high-speed passenger services. Major cities and towns in the north of England should be served by HSR stations where feasible. HSR should be connected to and integrated with the existing rail network, to allow high-speed services to operate to destinations off the high-speed line.

Source: Greengauge 21 interviews, November 2012

Investigations should be examining enhancements that are shy of fully segregated high-speed lines built to the EU loading gauge, but not restricted to alignments within land under railway ownership. There are plenty of ways to shave minutes off journey times on the northern sections of the WCML and ECML. Experience with the later stages of the West Coast Route Modernisation along the Trent Valley and in replacing the constraining junction at Norton Bridge show just how much can be achieved, without major disruption, using short sections of new alignments that require fresh planning powers, where necessary.

An aim, agreed in March 2016 between Westminster and Holyrood Ministers, of a 3-hour London-Glasgow/Edinburgh rail journey time target, is now being taken forward north of the border in feasibility studies by Transport Scotland[24], without as yet a complementary study south of the border, it would seem. In what is described as a 'major step towards three-hour journeys between Scotland and London', the next stage in plans for reducing train journey times between Scotland and England was announced by First Minister Nicola Sturgeon on November 6th, 2017. Addressing an audience of business leaders in Newcastle, the Scottish First Minister confirmed that feasibility studies were being commissioned to identify options to help improve train journey times, capacity, resilience and reliability on services between Scotland and England.

These very welcome studies are focusing on the east coast line south of Dunbar towards Newcastle as well as on the west coast line between Glasgow and Carstairs.

It makes sense to examine both of these corridors, yet the challenges and opportunities differ. HS2 Ltd has always planned that London to Glasgow and Edinburgh services would operate over the West Coast route once HS2 is complete. Equally appealing journey time gains to both Edinburgh and Glasgow have been seen as a pre-requisite by the Scottish Parliament. As we saw in Chapter 6, initial plans that such services might divide and join at Carstairs made little sense, although an equivalent arrangement at a more useful intermediate location such as Carlisle could broaden HS2 benefits further. The problem is line capacity, with a mix of differing passenger and freight train speeds operating over a lengthy two-track route north of Wigan. Addressing a Greengauge 21 conference held in Glasgow in August 2015, a Network Rail speaker made clear that the existing route is effectively full and HS2 will add to the pressure upon it. The set of solutions to this problem requires a judicious blend of infrastructure investment and revised operating practice.

The existing railway is an upgrade opportunity:
The West Coast Main line at Carlisle.

Photo: Greengauge 21

24. See Scottish Government, Cross-border rail improvements planned, November 2017 (www.news.gov.scot/news).

A strategy for the northern section of the West Coast Main Line

To get towards the target 3-hour London-Glasgow/Edinburgh journey time requires a coordinated strategy. HS2 says that its services following Phase 2 will be able to achieve a journey time of 3h40 (saving 42-50 minutes respectively on current Edinburgh and Glasgow – London journey times). A good interim target would be to reduce this to 3h15, which should enable rail to get the lion's share of the available market.

This could be achieved by:

- creating a segregated higher speed route between Glasgow Central and Carstairs as under examination by Transport Scotland (saving perhaps 15 minutes; freeing up conflicts with Strathclyde commuter services which will be able to be expanded);
- removing low speed sections of line, including at Carlisle and Preston (saving (say) 5 minutes, and providing each of these places with a modernised hub station);
- increasing line speeds where possible between Carstairs and Wigan to 140 mile/h (potentially saving a further 5 minutes, but exacerbating journey time differentials) enabled by the adoption of ETCS Level 2 cab-signals digital railway train control systems;
- ensuring that all passenger services can operate at the enhanced line speeds;
- obligating freight operators to use suitable electric traction;
- providing a set of strategic freight 'dynamic' freight loops or 'crawler lanes' for Shap/Beattock that allow passenger services to overtake freight trains without causing extended journey times for freight;
- reconstructing Carstairs junction to allow fast operation between the south and Edinburgh and upgrading the Carstairs-Edinburgh line to allow 125 mile/h operation.

In due course, new sections of high-speed line might prove worthwhile in Northern England that would allow the 3-hour target to be met, and the case for these is likely to rest on the need for more line capacity and so is most likely to arise south of Carnforth, the busiest section of route.

The east coast route does not have the significant freight volumes that arise on the west coast and creates a capacity challenge in combination with express passenger services. But it does provide an important connection between Newcastle and Edinburgh. Although here the current rail journey times and service frequency is very good (and quicker than the road alternative), these advantages are eroded once longer distance trips are considered – to other cities in Scotland (Aberdeen, Glasgow etc.) – and in England (Middlesbrough, Hull, Leeds, Sheffield etc.) – connections identified in Chapter 5 as being weak.

The existing route has some sections where line speeds are significantly constrained by route curvature, and these offer some prospect of journey time (and capacity) gains through the creation of 'cut-off' lines. These would benefit services operating over the East Coast Main Line further south in England as well as over HS2, for instance to Birmingham.

The Transport Scotland work also shows the advantage of a more strategic network development approach. A new fast alignment from Glasgow (Rutherglen) to Carstairs with a spur to the Shotts line into Edinburgh, combined with a new fast alignment between Dunbar and Newcastle could deliver a transformational Glasgow-Newcastle journey time of 1h40 (an hour faster than today's timings).

The question of further connectivity improvements within Scotland will continue to arise because rail journey times are so poor, and often much slower than the alternatives by road into which a lot of infrastructure investment is being made.[25] It would be wrong, however, to believe that – in contrast to Scotland's road network – the rail network can be left as it is.

The most glaring opportunity for rail north of the central belt[26] would see the re-creation of a direct rail link from Edinburgh to Perth (for which an Edinburgh journey time of 45 minutes is projected compared with the current 1h22 minutes), as advocated in 2013 by Transform Scotland. If this link can be configured to provide a faster route to Dundee as well as Perth there is the prospect of significant journey time reductions for both Aberdeen and Inverness as well (see Figure 7.9).

Such gains can magnify the benefits of investment in the central belt too, especially if a connection southwards from the new Edinburgh Gateway station that (opened in December 2016 near Edinburgh airport and served by the Edinburgh tram line) is created, to link with an upgraded Edinburgh-Carstairs line. This would open up the opportunity to operate long distance services including on a NE Scotland-NW England axis such as Aberdeen-Dundee-Edinburgh Airport-Carlisle-Preston-Manchester, linking cities in England and Scotland that have no rail direct rail connections and opening up access to Edinburgh Airport from North West England.

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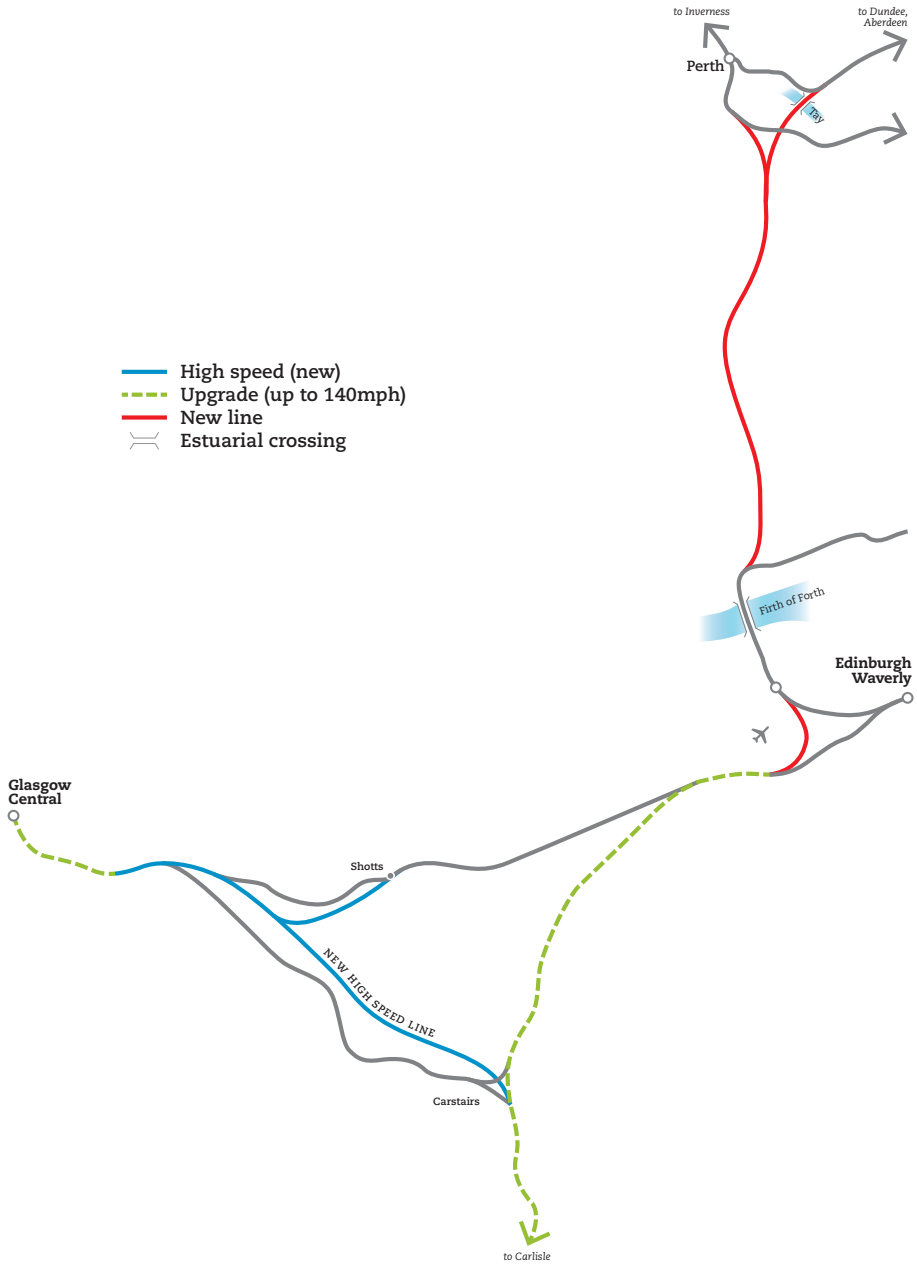
25. Key examples would be the Western Relief Road being built around Aberdeen and upgrades to the A9 and A96 (Perth-Inverness and Aberdeen-Inverness respectively), both of which have parallel (very largely unimproved) railways.

26. See Intercity Express, *What we want, Edinburgh to Perth Direct*, 2017 (ww.intercirtexpress.transformscotland.org.uk).

Figure 7.9: **Strategic rail development – Scotland**



Another potentially valuable new route that could use this link would be Glasgow Central-Livingston (where a new station is being considered)-Edinburgh Gateway (for the airport)-Fife-Dundee. This would use a spur from the new high-speed Glasgow-Carstairs line to connect with the Shotts line near Breich as is being examined by Transport Scotland, and this would provide a new fast link between Glasgow and Edinburgh Airport. In each case, no extra demand would be placed on the nearly-at-capacity routes from the west-side into Edinburgh Waverley.

A further connectivity gain for the rail-remote Borders region towns could be achieved if it is found possible and viable to extend the recently opened line from Edinburgh to Galashiels/Tweedbank onwards to Hawick and Carlisle.

London and North East/East Midlands

Under this heading, we consider the length of the eastern side of the country, following Network Rail's Route geography that embraces together the East Coast Main Line (ECML) and the Midland Main Line (MML) – and in future will also incorporate the eastern arm of HS2.

The expectation here is that HS2 Phase 2b will provide capacity relief to the ECML, which has capacity pinch-points at Welwyn, in Hertfordshire and, as previously discussed, between Darlington and Newcastle in County Durham. The Welwyn pinch-point might be partially addressed by a Digital Railway train control approach and could also be relieved in the longer term by the proposed new 'M11' rail route to Cambridge described in the next chapter.

The East Coast carries freight from Felixstowe towards Yorkshire, and about half of these movements have now switched onto the slower but less busy parallel route between Peterborough and Doncaster – the 'GN/GE Joint 'line via Lincoln and Gainsborough – which has been the subject of major works to improve signalling and level crossings. To free up more capacity for longer distance passenger services by removing the freight trains fully from the East Midlands section of the ECML, it will be necessary – as noted in Chapter 4 – to build a grade-separated junction on the north-side of Peterborough at Werrington – one of a small number of remaining schemes from the East Coast Upgrade programme that was cancelled in 2003, most of the others having been implemented in the meantime[27].

Over the last 15–20 years, ways of accommodating more long-distance passenger trains on the East Coast route have been found with three 'open access' operators now having track access rights as well as the franchised operator (Virgin Trains East Coast) until summer 2018.

Fast trains between London and both Leeds and York/Newcastle, as proposed by DfT in the HS2 business case, will switch from the ECML to using HS2. A range of potential ways to use the capacity released was identified for consideration by DfT in 2017.[28] A valuable new direct hourly service between West Yorkshire and Cambridge/ East Anglia was one of the possible services identified.

27. ECML Upgrades have been near continuous and have included: an additional platform at Kings Cross; re-opened approach line though Copenhagen tunnel (planned with station re-signalling in the near future); Hitchin flyover; Huntingdon-Woodwalton four-tracking (in hand); Peterborough station expansion; a new chord north of Grantham (Allington); a new platform at Doncaster; a new flyover to replace Joan Croft Junction in Yorkshire; additional platforms at York; power supply strengthening. But the widening of Welwyn viaduct relied upon a land acquisition programme that the SRA abandoned; the level crossing with the Lincoln-Nottingham line at Newark remains and grade separation at Doncaster hasn't been progressed.

28. DfT, *High Speed Two Strategic Business Case*, July 2017 (https://www.gov.uk/government/publications/hs2-phase-two-strategic-case).

Under current plans, on the other hand, there will be no capacity relief available on the Midland Main Line as trains from Derby and Nottingham as well as Leicester to London will need to remain. The southern section of this line is very intensively used, with Thameslink trains sharing use of the route south of Bedford. Plans to electrify the route have been cut back, with electrification works now committed only northwards from the current limit at Bedford to Wellingborough, Kettering and Corby.

Stakeholders, including a grouping of local authorities (ECMA), have identified the wider economic value in continuing investment in the ECML and HS2's eastern limb.[29] Improvements that could be made on capacity or connectivity grounds north of York can benefit both trains that run over HS2 and over the ECML south of York. But to some extent, there is a risk that the eastern limb of HS2, given its focus on accommodating fast London-Leeds/Newcastle services, reduces the case for investment in the ECML south of York to accommodate more of the same type of train service, as noted in the previous chapter.

One of the long-sought improvements on the ECML that might come to fruition with digital railway train control systems, is the adoption of 140 mile/h running, rather than 125 mile/h. Rolling stock fleets are already equipped to provide this speed increase and it would reduce journey times.

Operating some, but not all, trains in the ECML at 140 mile/h would exacerbate capacity pressures, through an increase in speed differentials between different train types. It would probably be impractical with today's intensity of services/infrastructure. But the narrowness of the time differential for North East England-London trains between routing via HS2 and an upgraded ECML noted in Chapter 6 suggests that an option that would use HS2 to remove the fast Leeds-London trains from the ECML, that freed up sufficient capacity to allow 140 mile/h operation of the ECML for North East England services could be the best approach. It would also liberate some of the HS2 eastern limb capacity for other services that can achieve bigger time savings. And, higher speed still may be possible – 150 mile/h[30] for example over some sections (such as Doncaster-York-Darlington, suitably upgraded).[31]

29. East Coast Main Line Authorities, *Investing for Economic Growth*, October 2016.

30. There are several designs for trains capable of this speed now in operation across Europe and elsewhere.

31. The section of line from Temple Hirst to Colton junctions (the 'Selby Bypass') was constructed by BR to 140 mile/h standards in 1982. Between Temple Hirst and Doncaster, route geometry is also potentially favourable to a line-speed up to 140mile/h but there is a series of level crossings which would need to be replaced (offering safety as well as speed benefits). New sections of line so that non-stopping services could avoid, for instance the 30 mile/h speed restriction and tortuous route through York station would also need to be examined.

The Cross Country Network

Under this heading, we consider connectivity that explicitly excludes London. Many of the nation's major towns and cities are cross-connected by services in the Cross Country franchise. Essentially, these broadly north-south services form a large-scale X-shaped network, intersecting at Birmingham. Trains operate at up to 125 mile/h (the same speed as London intercity services) over this network where the infrastructure permits.

Additionally, there are several other long-distance routes that fulfil a major city-city "cross-country" connectivity function. Together these can be summarised in a simplified manner as in Table 7.2.

Table 7.2: **Principal cross country inter-regional rail services (main stops only shown)**

Franchise	Scotland	Northern England	Midlands, East Anglia, and Wales	South
Cross Country NE-SW	Aberdeen, Dundee, Glasgow, Edinburgh	Newcastle, Darlington, York, Leeds, Sheffield	Derby, Birmingham, Cheltenham	Bristol, Exeter, Plymouth
Cross Country NW-SE		Manchester	Stoke on Trent, Birmingham	Oxford, Reading, Southampton, Bournemouth
Cross Country E-W			Cambridge, Peterborough, Leicester, Nottingham, Birmingham, Gloucester, Cardiff	
Great Western			Cardiff	Bristol, Bath, Southampton, Portsmouth
Arriva Trains Wales		Crewe, Manchester	Cardiff	
Trans Pennine Express E-W		Newcastle, Middlesbrough, Hull York, Leeds, Doncaster, Sheffield, Manchester, Liverpool		
Trans Pennine Express N-S	Edinburgh, Glasgow	Carlisle, Preston, Manchester		
East Midlands Trains		Liverpool, Manchester, Sheffield	Nottingham, Peterborough, Norwich	

These services provide valuable connectivity, but journey times are generally slow in comparison with travel to/from London; Newcastle to Liverpool, for example takes longer by train than the much longer distance journey by rail from Newcastle to London. Finding ways to speed up these cross-connections is important when it comes to examining high-speed rail infrastructure. So long as it remains quicker for the nation to hold meetings in London, despite its off-centre location, other cities will be at a competitive disadvantage in terms of national-level connectivity.

Within the Cross Country franchise X-formation, many journeys require a change at Birmingham New Street in the middle of the journey. There are, for example, no direct connections between Coventry/Birmingham International (Airport) and the East Midlands/Yorkshire/North East England, for example. This particular shortcoming could be addressed – once the necessary additional train path between Coventry and Birmingham comes available when HS2 is open.

There are also missed opportunities elsewhere, such as Nottingham-Sheffield-Leeds-Carlisle-Glasgow and Bristol/Cardiff-Crewe-Preston-Carlisle-Edinburgh: services that could be operated on the existing network – subject to capacity being available.[32] And it is notable that there are no longer-distance services that operate across London, so Gatwick Airport and Brighton no longer have any direct rail connections beyond the wider south east (although both will benefit from the full Thameslink service when it is introduced in 2018/19).

The current Cross-Country 'X' service plan centred on Birmingham New Street sits awkwardly alongside the HS2 infrastructure that will offer faster routes both north westwards and north eastwards but only from the Curzon Street terminus station in Birmingham. Curzon Street (for HS2 north of Birmingham) and New Street (for the existing network of service southwards to South Wales, the South West and southern England) are near each other but a 10-minute walk apart. This is an unwelcome and potentially off-putting gap for travellers making a longer distance rail journey especially with luggage. The options of car travel making use of the motorways that go around Birmingham, or direct point-to-point short-haul flights, will remain an attractive alternative.

Using the Phase 2 lines for some degree of cross country connectivity has always been in the minds of HS2's planners: Birmingham-Leeds and Birmingham-Manchester, for example, where significant time savings are in prospect. But the existing cross-country service business model relies on a large number of relatively small station-station flows. Longer distance cross country passengers making use of HS2 for part of their journey would need to interchange at major network hubs. Although there are now good plans for integrated station designs at both Manchester and Leeds, this is not (yet, at least) the case at Birmingham.[33] Long distance intercity passengers put an especially high price on the need to interchange en route, as we saw in Chapter 3.

32. Both the Settle-Carlisle and Newport-Crewe lines are under-used and could support faster end-to-end journey times with some investment; each provides a shorter route between key cities that lack good connectivity currently.

33. Plans are under development to provide a better link between the two stations.

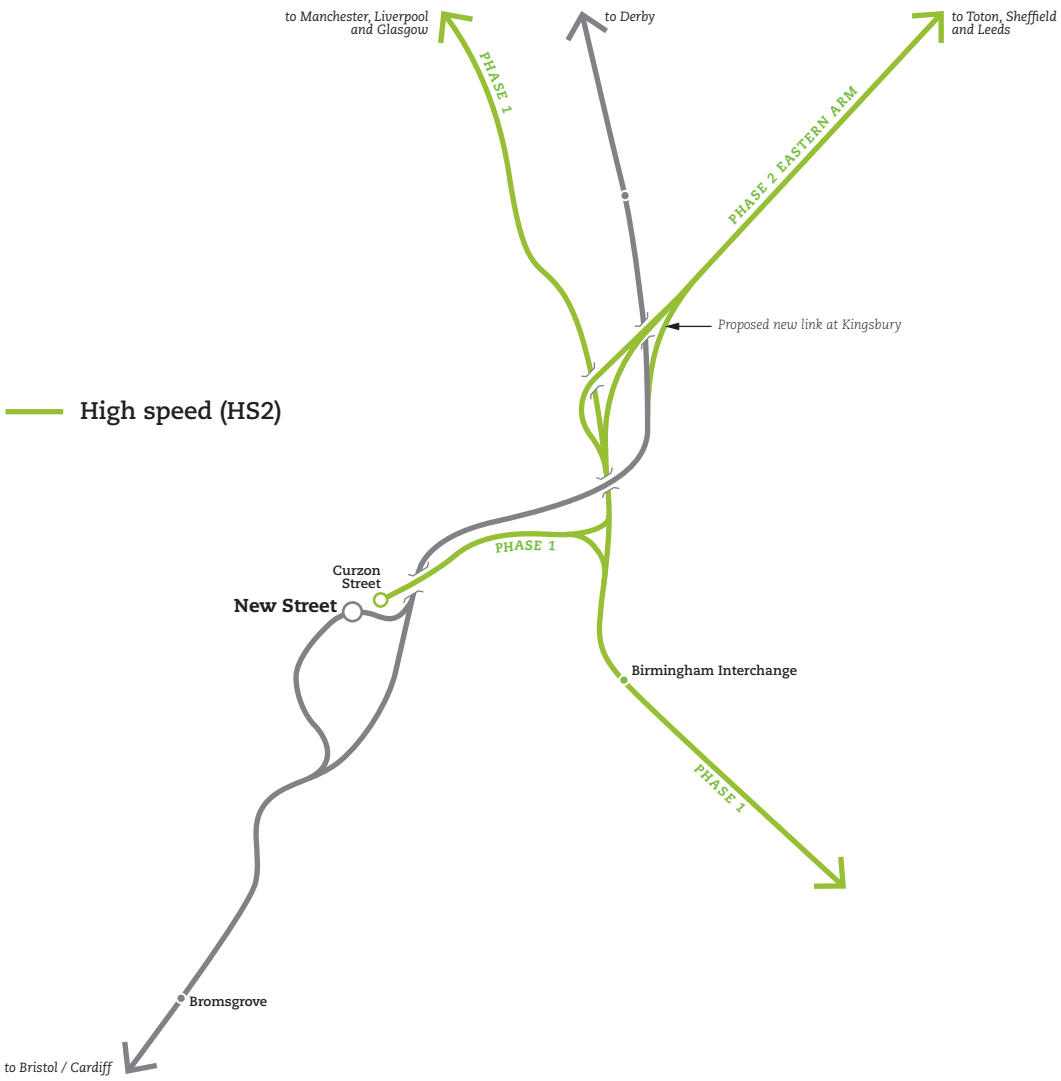
In any event, the pair of HS2 northern arms will bypass key intermediate places (such as Stockport, Stoke-on-Trent, Stafford, Wolverhampton; Wakefield, Derby, Burton-on-Trent) that would probably be best served by a continuation of the cross-country service that links them with each other and with Manchester, Birmingham, Sheffield, Leeds and many other places beyond the corridor of HS2 infrastructure, both to the north and south. Thus, it would seem most likely that the Cross Country 'X' pattern, while it might be adapted, will need to continue post-HS2, and this means that travel markets such as West Midlands-West Yorkshire will be shared between HS2 and existing lines' services.

A better approach would be to provide for HS2 trains from the north to use New Street rather than terminating at Curzon Street station in Birmingham so that they are then able to continue south-westwards from Birmingham as they largely do today. Transport for West Midlands has considered the possibility of adding a connection between the existing lines from Birmingham New Street to HS2 in the area of Kingsbury, north of the city. This would allow today's cross country trains operating on NE/SW and NE/S axes (that is from Edinburgh/ Newcastle/ York/ Leeds/ Sheffield to Cheltenham/ Bristol/ Exeter/ Plymouth/ Cornwall and Oxford/ Reading/ Southampton/ Bournemouth) to use HS2's eastern limb when it comes into use and gain the benefit of shorter journey times. If there is too much pressure on New Street station to accommodate all of these trains, some could bypass the city centre, saving further time by using the avoiding lines (via Camp Hill) to King's Norton (for South Wales and the South West) and Tyseley (for Leamington, Oxford and the South), or they could use the planned spurs into the 'Midlands Hub' – an expanded Moor Street station. The new linkages would likely add to the number of train paths operated over the eastern arm of HS2 and add to its benefits shown in Figure 7.12.

In the longer term, other (much more substantial) new connections could help with this problem, providing, for example, a southwards connection from HS2's Birmingham International towards Leamington for Oxford, or possibly towards Stratford-upon-Avon and, in future with line re-instatement, Cheltenham.

At the northern end of the HS2 route at Leeds, the likely addition of a new junction (number 1 in Figure 7.3) would allow cross country trains to continue northwards as they do today to NE England and Scotland. Trains for York could alternatively depart northwards from Sheffield on existing tracks via Doncaster having used HS2 from the south. But the Sheffield-Doncaster connection is slow, and the possibility of either upgrading this route or fashioning a further new connection directly from HS2 ('M18' alignment) into Doncaster would be worth examining. This would be – as today – a faster route from Birmingham and the south to NE England and Scotland than via Leeds, and it could also be used to add Hull to the Cross Country trains network, giving it a connection to the Midlands and beyond that it currently lacks.

Figure 7.12: **Connecting HS2's eastern arm across Birmingham**



Implications for the Eastern Arm of HS2

Having looked at the overall pattern of HS2 usage (in Chapter 6) and now the prospects for both the East Coast Main Line and services in the Cross Country franchise, we are in a position to define how the Eastern arm of HS2 could be beneficially re-purposed.

First, we should note that studies are in hand to create new connections to the route to broaden its value:

» Connections at Leeds so that services that use HS2 between Birmingham and Church Fenton, Yorkshire, can operate across the city of Leeds as today to reach NE England and Scotland;

- Connections from the south and north into Sheffield[34] that will allow the operation of fast Sheffield-Leeds services as sought by TfN, potentially four trains/hour as part of a cross-country service pattern or other longer distance routes (including to London over HS2);

- A connection near Toton so that trains from the Leicester direction (and indeed Nottingham[35]) could join HS2 and travel northwards.

The net effect of these changes will be to shift the balance of services operating over the eastern arm, with more inter-regional services – an additional function that stakeholders sought when consulted by Greengauge 21 in 2014[36] – and a much more complex operating pattern.

In practice, with multiple junctions, maximum line throughput can only be judged following detailed timetable simulation work. But it is clearly desirable to seek to balance at least broadly the demand for train paths with line capacity over the length of HS2's Eastern arm. That way benefits from the investment can be maximised.

As plans stand, assuming that the possible junctions are built and used by trains capable of using the HS2 full line speed, the route between Toton and Birmingham would carry fewer trains than its full capability. This is because if trains can leave HS2 southwards at Toton towards Leicester, there will be under-utilisation of the capacity of the Toton-Birmingham section of the HS2 route. Similarly, HS2 could also be relatively under-utilised where it parallels the lengthy route between Tibshelf and Clayton junctions which would not carry any HS2 trains serving Sheffield.

Better overall route utilisation could be achieved by:

1. Re-locating the southern approach to Sheffield further north, as already noted, and

2. By adding a complement to the Toton northwards connection, which would be a junction that would allow direct operation into Nottingham (Midland) from the south. For every train that left the route southbound at Toton, subject of course to detailed timetabling, another could join in the vicinity of Trent junction.

This second suggestion would allow the creation of a super-fast city centre-city centre link between Birmingham and Nottingham. Such services could either be free-standing, or, more beneficially, part of a longer distance service such as Cardiff-Nottingham.

34. We have suggested a shorter and quicker access to Sheffield from HS2 (south) that should be considered and would require some train reversals or modifications to these service patterns.

35. This would allow a fast Leeds-Nottingham service, that could be extended to join the ECML at Grantham and provide a fast link from Leeds to Peterborough, Cambridge and Stansted.

36. Greengauge 21, *HS2 Phase 2 Consultation: a summary assessment by Greengauge 21*, January 2014.

The wider implications for the existing rail network need to be considered carefully. Fast services between Leeds and Sheffield using HS2, for instance, can continue onwards to several destinations, and some of these trains usefully might continue as cross-country services over the Midland Main Line to serve Chesterfield and Derby (and places further south). But the more the rolling stock needed to operate such trains uses unimproved sections of the classic network, the less valuable will be its higher speed capability needed to use the HS2 infrastructure efficiently. And the more diverse service patterns carry a greater risk of performance perturbation between the classic and high-speed networks. A balance, therefore, has to be struck between a potentially rich diversity of routes using HS2 and a set of services concentrated on the largest demand flows.

We summarise our conclusions about the eastern arm of HS2 in the panel overleaf. To some extent, they are no more than a logical conclusion of studies already in hand.[37] They also take account of an element of prudence in service planning (which amongst other things means an assumption that not all of the currently identified Eastern arm HS2 services will be able to run to London because the capacity of the Y-stem will have reached its limit, as noted in Chapter 6). The revisions suggested would add significantly to the scale and spread of HS2's connectivity benefits and make more effective use of the East Coast Main Line as the fast route for the North East to London.

Consequently, we believe the eastern limb of HS2, should be 're-purposed' to assist in the development of city-city links primarily on the eastern side of the country. The ECML should be upgraded to accommodate higher speeds and be focused on better access for North East England and cities with non-existent or poor connectivity with the capital.

We have suggested previously that delivery of the Sheffield-Leeds segment of HS2, with its connections and upgrades to existing lines, could be usefully accelerated. This would help meet Northern Powerhouse objectives early and also better balance connectivity improvements achievable in the North during the 2020s: it remains a good prospect and it needn't await the construction of the new HS2 platforms at Leeds or the rebuilding and redevelopment of Sheffield Midland.

More recently, consideration has been given to accelerating the delivery of Toton station, at least its non-HS2 elements.[38] If the 'Network Rail' part of the station is built early, it would help kick-start the regeneration process locally, and new services could operate from Sheffield-Leicester serving intermediate stations including Toton allowing Nottingham-Sheffield services to be speeded up.

37. It will require detailed examination to establish that the suggested changes in utilisation and connections to/from HS2 represent best value for money.

38. https://www.globalrailnews.com/2018/01/12/deal-made-to-look-at-opening-east-midlands-hs2-station-in-the-2020s/.

Re-purposing the Eastern Arm of HS2

1) The primary purpose of providing a much faster connection between London and both Sheffield and Leeds should be prioritised (and Sheffield-London journey times could be shortened if a more direct access route into Sheffield is adopted).

2) Newcastle/York-London services should remain on the ECML with a target of closely matching the journey times that would be achieved by HS2, and ideally sooner than the HS2 Phase 2b delivery date of 2033.

3) Planned Leeds and Newcastle-Birmingham Curzon Street trains using HS2 should be operated across Birmingham (via New Street) and Leeds/Doncaster, speeding up existing cross-country service patterns (and in effect extending HS2 planned services north and south).

4) To ensure best use of high-speed train fleets, existing lines to the north and south of HS2 that will be used by such trains (i.e. Leeds/Doncaster-Newcastle, and Birmingham-Bristol), should be upgraded to higher speed operation, electrified where necessary along with such measures as are also necessary to provide sufficient line capacity.

5) The Doncaster-London section of the ECML should be upgraded using a combination of measures, including adopting digital train control systems (ETCS) and 140 mile/h operation.

6) The spare capacity that will be created on the ECML from removing fast Leeds services should be used to provide places lacking (or with sub-standard) direct services to London.

Key services across the North and the Midlands between city centres, such as Leeds-Sheffield and Birmingham-Nottingham can and should be accommodated on the eastern arm of HS2, increasing its role in providing cross-country city-city connectivity gains, with onward service extensions prioritised towards routes that are upgraded for higher speeds.

8.0 The South of England, Wales and London

We now consider the rest of Britain, including many of those regions and areas which were noted in Chapter 1 as appearing to get no benefit from HS2: in South West England, South and West Wales, East of England/East Anglia, and the South Coast (Sussex particularly).

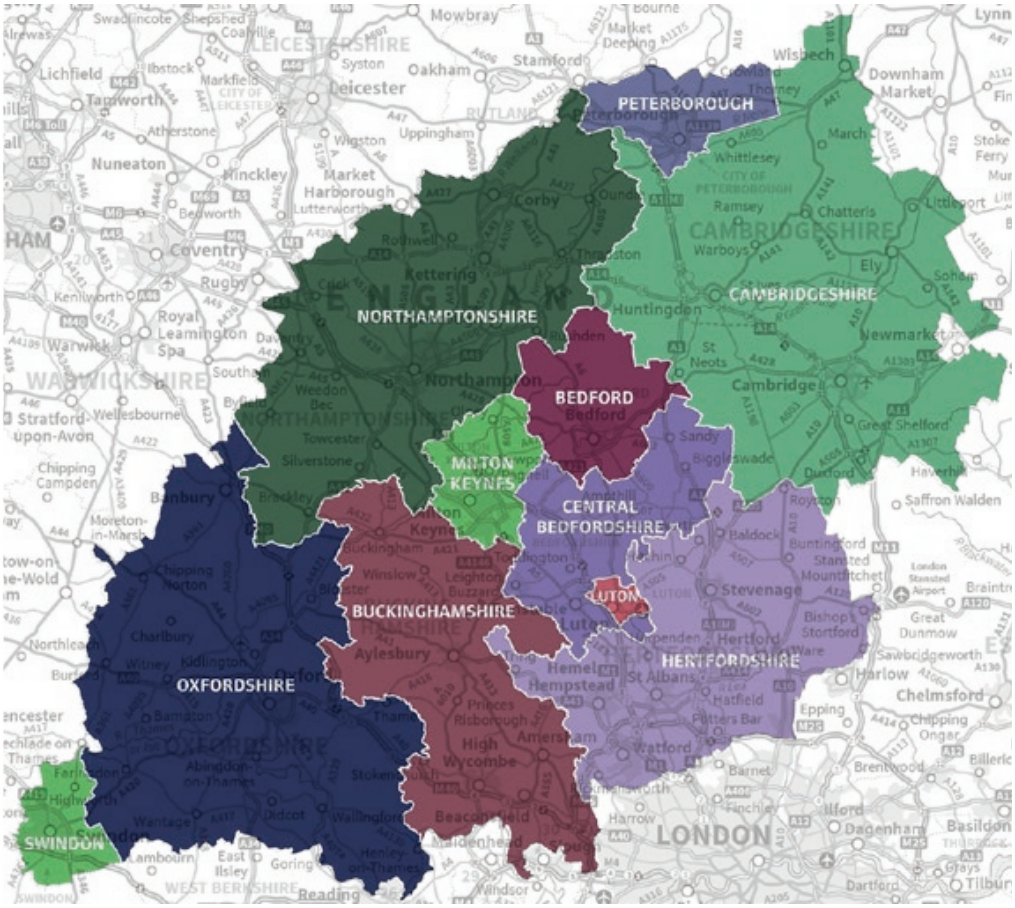
We conclude by picking up the challenge of London by considering the inter-relation between plans for London and the national rail network – rather than in terms of the plans and policies of the London Mayor which are directed towards meeting London's needs.

As in the previous chapter, we draw extensively on the work of regional stakeholders and on earlier Network Rail Route studies.

The English Economic Heartland

This is potentially a further 'sub-national' body covering an important east-west oriented swathe of the country of very significant economic prosperity based on scientific, and especially life science research, where growth is constrained by limited housing availability and poor transport connections. Figure 8.1 is a map of the original partners. However, the make-up of the sub-national body remains under consideration. As of April 2018, Swindon has accepted an invitation to join the strategic alliance, with the Cambridgeshire and Peterborough Combined Authority, and also Hertfordshire, planning to observe on both the emerging arrangements in the Heartland and Transport East.

Figure 8.1: **The English Economic Heartland**



Source: http://www.englandseconomicheartland.com/Pages/home.aspx

Lord Adonis, when Chair of the National Infrastructure Commission, said:

> **"[the] vital arc north of London (Oxford-Milton Keynes-Cambridge) is crucial… The proposed new 'east-west' rail line linking Oxford, Milton Keynes and Cambridge should produce dramatic agglomeration effects between these three high productivity cities."**[1]

The National Infrastructure Commission published its final report on the Oxford-Milton Keynes-Cambridge growth corridor in November 2017, and made a strong recommendation to deliver East West Rail – a re-established Oxford-Cambridge railway – as soon as possible.[2]

1. See 'The Golden Arrow: London 2030' Andrew Adonis, Inaugural Lecture as Visiting Professor of King's College, London Guildhall, 14 November 2017.
2. National Infrastructure Commission, *Growth Corridor – Completed Study*, November 2017 (www.nic.org.uk/our-work).

This is investment that will support some of the most productive parts of the British economy, where growth pressures are severe. Suitably high-density housing developments at a limited number of stations along the planned East-West railway should help create a more sustainable pattern of development and sustain the expansion of the burgeoning employment centres of the three main cities it connects. It fits well with HS2, which, by freeing up existing capacity, makes it possible to radically improve the stopping patterns on the West Coast Main Line, adding station calls at Milton Keynes to provide useful passenger interchange opportunities between north-south and east-west lines.

In wider network terms, the connection fills a missing part of the network: the nearest east-west rail link north of London, absent East West Rail, is between Leicester and Peterborough, 75 miles+ north of London. It has been under study since a collaboration between local authorities commissioned the first line re-opening study in 1994 (and before that was considered for re-opening by BR's Regional Railways sector).

Anglia route and Transport East

The fast-growing East of England region covers East Anglia. The emerging sub-national transport body (Transport East) may have overlaps with the one emerging for the English Economic Heartland to the west with Hertfordshire as well as Cambridgeshire and Peterborough observing on both. Cambridge in particular is an economic hot spot with its highly successful research cluster and plans have recently been announced for a £2bn city metro scheme potentially using autonomous control technology and with a central tunnelled section.[3]

East Anglia's rail network centres on two main routes – the Great Eastern Main Line (Norwich-Ipswich-London) and the West Anglia Main Line (Kings Lynn-Cambridge-London), from which Stansted Airport is served on a short branch. Both lines carry very substantial London commuting volumes, including many over long distances and both face major capacity challenges[4]. There are measures available, each with attendant costs, to address these problems: extra platforms at the Liverpool Street terminus in London; re-signalling sections of route such as Chelmsford -Shenfield; four-tracking (along the Lea Valley, for example); the provision of loops for the significant number of freight movements; and digital train control applications. Yet, as Network Rail's Anglia Route study concluded, even then:

> **"On the Great Eastern Main Line, further enhancements to support peak growth will be required."**[5]

3. BBC news, *Cambridge metro plans take a step forward*, 31st January 2018 (www.bbc.co.uk/news).
4. The region also hosts the UK's largest container port at Felixstowe, where about 25% of arriving containers continue inland by rail.
5. Network Rail, *Anglia Route Study*, March 2016.

Capacity is a problem on the region's road networks too. DfT's London-Ipswich Multi-Modal study ('LOIS'), reported in 2003 on the case for investing in the A12 trunk road[6]. It considered whether the rail network could make a bigger contribution and concluded that current capacity constraints precluded this approach. But it did consider new lines such as Colchester-Braintree-Stansted to relieve the A12 and the parallel Great Eastern Main Line. To be effective, such an idea would need to extend into central London (beyond the scope, no doubt, of the LOIS project).

There was a strong regional campaign in 2014–15 to speed up the rather 'tired' Norwich-London service which ran with a 'Norwich in Ninety [minutes]' campaign. While lots of positive support was gained, reality bites, and the new rail franchise has a requirement for such a timing only twice daily, likely to happen only in off-peak hours when the route is not as congested. While 20 minutes quicker than today's timings, this will be seen as a token gesture. The problem is that the intensity of use of the line precludes limited or non-stop services during the extended periods of the commuter peaks, but the need to accelerate Ipswich and Norwich services needs to be taken seriously, as it was prior to the 2015 General Election.

Stansted Airport's development is frustrated when comparisons are made with Heathrow and Gatwick by its lengthier rail journey times to London (45 minutes) – with commensurately high ticket prices. Discussion around 4-tracking the Lea Valley line within Greater London is closely linked with ideas around Crossrail 2 and a major change in land use from industry/mixed use to higher density housing. As such, it will address a London growth challenge but is unlikely to allow significantly faster journey times for Stansted/Cambridge-Liverpool Street trains.

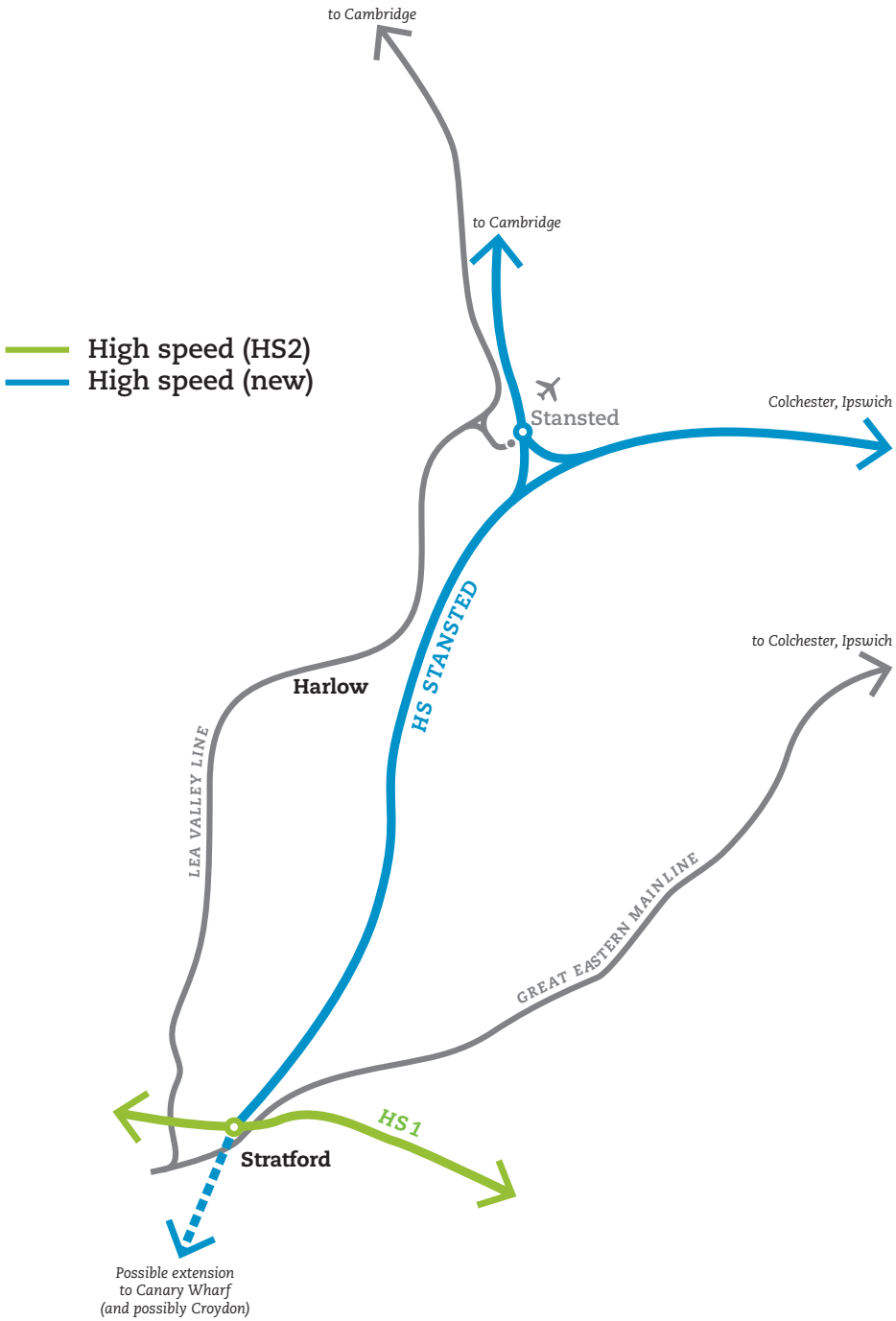
The prescription for East Anglia's radial routes into London must provide sustainable rail network capacity that will support and address the substantial demographic and economic growth opportunity of the region. Here there is the opportunity to create a single new high-speed radial route that will provide much needed capacity as well as connectivity benefits.

The known and unsolved capacity constraints on both the Great Eastern Main Line (precluding the sought-after speed-up of Norwich services through the day) and on the West Anglia line (meaning slow journeys to/from Stansted Airport and Cambridge) can be overcome, but not by the relatively modest level of adaptations to the existing lines considered in studies to date. Instead, consideration needs to be given to a new approach that would maximise the benefits of new high-speed line construction. Like HS2, this would need to 'plug into' the existing rail network and offer a bypass to its most critically over-stretched line segments. Unlike HS2 (under current plans) it could offer a direct interchange with HS1.

6. The Multi-Modal Study (MMS) programme was an outcome of the Government's strategic review of the roads programme, as described in "A New Deal for Trunk Roads", published by DETR (now DfT) in July 1998. This review was made in the context of the Government's White Paper "A New Deal for Transport – Better for Everyone", published earlier that year.

A high-speed line could be built, for example, along the M11 corridor from Stratford initially in tunnel, and branching beyond Stansted Airport to link the Great Eastern and West Anglia Main Lines. London terminus points could be at Stratford, or Canary Wharf (from which a cross-London route southwards for high-speed trains could be fashioned) or Liverpool Street (but the approach and station facilities here would be expensive). Stratford has excellent onward connections (enhanced further by the Elizabeth Line) and there is scope for 'place-making' around a new expanded station as has been done at Kings Cross/St Pancras.

Figure 8.2: **New high-speed rail link to Stansted**



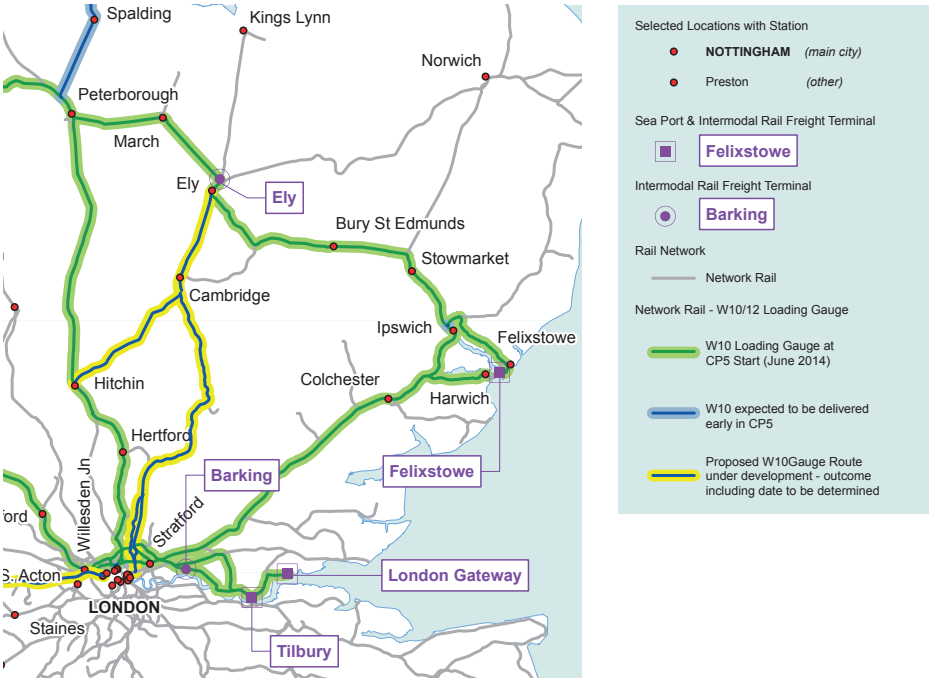
Such a link – illustrated in Figure 8.2 – would offer a rich set of benefits:

- A new faster route from Cambridge to London;
- Better access for Stansted Airport, with a fast (target: 15-minute) rail link to London and much improved direct connectivity to the airport from across East Anglia;
- Capacity relief to the Great Eastern Main Line, with a faster route via Stansted Airport for London trains from Norfolk and Suffolk, and the scope to intensify services from north Essex into the capital. A journey time of 25 mins – nearly halving times from Colchester to a new London terminus at Stratford would be feasible; 'Norwich in 90' would be readily achievable through the day;
- Released capacity to allow service expansion along the Lea Valley and support its associated development. This would support Crossrail 2 in due course and enable its operation to be segregated from the longer distance national rail network;
- A new cross-country axis between the North/Midlands-Cambridge-Stansted-Colchester-Ipswich;
- The capacity released in the Lea Valley could also potentially be used for freight from Tilbury/Thames Gateway (although this would need a new junction at Tottenham Hale), and/or there might be scope for a strategic freight interchange and associated railfreight flows. This might allow the southern end of the East Coast Main Line to be freed of freight;
- If later extended north of Cambridge to Peterborough (either by line of route upgrade or further new build), provide capacity relief to the East Coast Main Line and potentially (after 2040) form the southern end of a second north-south high-speed line;
- Act as a complement to the Felixstowe to Nuneaton freight route and a plausible extension to East-West Rail.

Managing freight flows across London

Intermodal freight is very largely blocked from using the London area network over lengthy morning and evening peak periods. The ports and routes involved are illustrated below.

Figure 8.3: **The freight network around London**



Source: Network Rail, Enhanced W10/12 "High Gauge" Network CP4 Period End (June 2014).

The creation of a new high-speed line to relieve the capacity constraints on the main lines into Liverpool Street complements the Felixstowe-Nuneaton strategic freight route and provides the basis by which problematic freight flows from Tilbury and Gateway might be handled in future.

There are currently two cross-London routes available:

- From Tilbury and London Gateway, via Barking, Gospel Oak and the North London line to Willesden. This route is completely segregated from the Great Eastern Mainline, but has a flat junction onto the busy North London Line at Gospel Oak.

- From Felixstowe, via the North London line through Hackney and Camden to Willesden. To get to this route, trains must cross-over the Great Eastern Main Line on a flat crossing at Forest Gate, a particular problem and constraint given the volume of traffic on it.

Both of these routes are now heavily used by passenger trains operated by TfL as part of the London Overground: this now offers 4tph from Barking to Gospel Oak and 6tph between Stratford and Willesden. A better approach is needed.

Possibilities considered over the years have included building a completely dedicated freight tunnel from the Stratford area to Willesden and bypass all the trouble spots in one go, but this would be very expensive. Another option would be to make use of the Lea Valley line from Stratford and route freight trains via Cambridge, Ely, Peterborough and Leicester to access the West Coast line, but this too requires difficult-to-construct new junctions in built-up areas in order to reach Barking and the ports.

Two other approaches are possible. One would be to develop a 'freight priority' route using the Gospel Oak-Barking line and a new tunnel between Gospel Oak and the West Coast lines at Chalk Farm, to help with Tilbury and London Gateway traffic in particular. This would bypass the constraining low-speed junction at Gospel Oak, and the North London Line through Hampstead. It was the subject of preliminary feasibility work by the Strategic Rail Authority in 2000 as part of the London East-West study that led to the adoption of Crossrail.

Another would be to create a new north-south link in Essex, essentially a link between Pitsea and Chelmsford (partly using existing lines), as mentioned in Network Rail's current Strategic Business Plan, albeit as a very long-term freight-only option. This would involve relatively short distance new links between existing lines. But rather than conceiving of it as a freight-only line, with limited benefits and only a long-term option, this should be created as a mixed-traffic route, providing missing passenger north-south rail connectivity in Essex and mitigating the risks around the long-term benefits of railfreight infrastructure. It would allow freight trains from Tilbury and London Gateway to avoid London and exit via the Great Eastern Main Line to Ipswich and then on to the capacity created by the Felixstowe – Nuneaton project.

A further step beyond this would be to consider the advantages of a new crossing of the Thames east of Tilbury, for both passenger and freight trains. This would potentially link onto the North Kent route near Hoo (east of Dartford) and permit a new network of Essex-Kent passenger services to be built up between the Medway Towns, Dartford, Maidstone and Tonbridge and destinations in Essex including Colchester, Chelmsford, Southend and Thurrock. This would not be a high-speed line so could have connections both eastwards and westwards to the c2c route at Tilbury. Given the volume of car traffic at the Dartford River Crossing, passenger demand for a link of this kind is likely to be high and remove the significant connectivity barrier that the Thames has become.

In Kent, this configuration would allow freight traffic from the Isle of Grain and other freight terminals – including that proposed at Erith, to be diverted around London. Channel Tunnel freight could be diverted from South London altogether, freeing up capacity for further metro services, by use of the Medway Valley route via Maidstone. This would require a new chord at Paddock Wood, and some work would doubtless be needed to strengthen the infrastructure which has only carried relatively lightweight trains for many years. This would be particularly useful as Channel Tunnel freight grows and we include it therefore in the strategy for the south east.

To complete the freight picture in the South East, we need to re-iterate the opportunity that HS2 and F2N create for more freight to be operated on the southern part of the West Coast Main Line and the obvious need for a strategic freight interchange(s) to be created in London to take advantage. To this needs to be added the opportunity (with the combination of F2N and the planned high-speed line for Stansted and beyond) to route freight trains for London – especially those supporting the construction sector, which is predominating to the east of London – away from over-stretched routes into St Pancras and Kings Cross and instead use the Lea Valley line which needs to be provided with appropriate freight terminals. It would be good if private sector developers come forward with suitable plans to make this happen, but history gives us little comfort that intermodal freight terminal locations will be located where there is adjoining spare rail capacity. The public sector should therefore take the lead on initiating this evolution in railfreight provision in London.

Western Route

Network Rail's Western route covers roughly the territory of the old Great Western Railway and later BR's Western Region, but excludes Wales. It comprises essentially a set of routes that radiate from Paddington station. The Great Western Main Line (GWML) links London, Bristol and Cardiff; the West of England Main Line serves the West Country.

Discussions are only just getting underway about sub-national transport bodies for the South-West of England with one for the South-West Peninsula (Cornwall, Devon, Somerset and Dorset) and another centred on the West of England Combined Authority and neighbouring authorities perhaps in prospect. Further east, the Western route serves parts of the area of the emerging sub-national bodies for the Economic Heartland (e.g. at Swindon) as well as the South East (e.g. at Reading).

The GWML is part-way through an electrification project that has not gone well; it is over-running on timescale and budget. Electrification to Cardiff (via Bristol Parkway) is committed, but completion dates for sections to Oxford and Bristol are not currently set. The major bottleneck and source of train-train conflicts at Reading has been removed through major station enhancement and grade-separation of key junctions. Greater use of bi-mode trains than had originally been intended will allow the replacement of life-expired 40 year-old rolling stock although journey times will be slower over non-electrified sections of the route.

Reading Station
Photo: Network Rail

The new junctions at Reading free up movements of freight trains on the Southampton – West Midlands corridor from train movements to and from London, as well as between GWML and West of England routes.

Between Reading and London, a new line that will form a western connection into Heathrow Airport is progressing through planning[7]. Unfortunately, this is being planned to support only a limited new train service with perhaps 4 trains/hour operating no further west or north than Reading. This will be solely a local service, useful of course, for Thames Valley residents and businesses, but travellers to the airport from a much wider geography will still need to change trains to access the airport. But there are aspirations for direct airport services from the West Midlands, South Wales, Bristol and the South West of England.

Across our near neighbours in Europe, major airports have been plumbed into national intercity rail networks – at Zurich, Copenhagen, Brussels, Amsterdam (Schiphol), Frankfurt, Paris Charles de Gaulle and Lyon (Saint-Exupéry). In the latter four cases, the connection is directly into the national high-speed rail network. It would be wrong to overlook the competitive economic advantages such linkages provide.

7. An application by Network Rail was expected to be submitted to the Planning Inspectorate in Q4 2017, but appears to be facing a 24-month delay.

Photo: Greengauge 21. Frankfurt Airport's high-speed rail station, 2012

For the Great Western Main Line, there is a major policy issue to be faced. Over the last 40 years, the route has seen substantial growth in longer distance commuting to London. Additional stops have been introduced into longer distance services from Bristol and South Wales to provide extra capacity from stations at Swindon, Dicot and Reading, but also lengthening journey times. As a result, even with the route electrified, journey times between Cardiff, Bristol Parkway and London are likely to be little changed from those provided 40 years ago when 125 mile/h operation commenced, although it might prove possible to squeeze in a couple of additional peak trains that might operate non-stop, for example, between Bristol Parkway and London with faster timings.

If investment is to be directed – as it has been over the decades – into meeting capacity challenges and maximising rail revenues, then the route infrastructure can support 'more of the same': a higher frequency of semi-fast services making multiple intermediate station calls. If the priority is to be shifted, to take account also of connectivity aims and the wish to re-balance the economy, then a different approach is needed, with non-stop services (say between Bristol Parkway and London) re-introduced, allowing a reduction in journey times between West/South Wales and London operating alongside semi-fast services.

To accommodate both – and direct services between South Wales and Heathrow – would require a progressive enhancement of the route, as set out in a set of quantified 2012 'Conditional Outputs' envisaged for the GWML in 2012[8]:

- A progressive speed up of the route, created by a route upgrade that extends the four-track railway westwards from Didcot to create additional route capacity (which allows a useful new local station to be provided at Wantage/Grove, long-sought by Oxfordshire County Council) so that semi-fast trains can be overtaken. Operation of the train fleets using their 225 km/h capability (specified in the GW overhead line electrification equipment) could be exploited so that, along with the removal of intermediate stops, and grade separation of junctions at Didcot, Wootton Bassett, and Westerleigh, Bristol Parkway-London timings should be 20 minutes quicker. All fast trains would be routed via Badminton, while services via Bath would retain station calls at Swindon, Didcot and Reading. Swindon could become the terminus point of the commuter network, joining Oxford in having fast direct access for commuters to the significant centres along the Thames Valley as well as London;

- Higher frequency services between Cardiff and Bristol. This is a city pairing with higher cross-commuting than Leeds-Manchester, and an expanded and modernised facility at Severn Tunnel Junction would add a large commuter catchment of travel into both cities, in an area that is likely to see a significant increase in congestion as the Severn Bridge road tolls are removed;

- A western connection to Heathrow with direct longer distance services and Heathrow becoming a rail hub.

This vision was reflected in the original outline national Greengauge 21 high-speed strategy, in which some routes would be upgraded to provide better connectivity and capacity, whilst in other corridors new high-speed lines would be provided, but all of them were to be inter-connected. There is no reason to change this philosophy, even though developments in the Great Western zone since have not gone to plan (Reading and London-Cardiff electrification upgrade aside) and HS2 has dropped its Heathrow connection. Scrapping the HS2 line to Heathrow means that the western connection to the airport for a wider national geography with direct services, which could include cities such as Bristol, Cardiff, Oxford, Milton Keynes, Coventry and Birmingham, is even more important.

8. Greengauge 21, *Great Western Conditional Output Statement*, March 2012.

Our work in 2012 for the Great Western Partnership uncovered research carried out for the former South West Regional Development Agency that shows that journey time to London (which ranges from one hour to over five hours across this particular region) is a crucial factor in the economic development of the West Country. Economic development drops away at locations beyond a two-hour access time to London. There are similarities in terms of economic outcomes and performance 'west-east' for the West Country just as 'north-south' for the North of England. Cornwall is in fact one of the most deprived areas of the country. It, for example, experiences low wages (77% of national average), with 43% receiving less than the living wage; homelessness is the third highest in the country; a quarter of children are living below the poverty line; and 17 neighbourhoods are in the 10% most deprived in the UK. This is a peripheral part of the country because of its slow and vulnerable transport links, an issue to which we return in Chapter 9.

The far South West will not benefit greatly from the limited route electrification taking place in Berkshire. The line westwards from Reading to Taunton, Exeter, Plymouth and onwards across Cornwall to Penzance is not currently capable of supporting train speeds over 110 mile/h, and in many places, much less, because of gradients and tight curvature. The line is used by long distance passenger services and heavy-haul aggregate trains from quarries in the Mendips to the London area.

It is therefore over the 2-track section of line that carries this more intense traffic mix, between Taunton and Reading, and where passenger train load factors are also at their greatest, that any significant investment such as cut-offs designed to increase line speed for faster passenger trains and in effect to create four track sections where fast trains can overtake slower ones, should be focussed. There are some obvious locations to target, such as where there is a significant dip in the line speed profile.

The case for using tilting technology – especially on a lengthy route with precious few tangent ('straight') sections of line – an overlooked British success story on the West Coast Main Line – should also be considered: it alone would save 20 minutes on the London-Plymouth journey time with minimal spend on infrastructure.

The curves continue all the way: Penzance is 110 miles from Exeter, but journey times are 3 hours at best. Even Plymouth lies a full hour beyond Exeter on the fastest trains, and there is a continuing risk of sea-overtopping at Dawlish and of flooding and earthworks slippages elsewhere cutting off services.

The most significant (but not the only) problem with protecting this railway arises where it traverses the sea wall at Dawlish. After the sea wall and railway line was breached in February 2014,[9] this attracted some consideration of building a new (tunnelled) inland route that could have offered a modest speed improvement (around 7 minutes). But this would have been west of Exeter, where demand is lower, and such notions were soon dropped since access to the coastal towns and the sea-wall itself would need to be retained.

9. BBC News, *Dawlish's storm-damaged railway line reopens*, April 2014.

Yet there is a case for investment in network resilience that would benefit both Cornwall and Devon, based on some preliminary research carried out in 2015.[10] With the coastal route at Dawlish likely to be the source of foreseeable, ongoing, service disruptions, besides a programme of remedial works, it makes sense to re-create an alternative route, especially since much of it is still in place. The route between Okehampton and Tavistock, if rebuilt, would also bring a transformation in access to a part of the country that is remote and has weak economic performance. It is a proposal for which support is growing, including from local MPs.

Network resilience is achieved by providing an alternative route that avoids the sea wall section and the flood-prone Cowley Bridge junction near Exeter, the latter by building a short new east-west connection to the north of the junction, allowing direct operation of trains from the Taunton direction to Okehampton, Plymouth and Cornwall (as well as to Barnstaple in North Devon).This approach would result in journey times for London/Bristol – Plymouth and Cornwall no slower than the existing line (and potentially slightly quicker), as well as offering the prospect of a guaranteed year-round service (see Figure 8.4).

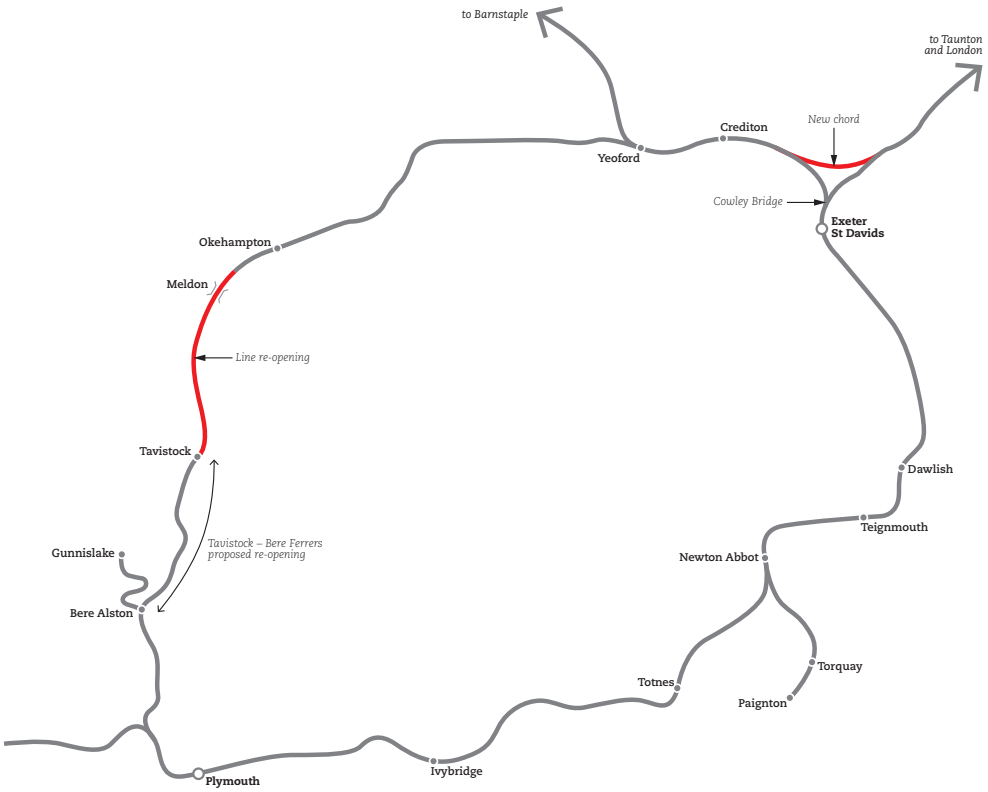
Network and service resilience has to be placed ahead of 'better connectivity'. This is why Cornwall County Council's Director for Transport and Infrastructure, Nigel Blackler said in 2017:

> **"there is definitely merit in exploring the building of a new line that either bypasses Dawlish or travels further north around Dartmoor. We need to start thinking about this now".**[11]

And since then Storm Emma closed the route for 36 hours in March 2018. Nowhere else in Britain is the continuity of main line rail connectivity as fragile as here. The Peninsula Rail Task Force – a collaboration between west country authorities – has kept this plan on its longer-term agenda, but it needs to be prioritised further. So long as rail connectivity is at risk because of adverse weather, other investments along the route risk being de-prioritised; the far west will not find it feasible to attract a switch of freight from road to rail; and vulnerability in the South West's economy – in its highly important tourism and other sectors – will remain.

10. Greengauge 21, *Rural Reconnections: the social benefits of rail reopening*, June 2015.
11. Transportation Professional, p17 July/August 2017.

Figure 8.4: **Upgrade and new lines to create second route via Okehampton and Tavistok to Plymouth and Cornwall**



Wales and the English borders

There are three strategic rail routes in Wales, as has been long recognised by the Welsh authorities. All three run east-west. They are the main line in South Wales – from the Severn Tunnel through Newport and Cardiff to Swansea and West Wales; the main line along the North Wales coast that links Chester with Llandudno, Bangor and Holyhead; and the Cambrian main line linking Shrewsbury with Aberystwyth. The only usable north-south route (leaving aside the 'Heart of Wales' line between Llanelli and Shrewsbury), runs along the English side of the border through Hereford, and this is the route used to link North and South Wales by train.

Local and regional authorities both north and south recognise the strong economic linkages that lie across the England/Wales border. In North Wales, the case for improved rail connectivity is being made by the 360° Task Force, centred on the Mersey-Dee area: there is a hugely significant industrial sector straddling the border with major employers such as Ineos, Airbus Industries and Tata Steel. In South Wales, there is a high level of cross-commuting between Cardiff (and Newport) on one side of the Severn Estuary, with Bristol, on the other.

An essential part of the Strategy for Wales must therefore lie in seeking to ensure that Wales, north and south, benefits from wider rail investment programmes and that there is no degradation of services at the border. In both cases, the limits of electrification programmes have potentially posed a risk – in the north, if electrification was to be extended from Crewe to Chester but no further; in the south, if only the fast lines are electrified, inhibiting the development of a high-quality regional electrified service between Cardiff, Newport, Bristol and Bath, potentially denying the opportunity for agglomeration benefits across the Severn Estuary.

The now favoured mitigation for cutting back electrification is the use of bi-mode trains. In the North Wales case, their adoption in franchises such as Trans-Pennine Express is a welcome sign of opportunities ahead – for example for North Wales to be added into the set of destinations linked east-west across the Pennines and not simply just to Manchester. Bi-mode units capable of 125 mile/h[12] might provide a suitable basis for a North Wales-London service, but these would continue to operate over the West Coast Main Line rather than over HS2. Connectivity, in this case, is a matter of availability of suitable rolling stock, just as much as elsewhere infrastructure is critical. Customers could have the choice, however, of a transfer at the planned Crewe Hub station to make a quicker end-to-end journey (at the price of an interchange en route).

For North and Mid Wales, rail connectivity to airports (Manchester and Birmingham especially) is critical. The adoption of a western connection to Manchester Airport (noted above), overcoming a very clear missing link in the present national network, could be transformational for Chester and North Wales.

The creation of a Metro for Cardiff City Region – and possibly an equivalent for the Swansea Bay area – will strengthen the economies of these cities. The wider national connectivity issue arises from the linkages between these cities and the major centres across the UK. Cardiff should be a hub of a network of high-quality longer distance services to Chester/North Wales, Liverpool, Manchester, Glasgow, Sheffield, Leeds, Edinburgh, Birmingham/Nottingham and Southampton/Portsmouth. The infrastructure exists, but the services are patchy, with South Wales being on the margins of the Cross-Country franchise and the potential of the Newport-Crewe direct line remains unexploited. The services should perhaps be brought together in one train operating company to provide a clearer focus.

A candidate for connectivity improvement could also come from a short section of new rail infrastructure in the Swansea Bay area, where a coastal route could halve the time trains take to travel between Port Talbot and Swansea; and if Swansea could have a through station rather than a terminus, there would be further time savings for West Wales travellers too. But such changes depend on their enthusiastic support from the relevant city authorities, who will need to show resolve in regard to schemes that entail new rail infrastructure in or near city centres.

12. Or purpose-designed loco-haulage west of Crewe for Pendolinos, for example, could be equally attractive.

The South: the Wessex and the South East Routes

The area covered here is (broadly speaking) the territory covered by British Rail's Southern Region, a network of lines spreading southwards of the Thames from London, with a common feature in the widespread use of third rail direct current electrification systems.

Network Rail's Wessex Route comprises the lines into Waterloo that serve Surrey, Hampshire, Wiltshire and Dorset; the South Eastern Route accounts for all of the other London's south facing termini, and also includes parts of the London Overground, Thameslink and High Speed One, over which a very successful high-speed commuter service operates. Much of both routes lie within the area covered by Transport for the South East, the sub-national transport body in formation for Berkshire, Brighton and Hove, Kent, Hampshire, the Isle of Wight, Medway, Portsmouth, Southampton, Surrey, East Sussex and West Sussex.

A large part of the debate around this part of the national rail network centres on its relationship with London, and questions around whether it would be better if the 'inner suburban' services were managed by Transport for London rather than DfT. A change of this type would lead to more of the concessioning model used with London Overground (here the operators are paid to deliver a service to a set of standards, with the public sector retaining the revenue, in contrast to the franchising model in which the revenue accrues to the operator). It would require a much sharper division in terms of fleet, depots and calling patterns than today. And to achieve separation of tracks for within-London and longer distance services could jeopardise the flexible diversionary route capability of the 'southern region' network: currently maintenance work is carried out by planned day-long or full weekend route closures, with trains kept running by extensive use of diversionary routes.

The question of capacity into the centre of London has been the dominant concern, and the railway network is used by both inner and outer suburban services as well as some long-distance trains. Indeed, typically, as on the Wessex Route, there are three overlapping sets of services with inner suburban services (London and slightly beyond), and services into the Shire Counties themselves divided into two, between those for stations typically in the 15-50 mile range (Surbiton – Basingstoke, for example, on the Wessex Route) operated alongside longer distance trains that are concentrated on serving the 50-150 mile range (Winchester, Southampton, Bournemouth and Weymouth, in the same example). Combining three overlapping service types onto two pairs of inbound and outbound tracks at Waterloo is a delicate balancing act in terms of timetabling. All three categories carry high commuter volumes.

The Wessex Route is an example of where it is intended to increase seating provision/train capacity at peak times, following a recent franchise award. The operation of longer trains (10-car instead of 8-car on inner suburban and medium distance lines) has increased capacity by 25%; increases in frequency are also expected from December 2018, and it would appear likely that some innovation in train control systems will be put in place to deliver this. Short of adopting fully automated train control systems, this may represent the limit of what can be achieved with existing infrastructure.

For the longer term, if further capacity increases are to be found south of London (along with much needed enhanced service reliability), they will likely rest on:

(i) More substantial infrastructure schemes, resolving junction conflicts (this is likely to happen at selected points on the Brighton Main Line in the South Eastern Route);

(ii) The introduction of further cross-London routes and services to untie the operating constraints of existing terminus stations. Thameslink has this effect, and adds a substantial volume of (longer) trains to the South Eastern Route, in turn requiring platform lengthening, junction improvements, the use of automated train control systems through the central core 24 trains/hour section of route, and the total rebuild of Blackfriars and London Bridge stations. Crossrail 2 is the next key candidate scheme, currently, with a £30bn+ capital cost and an estimated delivery timescale no earlier than 2030;

(iii) 'Metro-isation' of the inner suburban parts of the network. This implies an end to the practice of a complex mix of service types using shared tracks and instead route segregation. One corollary is passengers needing to change trains more, but then service frequencies would be higher. This would require a major power supply upgrade, along with major investment at stations and junctions, including grade separation at Windmill Bridge junction, Croydon, currently at the design stage. And a revised track access strategy for maintenance would be needed too. The current operational complexity and poor service quality can be improved by allowing higher frequencies on some routes and less on others, giving some lines away (to Tramlink) or to (potentially automated) shuttle-style operation such as already operates at Bromley North;

(iv) Extensions of London Underground lines to provide substantial extra capacity and passenger transfer away from national network train services – the Bakerloo Line extension along the Old Kent Road to Lewisham being the latest (and probably the last since the other available lines are already operating at capacity across central London).

These options are clearly very closely related to questions about London's network as a whole – and are picked up in the following section on London.

Whether entirely new routes could or should be created to serve the London market has arisen in the context of the Brighton Main Line, where what was originally seen as a line re-opening that would make good a short-fall in local connectivity – the link between Lewes and Uckfield – has spawned the idea of a completely new Brighton Main Line (BML2) that would reach central London, and possibly operate on a cross-London basis. As such it joins a short list of candidate schemes such as Crossrail 2, but with a differing emphasis since it is intended to serve longer distance markets and so would need fewer (or no) intermediate stations. The case for such a new line sits uneasily alongside the business case for improving the existing Brighton Main Line[13], as favoured by Network Rail: a choice has to be made.

In summary, then, there are four options if a major increase in capacity is to be provided on the commuter rail network south of the Thames:

- Line of route upgrades;
- Extension of London's 'metro' network, the London Underground & Overground ('metro-isation');
- Addition of new cross-London 'regional metro' lines (Thameslink, Crossrail 2 are examples);
- New lines for outer suburban and intercity flows (BML2, being a case in point).

The question of non-London routes is also relevant, and these can be characterised as orbital lines. The Ashford – Redhill – Guildford – Reading line, along with the line that follows the south coast from Ashford to Brighton and Portsmouth/Southampton are the only two of any great significance. Neither is used to operate freight trains 'around' London, because at key locations the routes are incomplete and would require train reversals. Passenger services over these lines are also relatively slow – a journey from Ashford to Guildford takes over 2 hours with two changes, for example and are uncompetitive with the motorway network. While some useful linkages are provided (especially to/from Gatwick), these lines fail to create a wider 'mesh' of rail routes across the South East.

13. 'A major redevelopment of the railway through central Croydon to transform railway performance and potentially allow more trains to run on the Brighton Main Line – including a new, expanded East Croydon station, extra tracks and flyover junctions – moved a step closer … with confirmation of government funding for Network Rail to deliver the design stages of the project' see https://www.networkrail.co.uk/feeds/brighton-main-line-upgrade-moves-a-step-closer-as-croydon-railway-redevelopment-gets-funding-boost/ of 26th February 2018.

One opportunity to begin to redress this weakness arises with the possibility of a southwards extension of a new line from Heathrow Airport towards Woking for which Government has announced plans to seek private sector funding. Another modest proposal is the now-stalled Metropolitan Line Extension to Watford Junction (the Croxley Link) which could accommodate services from Aylesbury and Rickmansworth to Watford Junction, strengthening the 'hub' role of the latter, an approach that becomes realistic once HS2 is open and the WCML timetable is re-structured.

High Speed Rail

In the south east, the HS1 line supports the country's only high-speed commuter service. Despite its 30% fares premium, it is very popular, as we set out in chapter 3. There are stakeholder ambitions to extend the service to Hastings, as well as to intensify the service to increase capacity which is now under pressure at peak periods, but these ideas have been left for bidders to consider in the current franchise renewal: they are not requirements.

As for HS2, it has no southern onward network connections that would allow through running, but it does have an important interface with Crossrail at Old Oak Common. Crossrail 2 potentially offers a further significant benefit by providing a link from a large part of South West London to Euston for HS2 (and indeed to the HS1 terminus at St Pancras). The benefits of this connectivity gain to SW London as well as the investment case for HS2 have been under-played.

Instead, the argument has been made by successive London Mayors and TfL that without Crossrail 2, it is not possible to handle the increased demand that HS2 Phase 2 will bring at Euston. As HS2 Ltd has pointed out, the percentage increase in overall (national rail plus London Underground) peak passenger numbers at Euston is only driven upwards by a small percentage by the arrival of HS2; the problem is more that, by 2033, there is expected to have been so much background growth that it would be desirable to have additional London Underground capacity beyond the increments that will be gained from current plans: the significantly increased frequencies planned for the two Northern branches of the Northern Line. In any event, 11% of the Phase 2 maximum HS2 demand at London is taken away if a 16 trains/hour limit on HS2 is presumed, as suggested earlier in Chapter 5.

In short, it is incorrect to argue that Crossrail 2 is a prerequisite for HS2 Phase 2. But it is true that Crossrail 2 would add a significant connectivity gain, part of which would be experienced by HS2 passengers accessing Euston from the south west.

London

Since the 1980s, London's population has risen two million to 8.6 million – matching its previous peak reached in 1939. It is set to grow by a further 3.1m by 2050 (according to the Mayor's strategy). Its proportion of the nation's GDP output is growing – it accounts for about a quarter of the nation's economy, and a higher proportion of its tax-revenue.

Outer London is expected to grow faster in population terms (at an estimated rate of 12.9% over the period 2013 – 2025) than the rest of London (according to the Greater London Authority). The capital city needs more homes – especially affordable homes. Planning consents are dependent on, amongst other things, public transport accessibility. So, land use development is tied effectively to public transport provision. This underpins the claim that Crossrail 2, with its attendant plan for major housing development along the Lea Valley, needs to be regarded as an integrated piece of infrastructure development, able to deliver sustainable development and housing outcomes.

While such an approach could beneficially be adopted more widely (London is not alone in facing a shortage of affordable housing), the ability of development to fund new transport links (fully, in the case of the Northern Line Extension to Battersea, partially in the case of the Jubilee and Bakerloo line extensions) is unlikely to be a viable model for the rest of the country (although Cambridge's prospective tunnelled transit system might be a partial exception).

The particular London-based issues that need to be considered in this report are those that relate to

i. HS2:

- access to/passenger dispersion from its stations at Old Oak Common and Euston;
- its connectivity with HS1;
- the use to be made of released capacity on the West Coast Main Line

ii. The need for more central London access capacity in other corridors;

iii. The need for better cross-London connectivity, largely ignored by the rail industry's current planning process (Thameslink 2000 and Crossrail 1 were first seriously advanced in the Central London Rail Study 29 years ago).

These issues reflect a deep institutional problem, which is that while London's rail priorities understandably are centred on meeting the challenges of capacity and connectivity within Greater London as perceived by the Mayor and Transport for London, national rail routes (including HS2) are designed to reach central London with onward passenger distribution treated as an external problem for others (TfL) to solve. Even worse, no authority pays attention to rail connectivity between London's strategic radial corridors except as they provide a cost-effective way of sourcing traffic for (underground) central London rail links. The proof of this last point lies in the source of the soon to be completed Crossrail project that links the Great Western and Great Eastern Main Lines: the Central London Rail Study of January 1989. The clue is in the title – the word 'Central'.

London is benefitting from the development since 2000 of three major projects: the East London Line extension that allowed the creation of the 'outer circle' London Overground; Thameslink and Crossrail. Together these investments create a superb rail-based complement to the London Underground – an S-bahn in the eyes of some (see Figure 8.5).[14]

As a consequence of the central London planning perspective – understandable if the aim is to relieve overcrowded underground lines which are at their busiest in central London – it is frequently overlooked that London is a barrier to an important set of longer distance national rail journeys (to/from Kent, Sussex and Surrey; to/from Gatwick Airport; to/from HS1), although Thameslink and Crossrail help to address this problem.

High Speed Two

With connections to HS1 and Heathrow that featured in the original HS2 plans now both abandoned, strategic connectivity issues in and across London arise just as much with HS2 as they did in the 19th century era of national rail network development, with the ring pattern of main line termini around the centre of London.

Neither Old Oak Common nor Euston are located at natural development sites (in the way that both Stratford and Kings Cross were, with large-scale ex-railway/industrial lands suitable for remediation and regeneration for HS1). So, the bonus of highly localised 'walk-in' demand will be reduced – although the option of much costlier oversite development will no doubt be considered. In the case of Old Oak Common nearby industrial sites will probably be displaced, predominantly by housing developments. But the key driver of this development demand is access to the planned Crossrail station, as well as the mix of rail services available at nearby Willesden Junction, rather than HS2.

14. Transport for London does not show Thameslink on its maps, so the brilliance of the '+' shaped (Thameslink/Crossrail) network is not yet apparent to many, although it will be fully opened within the next two years.

Figure 8.5: **An S-bahn for London?**

Source: 'U-Bahnfreunde' of Hagen, DE: https://upload.wikimedia.org/wikipedia/commons/4/4d/Netzplan_S-Bahn_London_2019.png

Euston has excellent rail and bus connectivity (although there is continuing pressure on capacity as is common across London's central area); Old Oak Common lacks both a suitable surrounding road network and – while there are plenty of railway routes nearby – none of them other than the Great Western Main Line are adjacent to the planned HS2 station.

The provision of **better access to Euston** is generally seen by stakeholders as being tied to the creation of Crossrail 2. As Greengauge 21 has pointed out on more than one occasion since 2010, the obvious (and far less costly) means to take the pressure off Euston is to reduce the number of main line commuters needing to transfer on to the Underground at the station by connecting the West Coast Main Line commuter services into Crossrail. Only a short connection is needed (in the vicinity of Old Oak/Willesden Junction) where the West Coast Main Line and Great Western Main Line come close together. Such an approach is feasible, has been costed, has a good business case and has been supported by Network Rail[15] and by Transport for London. It remains available as a way to avoid the need for a second stage rebuild of Euston station during the early period of HS2 operation in the years 2026-2033 – a prospect that risks discouraging use of HS2's Phase1 /2a services, adding to the costs of Phase 2, as well as dismaying the local community.

Paris Gare du Nord with Eurostar, Thalys and TGV high-speed trains at platforms that were once used for suburban rail services. The same approach can be adopted at Euston to avoid the need for a second stage rebuild over the 2026-2033 period. Suburban rail services would leave the approaches to Euston near Willesden Junction and instead join the Crossrail (1) route into central London.

15. London and South East LTPP study, Network Rail, 2012.

Crossrail 2 will bring Euston the benefit of better connectivity and access from South West London as previously noted. But the most critical underground links for 'dispersing' HS2 demand are likely to remain those between Euston and the City (even with the planned direct connection with the nearby Metropolitan/Circle line station at Euston Road – a key wider benefit of HS2 for London). There is a TfL scheme to extend the DLR westwards from Bank station to Kings Cross and Euston that would fill this gap and could also be designed to provide a 'long-distance passenger-friendly' connection between Euston and Kings Cross/St Pancras. If Euston were the only consideration (it isn't, of course), here is a scheme with a tenth of the construction cost of Crossrail 2, to manage passenger 'dispersal'.

Old Oak Common is built into HS2 Ltd's plans because, in effect it was in its remit at the outset. This was in contrast to HS2 Ltd's overall objective which was not prescriptive as to route, being expressed to develop a high-speed rail scheme to connect 'London and the West Midlands and potentially beyond'.[16] But the remit from DfT was specific in one particular respect: it obligated HS2 Ltd to provide an interchange with the Great Western Main Line between Paddington and Airport Junction. In practice, the only realistic location for achieving this was at Old Oak Common. But much of the railway land at Old Oak Common has since been taken up by a new depot for Crossrail which does not provide for over-site development: it has an arched roof. So, while an HS2 station can be fitted in readily, adjoining development has proved to be a tougher challenge, with a Mayoral Development Company established to coordinate and drive it forward.

The original ambition as per HS2 Ltd's remit had been to provide an interchange station that would allow HS2 passengers to access Heathrow Airport via transfer at Old Oak, but HS2 Ltd's models suggested few passengers (c2,000/day) would elect to do so (those using rail for longer surface access journeys to reach airports being known to be resistant to a need to interchange en route). On the other hand, HS2 Ltd's models suggested a third of HS2's morning peak period passengers would transfer from HS2 trains at Old Oak rather than complete the journey at Euston because of the assumed ability to transfer onto Crossrail at Old Oak. This, of course, would provide very useful relief to the pressure on Euston station (although less than the even larger numbers of commuter travellers that could be diverted in entirety from Euston under the WCML Crossrail branch proposal noted above).

What is not clear, given that all of the modelling work has been on the basis of the morning peak hour, and with no particular evidence on high-speed rail traveller behavioural preferences, is whether Old Oak Common station would be much used for this kind of interchange through the remainder of the day. Outbound travellers from London are quite likely to prefer to board at the terminus station rather than face the anxiety of finding their seat in a 400m long train at a tightly-timed intermediate station call. There is a risk that Old Oak Common HS2 station will be relatively lightly used except for inbound passengers during the morning peak period.

16. in Greengauge 21, *High Speed Two – A Greengauge 21 Proposition*, June 2007.

Current HS2 plans are predicated on all trains stopping at Old Oak Common and infrastructure plans for the GWML also seem to be based on all Paddington trains stopping at the new station too. This makes little sense: adding up to five minutes to all these journeys is unnecessary and adding eight to ten minutes round trip time into all HS2 and GWML Paddington trains will have implications for fleet size too. Old Oak needs to be designed to operate with some trains on HS2 and some or all trains on the 'fast' pair of GWML tracks not stopping at Old Oak Common station. The benefits are compound: faster HS2 and GWML longer distance journeys from London to all destinations; lower construction costs at Old Oak Common; a more compact station design that is more attractive to users (especially those interchanging); and maximisation of surrounding development potential with a smaller station foot-print.

To be set alongside this refined vision for Old Oak Common is a potential additional rail facility that would strengthen its role as a rail hub.

While TfL has consulted on adding stations to nearby (but not adjacent) Overground lines to provide additional access to Old Oak, Chiltern Railways has developed plans to make use of the available surface rail corridor from its main line through Hanger Lane to reach the new Old Oak Common station.[17] By this means Chiltern Railways gains access from its route across Warwickshire, Oxfordshire and Buckinghamshire to Old Oak Common and provides convenient passenger interchange there with the planned Crossrail station.[18]

But while this incremental development has its virtues, it could be used as the basis for a much more beneficial development that would yield very much wider connectivity gains and create day-long value in the interchange function of Old Oak's HS2 station.

Greengauge 21 has carried out various studies[19] into the case for a HS1-HS2 connection. The prospects of direct services to/from Europe from UK cities other than London have evaporated as border control sensitivities have increased. But the potential value of a HS1-HS2 connection remains and it is important that the design for Old Oak HS2 station does not preclude such provision, if necessary, at a later date.

17. See Network Rail, *Chiltern and East West Rail Strategy summary document*, August 2017.

18. This proposal has only minor relevance as an access route to HS2; its merits rest on the Chiltern-Crossrail connection, and it is being pursued following the receipt of Phase 1 Parliamentary Powers as a possible scheme variation.

19. See Greengauge 21, *HS1 – HS2 connection: a way forward*, April 2014.

The Chiltern line extension forms the western approach to a route that needs to be married with a tunnelled connection to the east. The latter is provided for 'passively' in HS2 plans, and would connect with the existing line though Primrose Hill that is in turn already connected with HS1 at the north end of St Pancras. Such a route would connect the Chiltern Line with HS1 and its successful high-speed domestic trains services. It could therefore, if extended as proposed here, offer cross-London regional services between Kent (and East Anglia via an interchange at Stratford) and the Chiltern line from the West Midlands through Warwickshire/Oxfordshire/Buckinghamshire. It would have key interchanges en route across London at Stratford and Old Oak Common that would provide a multitude of significant new linkages. It would offer a connection from the fast-growing east side of London (and Essex and Kent) to HS2 and Heathrow Airport and would provide the missing rationale for some day-long station calls at Old Oak Common by HS2 trains. In effect HS2 would extend its appeal across a wide southern catchment of East London, Docklands and Kent.

The scaled-back stopping pattern for HS2 trains at Old Oak Common identified in Chapter 6 should mean that only a single platform for high-speed trains in each direction would be needed (along with a pair of through tracks for non-stopping HS2 trains). This should free up space in the HS2 design for Chiltern-HS1 trains that would need a conventional 2-platform station. The same would suffice for the Elizabeth Line if its link to the WCML suburban lines was created – that is, the need for separate turnback platforms would disappear. The revised approach would provide multiple benefits:

- valuable, day-long interchange opportunities;
- increased access to HS2 services;
- interchange between HS2 services, Great Western (relief line/Elizabeth Line services), WCML suburban services and Chiltern-(cross-London)-HS1 domestic trains[20];
- the majority of HS2 trains usefully speeded up;
- avoiding extended journey times for Great Western fast line services.

20. HS1 has spare capacity to support this development.

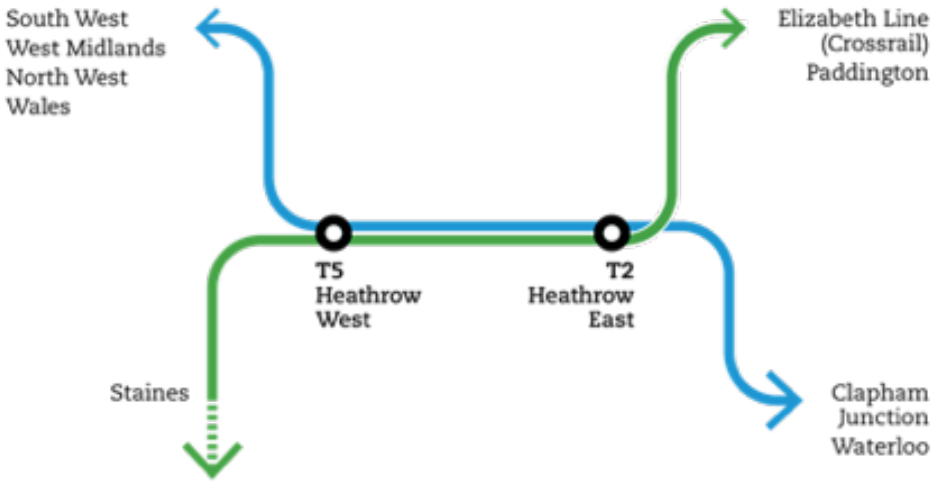
Heathrow

The need to create a rail hub at Heathrow has been much discussed.[21] This will take some pressure off London radial rail corridors as well as key highway facilities such as the M25. But the primary reason for improving rail access from across the nation is that Heathrow has been selected as the Government's preferred location for runway and capacity expansion because it says it is the best location for a hub airport for the nation as a whole. Yet Heathrow only has rail links with London.

Providing the rail connectivity from across Britain to Heathrow should be a major feature of any national connectivity strategy. Indeed, this was once the single most important agreed transport priority identified in a study commissioned by the English Regional Development Authorities.[22]

It can be achieved by cross-linking routes across the airport – using the western and southern access schemes, which have protected alignments into (and provision of platforms at) Terminal 5. But for this to work effectively, an additional link is needed so that both of Heathrow's future east and west terminals (today's terminals 2 and 5) can be served while avoiding the capacity constraints of the Great Western line into Paddington. This can be achieved as shown in Figure 8.6.

Figure 8.6: **Schematic rail hub at Heathrow**



21. See Greengauge 21 blog, *Greengauge 21 says that expanding Heathrow must be accompanied by an expanded rail network west of London*, October 2016.

22. Surface Infrastructure of National Economic Importance (SINEI), A Study for the English Regional Development Agencies, Faber Maunsell and Ecotec, January 2004.

Cross London Connectivity and central London Capacity

The challenge of increasing capacity into 'Southern Region' and East Anglia's termini, (which have the busiest of London's commuter stations) remains to be considered. They have differing long-term solutions.

On the south side of London, the best approach will be to adopt a progressive 'metro-isation' of the inner suburban network. This requires the conversion of lines to metro-style operation, with higher service frequencies, greater levels of passenger interchange and the adoption of high levels of automation of train control systems. There are highly successful precedents in the form of the DLR as well as (increasingly) on London Underground routes. Indeed, as Lord Adonis described it[23], this is the idea of 'turning South London Orange': extending the high-frequency London Overground to include all of south London's heavy rail commuter lines.

The capacity to operate longer distance service on separate tracks has to be protected under such a development. There will be a loss of flexibility of routeing that is especially valued at times of engineering works. But the benefits are substantial.[24] Capacity into central London will improve but so too will the ability to get around inner and outer London, places where the scope to provide an effective alternative to car use is all the greater.

This approach is likely to be preferred to a 'build a new railway' approach of the BML2 type referred to earlier because 'central London' is too broad a set of destinations to be easily served by a single new line from the south and the geography of places to be served at the country end of the route is likewise far too broad to be served by a single (or even two) new lines. Yet such a tunneled route for long distance trains might be worthwhile if it facilitated 'metro-isation'.

Crossrail 2 and other such schemes should be examined in the context of the need to reform the service pattern over the southern region network in south London. Current plans envisage that existing inner, suburban and long-distance services on routes into Waterloo would be retained and Crossrail 2 services added. This means inter-working new high-frequency cross-London metro services on the same tracks as main line rail services. It would be far better if any new routes such as Crossrail 2, which have segregated core routes across central London, are linked to branches that are exclusively operated by the new (cross-London) service, with convenient interchange to the national rail routes. In other words, Crossrail 2 and metro-isation could complement each other well, and in practice, their adoption needs to be planned together, improving each other's business case. Crossrail 2 branches themselves might be cross-linked by means of short new chord lines to offer non-radial connections, for instance between Kingston and Epsom.

23. Adonis A, London Guildhall, November 17th 2017.

24. See Turning South London orange, reforming suburban rail to support London's next wave of growth, Sam Sims, Jonathan Roberts, Brell Wilson (www.centreforlondon.org.uk).

Conclusion

Across southern England, there are whole regions that we have identified as potentially not benefitting from HS2. But there are others where full use of the capacity to be released by HS2 can spread benefits very effectively, especially across the English Economic Heartland.

Further afield, the connectivity challenges in both south western England and in East Anglia require significant investment in existing and new lines. The Great Western Main Line needs to be upgraded for higher speeds for which its electrification system and new rolling stock have been designed. The extension of HS2 services southwards from Birmingham to Bristol described earlier in Chapter 7 requires that the route is electrified (an infill scheme from Bromsgrove to Bristol Parkway with no complex major stations and upgraded for higher speed operation). In the far South West, we have shown how a short new line combined with re-opening the Okehampton-Tavistock line can create a second railway to achieve resilience for Plymouth and Cornwall rail connectivity, no slower than the existing line while providing valuable new linkages to south, west and north Devon and Cornwall. Speed gains will need to come from line of route improvements further east between Taunton and Reading, as well as from the potential use of tilting technology rolling stock.

New access links to Heathrow can and should be fashioned to accommodate direct services from the South West, South Wales, Surrey and Hampshire, the English Economic Heartland and the Midlands.

The capacity constraints into Liverpool Street from across East Anglia need a decisive response and we have proposed a new high-speed line from London to Stansted where it would split to connect with existing lines into Cambridge and Colchester.

Consideration of London's rail network development, along with airport and HS1 access has revealed options for vastly improving arrangements at both Old Oak Common and Euston: significant wider benefits, and a better HS2 business case are possible.

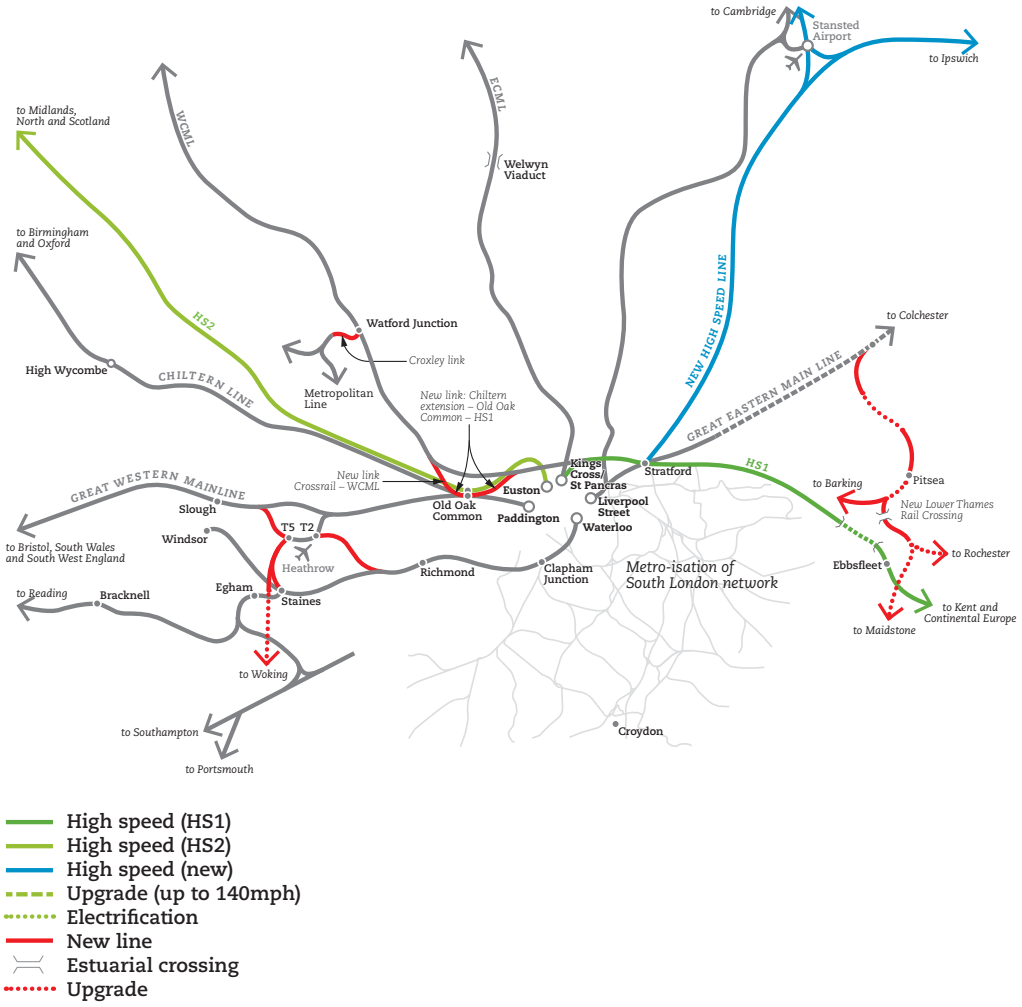
The key rail schemes that need to feature in a national rail connectivity plan for London and the South East are shown In Figure 8.7. They include:

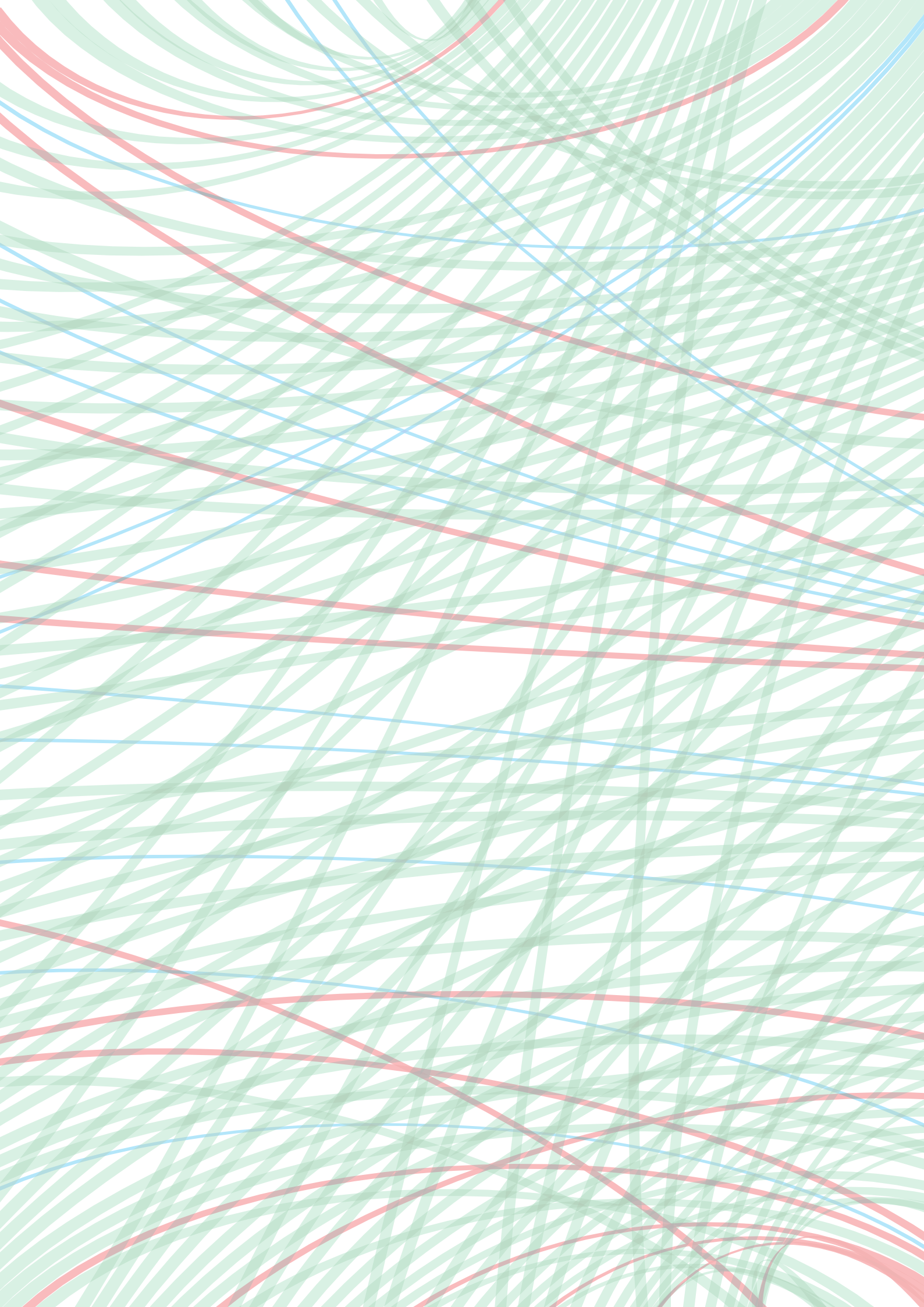
- Heathrow Rail Hub;
- The Kent-Chiltern connection via Old Oak Common;
- The metro-isation of the 'Southern Region' using digital railway' train control systems;
- A new high-speed line from London to Stansted and linking onwards to the Cambridge and to the Ipswich/Norwich main lines;

» A new mixed-traffic route – a new low-speed line, relatively speaking – linking Pitsea with the Great Eastern Main Line south/west of Chelmsford, providing access to Thames estuary ports and, with a new Thames Crossing, new passenger rail services between Essex and Kent;

» A Chiltern-HS1 link and the addition of a WCML branch to the Elizabeth Line, creating a much more valuable interchange at Old Oak Common – and potentially eliminating the need for a disruptive second phase of works for HS2 at Euston.

Figure 8.7: **London Area Schemes**





9.0 Re-connecting places left behind

Previous chapters have mentioned places 'left behind' – those places that are struggling economically, often having lost a major industrial or other focus to the local economy in a previous era, as discussed in Chapter 2. Given Government's commitment to re-balancing the economy, it is right that attention should be focused explicitly on what investments should be made for such places in this national strategy.

We say 're-connecting' because for many, not only has the foundation of the local economy passed on, but a sense of loss of community has followed, often with associated adverse consequences for human health and well-being.

Rail connections may have been lost as well. For those places where rail connections remain, the cost of rail fares may be a deterring factor.

There are good examples of where rail services have been brought back with these concerns in mind. The rail services linking Mansfield with Nottingham, Ebbw Vale with Cardiff, Alloa with Stirling (for Edinburgh and Glasgow) have been successful, for example, achieving demand levels above those initially forecast, linking former coal mining towns with cities with better job prospects. The development of proposals to operate a passenger rail service from Blyth and Ashington in Northumberland to Newcastle is a good contemporary proposition. In conurbations, the evolution of Light Rail Transit (Tram) systems has fulfilled similar functions, for example in the Black Country in the West Midlands.

But all of these approaches are capital-intensive, and the rate of progress is slow. Not all new line or re-opening campaigns will succeed. And when it comes to setting investment priorities, the scale of measured benefits is often larger and more secure in areas of greater prosperity, where congestion – and the benefits of overcoming it – are higher.

Continuing to set investment priorities on that basis without regard to the questions of social inclusion and of economic re-balancing will perpetuate the current position in which growth goes to the South East of the country, and within regions, to areas of existing prosperity. Policy-makers may question whether costly transport connectivity measures alone will help make a difference to the aim of regional re-balancing, but then it should be realised that:

1. There are lower cost and smarter connectivity measures available – appropriate for addressing lower aggregate levels of demand, but still effective – and many of which are rarely considered, including the provision of selected through trains, perhaps only once/day, to provide direct train connectivity for remoter areas and integration with interurban services (as we describe below);

2. In the absence of other place-based policies in industry or housing[1], for example, transport is one of the few remaining levers Government has available to address the needs of specific places, including those 'left behind'.

According to the Social Mobility and Child Poverty Commission – an official advisory body formerly chaired by Alan Milburn (until his resignation in December 2017), transport connectivity is a factor. As it concluded in its 2017 'State of the nation' report:

> **"a stark social mobility postcode lottery exists in Britain today where the chances of someone from a disadvantaged background succeeding in life is bound to where they live."**

The report showed 'a striking geographical divide with London and its surrounding areas pulling away from the rest of England, while many other parts of the country are being left behind economically and hollowed out socially.' But it also showed great variation within regions (see Figure 9.1).

1. While the Government's draft Industrial Strategy of 2017 spoke of place-based thinking to ensure nowhere was left out, the revised version following consultation was entirely sectoral in structure. In the absence of regional spatial strategies which set out where housing allocations would go, there is no spatially based housing policy either. But in Scotland there is a national framework for the spatial development of Scotland as a whole (see National Planning Framework 3 for Scotland at http://www.gov.scot/Topics/Built-Environment/planning/National-Planning-Framework). And there is a statutory requirement under the Planning and Compulsory Purchase Act 2004 for the Assembly Government to produce a Spatial Plan for Wales (see Wales Spatial Plan at http://gov.wales/topics/planning/development-plans/wales-spatial-plan/?lang=en). This is a particularly English deficiency although in the North, IPPR North and the Royal Town Planning Institute are preparing a bottom-up Great North Plan, of which Transport for the North's transport strategy would form a part (http://www.greatnorthplan.com/).

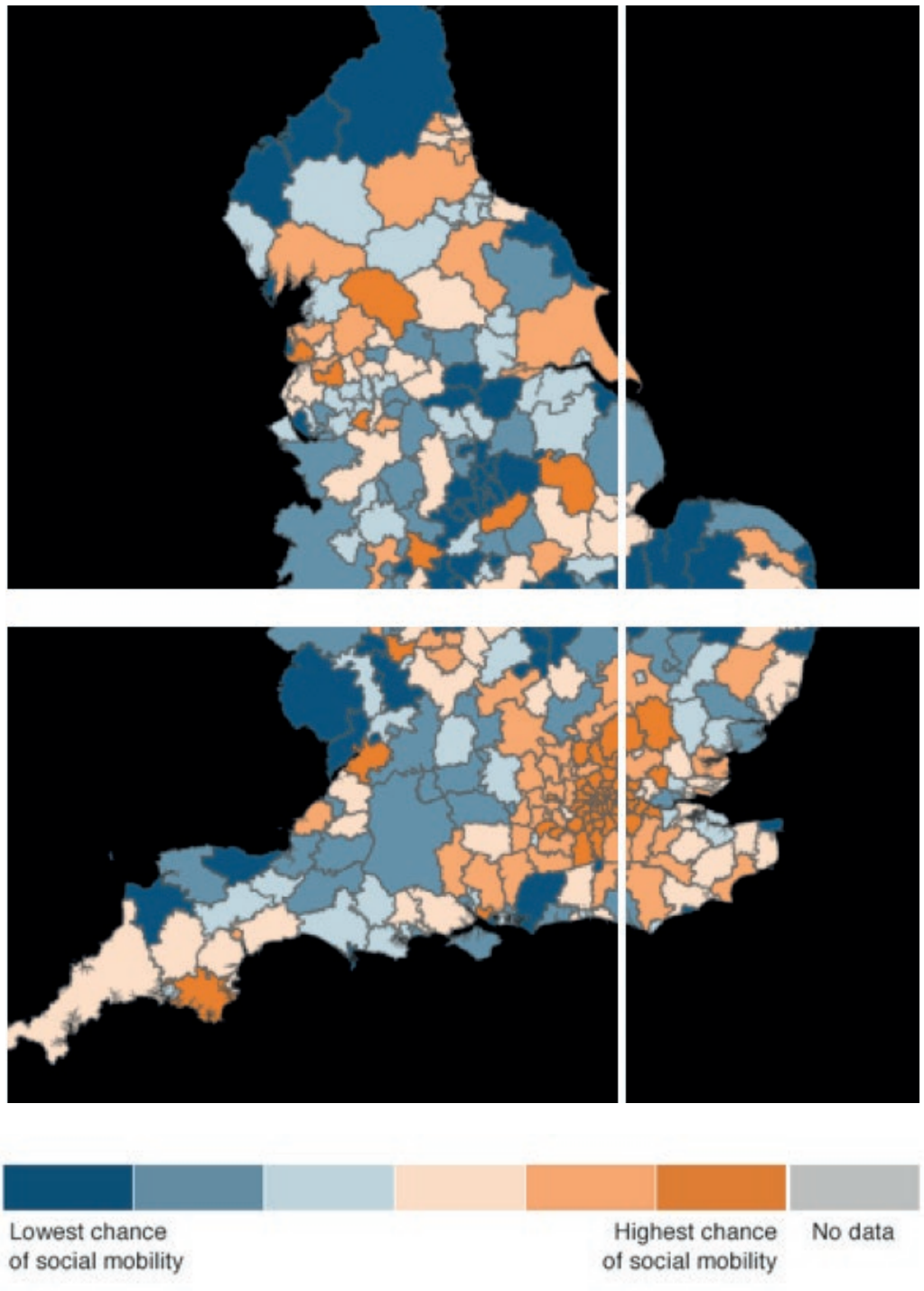


Figure 9.1: **How the chance of social mobility varies by local authority**

Its index revealed that:

> **"the worst performing areas for social mobility are no longer inner-city areas, but remote rural and coastal areas, and former industrial areas, especially in the Midlands. Young people from disadvantaged backgrounds living in these areas face far higher barriers than young people growing up in cities and their surrounding areas - and in their working lives, face lower rates of pay; fewer top jobs; and travelling to work times of nearly four times more than that of urban residents."**

The Commission was not able to undertake the same detailed analysis in Scotland and Wales due to data constraints but nevertheless undertook some ranking to highlight geographic variations in both countries.

In Scotland, rural and semi-rural areas make up most of the best scoring areas across all indicators considered. By contrast every major Scottish city outside Edinburgh (Glasgow, Aberdeen and Dundee) reports below average figures with Dundee falling in the bottom 20% of authorities across all indicators. However, as in England, it is former industrial areas such as in East Ayrshire, Midlothian and Clackmannanshire that tend to report the worst problems.

The major towns and cities are also not social mobility drivers in Wales, with Newport scoring the highest out of the main cities and Wrexham scoring very badly. Cardiff and Swansea are mid-ranking although their city regions are expected to deliver 35,000 new jobs through city deals over the next 15-20 years and provide a major boost to the Welsh economy. Once again it is the former industrial areas, this time in South Wales that also score badly, particularly Neath, Port Talbot and Blaenau Gwent; as well as coastal areas such as Conwy in North Wales and Pembrokeshire to the west.

Alan Milburn, introducing his annual report in December 2017 commented:

> **"too many rural and coastal areas and towns of Britain's old industrial heartlands are being left behind economically and hollowed out socially. Recommendations in the report include "fairer transport funding, including transport subsidies for poor young people in rural areas."**[2]

So, it is worth re-stating that the value of better transport connectivity lies in its encouragement of community self-reliance; its triggering of private sector investment; the help it offers to persuade those that would otherwise leave home to get the job they are seeking; that commuting is an option that helps bring income and wealth home; in ensuring that residents can access facilities and services that no longer exist locally; and in attracting visitors to local amenities and services.

2. BBC News, *Social mobility: The worst places to grow up poor*, November 2017 .

The situation in terms of funding for areas in greatest need is precarious. It is not yet clear whether the funding available to the UK through EU Structural and Cohesion funds which have been used to finance or co-finance many transport projects, especially in peripheral areas, will be replaced to the same value after Brexit through the proposed 'UK Shared Prosperity Fund'. Certainly, the EU principles of social cohesion and subsidiarity which drove the EU regional funds do not take expression in EU law and therefore will not be transposed under the Great Repeal Bill, leaving communities more exposed to market-based policies and realities in the absence of an explicit policy-driven funding scheme for areas of economic under-performance and social isolation.

Categories

For our purposes, left behind areas can be classified as:

- Disadvantaged – performing poorly on economic, social and health outcome scores;
- Peripheral – places at the geographic edge of the nation;
- Remote – places that have especially lengthy journey times to reach major/regional economic centres.

The distinctions are important, even though some places can be categorised under more than one heading (and peripheral and remote places overlap significantly), because the policy prescriptions vary between them.

Disadvantaged Areas

Taking the social mobility commission's index of outcomes at local authority level as a guide, we can sub-divide the most disadvantaged areas into two categories when it comes to considering transport measures:

1. Places that are near to or even part of major metropolitan areas;
2. Rural areas, remote from major cities.

We will consider the second category later, under the headings of remote and peripheral. Here we need to consider places of deprivation that are close enough to areas of jobs and prosperity but still falling behind, often because of the loss of local employment in a local industry.

In the case of places that are in or around Britain's major cities, rail, metro or LRT systems may have a role to play. Many stand to gain substantial connectivity benefits from HS2. But planners will typically overlook disadvantaged areas when they come to consider new routes or stations because they will see lower levels of demand. Yet they could be a life-line. City region level planning needs explicit objectives to address this type of challenge, with clarity on related land-use policy, especially on housing.

Looking ahead, two factors will further shape what is needed. The effect of investments like HS2 – sharply focused on strengthening major city economies – will result in an intensification of demand and a stimulus to economic growth across the wide catchment of its stations, with an intense positive impact (dependent on local place making and planning responses[3]) in the immediate station surrounds. This means re-shaping thinking about public transport networks. Communities near enough to new HS2 stations will want to be able to access improved longer distance rail services, but the greater volume of travel is likely to be to the economic hubs around the immediate station surrounds where a range of knowledge-intensive businesses are likely to gather along with the retail and service industries that support them.

We noted earlier the importance of creating fast and convenient rail links between the Black Country and Birmingham's Curzon Street HS2 station; also in the West Midlands, plans for the east-side LRT line to reach Birmingham Interchange HS2 station is an excellent illustration of the kind of measure needed.

The second factor is the over-arching change that will affect employment opportunities, with new technology and especially automation, including robot technology, replacing jobs across many sectors. The North and the Midlands are projected to be hardest hit, with places such as Sunderland, Wakefield and (most vulnerable of all) Mansfield suffering the biggest losses.[4] Such places, smaller than the major cities that will be served directly by HS2, have in recent years sought to counter unemployment through, for example, hosting call centres and distribution centres. But these are vulnerable to new technology takeover, and such places require particular attention.

Sunderland and Wakefield[5], while not served directly by HS2, can each gain better long distance connectivity by using capacity released by HS2 on the East Coast Main Line (as well as by using some of the additional capacity that has to be created to overcome its pinch-points in the proposed ECML upgrade programme). These two cities serve to underline the importance of the wider strategy set out in this document, and the need to transpose the proposals that combine to form this strategy into firm plans and commitments.

In short, based on the implications of looking at the case of Mansfield which is but one example, disadvantaged areas require explicit recognition in planning policies, with new and better public transport in metropolitan areas and rail service developments that complement, but stretch well beyond, HS2 itself.

3. High Speed Rail and Connected Cities; Accessible Places for Growing Economies. Independent Transport Commission research report. May 2016.

4. BBC News, *North and Midlands "most likely to lose out to robots"*, January 2018 .

5. We envisage that it would make good sense to re-instate the missing chord at Wortley Junction as shown in Figure 7.4 and operate a Bradford-Wakefield-Doncaster-Kings Cross service; with Leeds-Kings Cross fast trains no longer having a role once HS2 is open, providing Bradford with a faster direct London service becomes attractive.

Mansfield case study

Mansfield has the benefit of a successfully re-opened rail link with its closest major city, Nottingham. But on current plans Nottingham is not going to be served by HS2, which will instead be served by a station at Toton, to the west of the city.

Two propositions can address the problem this creates for Mansfield. The first – set out in Chapter 7 – is the provision of an additional HS2 junction so that HS2 services from the south can run directly into Nottingham Midland, which is also where Mansfield trains call, and where the surrounding area would be highly likely to see a boost to employment. The second is that it would be feasible to link Mansfield with Toton, using a link that currently only carries freight. A Mansfield-Kirkby-in-Ashfield-Langley Mill-Ilkeston (new station)-Toton (for HS2)-Long Eaton-Derby service could provide a valuable feeder to Toton HS2 station, and it would be possible as well to think in terms of a Mansfield-Toton-Leicester-London (St Pancras) service subject to the constraints of the Midland Main Line timetable.

Places on the Periphery

It is striking how many towns on Britain's coast line – places on the periphery – face major social mobility challenges: towns in Northumberland, North Yorkshire, NE Lincolnshire, parts of Norfolk, East Kent, North Devon, West Somerset (where Minehead was identified as the worst place of all on this score)[6], Cumbria, Conwy, Pembrokeshire, Moray – and on the Welsh border in England – Herefordshire too.

Some towns along these (largely) coastal areas have rail connections,[7] but none of them have viable commuting journey times to major cities (in less than one hour). In places that are 'left behind' – as Alan Milburn pointed out – there will be concerns over fares levels. This is why scheduled public transport is so important. Job seekers are not going to be Uber-users, but there is always scope to offer deep discounts on fares to targeted groups such as young (and older) members of the local workforce, provided there is a viable service on which to apply it.

A Jobseekers rail card is available, although these are issued at the discretion of DWP offices for those 'actively seeking work'.[8] This could be extended to provide 50% off fares for (say) the first 18 months in employment following a period of unemployment.

Many places on the periphery have high quality interurban bus services, offering regular frequency (hourly or better) services with modern vehicles equipped with luxury seats, with provision for wheel-chair access, and free wi-fi as a recent study has shown.[9] Identifying interurban bus as what can fairly be described as a 'forgotten' travel mode, the study showed what measures were needed to transform awareness of these services and get them recognised as a key component in the nation's scheduled public transport network.

In general, these interurban services are operated entirely commercially, with fares lower than by train. Unlike deep rural bus services which have been radically cut-back in many places in recent years, demand growth for limited stop interurban bus has been stable or growing. Services are performing well in all types of places, in those succeeding economically, and in those struggling. Non-rail connected Ripon in North Yorkshire is served by an interurban bus route through prosperous Harrogate to Leeds (where it competes with a local rail service), and offers a 10-minute peak service frequency. But in other parts of the country, including many of the peripheral areas, they provide the key missing links in rail's network coverage, for example: St.Andrews-Cupar, Whitby-Scarborough, Grimsby-Skegness, Boston-Spalding-Kings Lynn-Norwich, Bude-Exeter, Glastonbury-Wells-Bath, Gloucester-Ross-Hereford, Aberystwyth-Carmarthen…

6. Transport Times, *The End of the Line*, December 2017.

7. Scarborough, Whitby, Grimsby, Kings Lynn, Yarmouth, Margate & Ramsgate, Barnstaple, Hereford, Workington, Conwy, Pembroke, Elgin.

8. See www.moneysavingexpert.com, *Jobseekers urged to apply for free railcard giving 50% off fares*, March 2018.

9. See Greengauge 21, *Interurban Bus Report*, March 2018.

In some cases,[10] interurban bus serves corridors where there are campaigns to re-open long lost rail connections, but not all of these projects will be affordable. Something more affordable is needed, at least in the meantime.

The proposal that forms part of this strategy is to use interurban bus, in combination with rail as appropriate, to create on a small scale elsewhere the economic hubs that HS2 will help fashion in the major cities it serves. Creating easy-to-use interchanges between rail and interurban bus can create localised agglomeration benefits. The first aim will be to create local bases for new knowledge-based and other jobs, accessible to a younger generation (as well as others) that is increasingly less likely to use their own car.

Many of the rail services in peripheral areas have active Community Rail Partnerships. In some cases, service enhancements are being considered, along with other promotional measures. A once-common feature of railway operation that should be re-examined is the use of selected through services. A direct through train, say once daily, between York, Middlesbrough and Whitby, for example, would open up perceived travel opportunities, and might especially help the tourism sector.

Peripheral areas often lack direct transport links, especially by rail, as they need to negotiate the topography of convoluted coastlines. Catchment areas for local businesses shrink as a consequence. In the longer term, the case for new estuarial rail crossings needs to be considered. While there have been new road crossings (of the Dornoch, Forth and Moray Firths; the Humber, Orwell, Severn, and Mersey Rivers/Estuaries, with plans in formulation for major new road crossings of the Tees, Thames and Usk), there have been no new estuarial rail crossings in over a hundred years. Rail journeys are typically slow in coastal areas – and relative to road – getting slower. Going forward, no new road crossing should be considered without examining the opportunity to add a new rail connection, some of which may be worth considering in their own right.

10. For example, in Wales, Aberystwyth-Carmarthen, in England, Lewes-Uckfield, in Scotland Leven-Edinburgh.

Remote areas

Here we can consider much of Scotland (including the whole of the Highlands and Islands), West Wales, Cornwall, and West Cumbria. Typically, these have been places that have qualified for and received substantial amounts of funding under EU programmes. These are places where demand may be thin, but responsible Governments' cannot ignore residents' mobility needs. And they are also typically five hours or more from capital cities and major airports.

Air services, ferries and (especially in Scotland) long distance bus/coach services able to use improved road infrastructure need to be considered together alongside rail.

Resilience, especially in harsh weather conditions, is often a factor, and will inevitably in future influence investment decisions. Sometimes this will favour the rail mode, on other occasions not. In some cases, rail investment will be justified – or, as we argue in relation to South West England, needed (see panel).

The Far North line in Scotland, linking Inverness with Wick/Thurso, is seeing decline in passenger carryings (against the trend elsewhere in Scotland). It is a journey that with relatively recent estuarial crossings can be made faster, more cheaply – and probably as reliably, by coach. But as ever, options to turn the situation around and get more value from the rail infrastructure do exist and, in this case, perhaps the best of them is the prospect of introducing an overnight sleeper service.

In West Cumbria and across the border in Dumfries, much will depend, in practice, on service levels at Carlisle once HS2 is open in 2026, at which time the West Coast Main Line will be under greater capacity pressure than it is today. Earlier, we identified this northern section of the WCML as needing investment to complement HS2 and extend its benefits. The additional capacity this will create should be used, amongst other things, to ensure that Carlisle receives a speed-up from HS2. With well-timed connections at Carlisle, this should give Dumfries, Workington and Whitehaven, Maryport and Aspatria their best-ever connectivity with London, some 45 minutes faster than is possible today, in around 3½ hours.[11]

11. When there were through trains provided from Workington to London Euston in the early 1960s, they would take about this long to reach the West Coast Main Line.

Cornwall and Devon

The case for re-creating a railway route to the north of Dartmoor was prompted by the disruption and economic costs of the loss of South West England's main railway line at Dawlish in February 2015, when the sea 'over-topped' the sea wall. Other less dramatic floods occur elsewhere on the route, including at Cowley Bridge, to the north of Exeter. Plans exist to address the Dawlish problem, but further disruption is expected ahead. Realistically, some of the engineering solutions will require a significant closure of the route in any event. This cuts off Torbay, Plymouth and Cornwall from the rest of the country.

Re-opening the line via Okehampton and Tavistock – as shown in Figure 8.3 - would have a cost in excess of £0.5bn, but without it, the value of the rail asset in SW England is undermined, because of its lack of dependability. To make a sound investment case for the second line, it is important that it is able to offer similar journey times to the existing route via Dawlish and for it to avoid the second area of flood risk at Cowley Bridge.

The northern route would fit well with plans for housing development in West Devon.[12] What is needed is to combine re-opening this route with a new short cut-off line so that trains can avoid the area of flood risk as well as sea wall over-topping and, in the process, deliver just as fast a connection for Plymouth and Cornwall as today's railway offers (and a faster route to Barnstaple, north Devon).

Meldon Viaduct.
Photo: Greengauge 21

12. Greengauge 21, *Rural Reconnections: the social benefits of rail reopening Exeter – Okehampton – Tavistock – Plymouth: a case study*, June 2015.

Conclusion

Government has talked extensively about the need for geographic re-balancing and of its principles on inclusiveness. The Social Mobility and Child Poverty Commission has shown in its 2017 update report that lack of social mobility is not restricted to inner city areas, but features in rural, coastal and former industrial areas. These are places where lack of connectivity, including by rail, is part of the problem.

Former industrial areas loom large in the Midlands and North of England, as well as in South Wales and the central belt of Scotland and there are examples where new rail links, re-established over the last 30 years, have made a real difference. But these are places where replacement industries are most prone to job losses from the automation and robotics that lies ahead. Further development of the transport network is needed as at least part of the policy response.

EU funding has been applied extensively in the remoter parts of Britain to help provide transport improvements that would not have been prioritised under national transport investment appraisal criteria. Replacing these funds as Britain leaves the EU is essential: places already written-off cannot be expected to survive unscathed otherwise.

We have identified a set of measures for places 'left behind', some of them low cost. These are, in summary:

- New rail services to access HS2 hubs in the Midlands to give access from places 'left behind' to new economic opportunity areas;

- In North West England and Yorkshire, the creation of much strengthened city region rail networks. For the broad catchments of Leeds and Manchester this means widened access to HS2 hub stations[13], for Bradford to gain the rail connectivity it has always lacked; an extension of the Merseyrail network to Preston and Wrexham and in North East England, the development of improved and new rail services to access the HS2/upgraded ECML stations at Newcastle and Darlington; in the Midlands, the creation of new direct cross-city services to link the Black Country, Wolverhampton and Walsall with the HS2 station at Curzon Street;

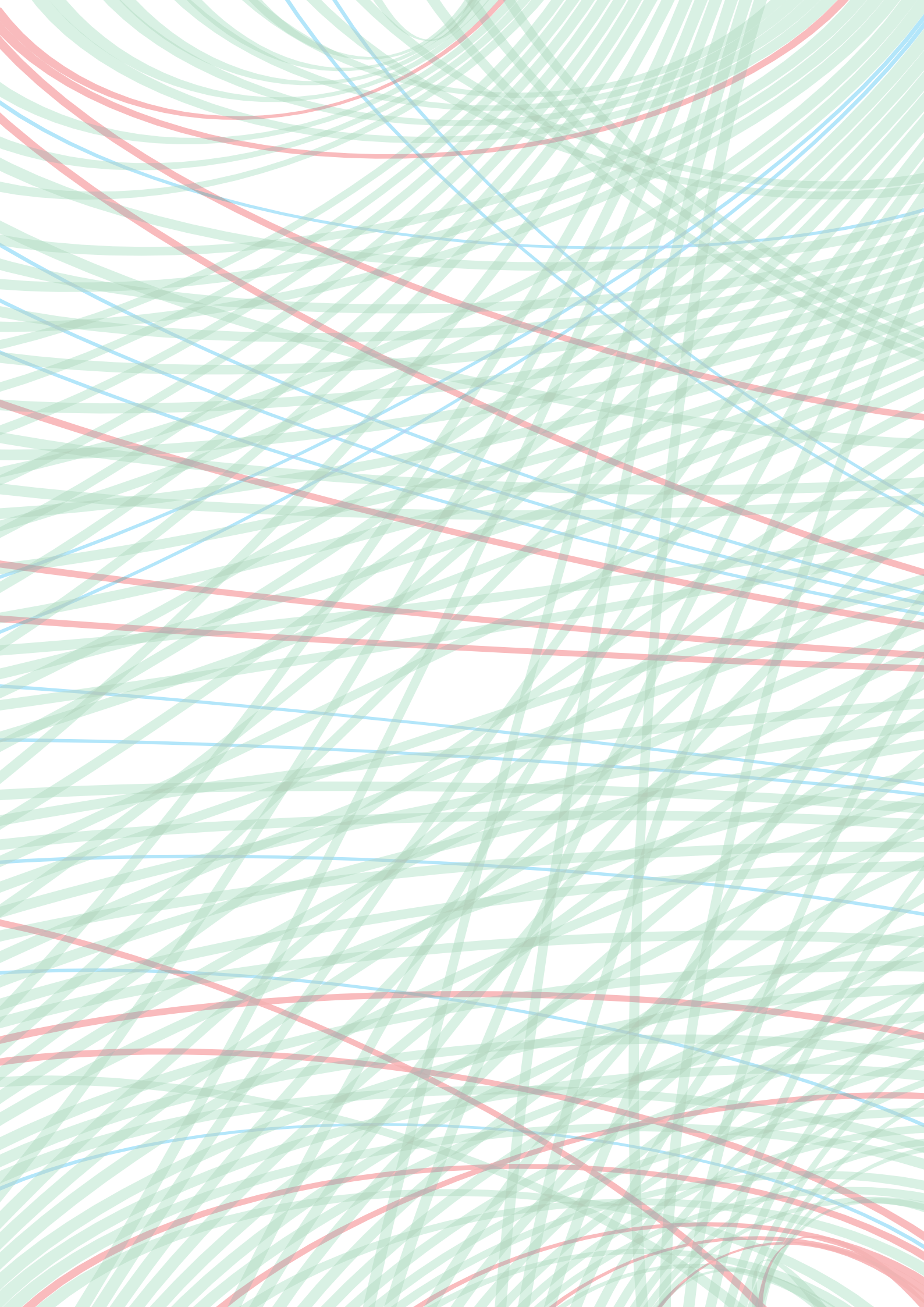
- Using HS2-served hub stations at Carlisle to serve west Cumbria and Dumfries, at Crewe to serve the North Wales coast and Wrexham;

- In South West England, the creation of a second line from Exeter to Plymouth to provide network resilience for Devon and Cornwall and serve remote areas of the two counties;

13. See Chapter 7.

- The identification of a national network (across England, Wales and Scotland) of limited-stop interurban bus services to form, with the rail network, a set of mini-hubs to foster economic development in places remote from the major cities served by HS2;

- In the longer term, to consider the need for, and value of, new estuarial/river rail crossings across, for example, the lower Thames estuary, the Tees at Middlesbrough and the river Neath in Swansea bay, potentially speeding up journeys to Swansea and West Wales.



10.0 Conclusions

The Urgent Need for a National Strategy

We took HS2 infrastructure – to be implemented in Phases 1, 2a and 2b in years 2026–33 – as a commitment and asked what lay beyond. We reasoned that a national rail strategy would surely need to contemplate more than a single project if national connectivity and network capacity needs are to be met.

In the absence of an industry plan, we set out to develop one. Our planning horizon is 2040, but much of what we have considered could be implemented in the 2020s. Others – notably the National Infrastructure Commission – are looking even longer term, to 2050. The NIC will find, as we did, there is a shortage of longer term plans for rail, comprising only one or two well-known mega-projects and no overall strategy. We trust that, as well as others, the NIC will be able to make use of this piece of work in their planned 2050 vision document.

Our rail system, we found, is playing a growing and central role in supporting the national economy. Over the last 15–20 years, it has been the fastest growing major rail system in Europe, and has become its safest.

The default alternative to rail is a reversion to over-reliance on the road network. But this in practice only holds a prospect of greater congestion – a damaging surcharge on economic activity – and this would be the case even if there was to be a huge new road building programme.

Rail is best attuned to the accommodation of concentrated demand flows. It is the mode of transport that makes cities with thriving centres possible. Cars, on the other hand, are space-inefficient, and growth in their use through the last century has promoted large swathes of urban and suburban sprawl.[1]

This doesn't change with the prospect of autonomous vehicle control systems. The cherished pattern of town and country planning and development is, if anything, put at further risk by this type of technological development.

1. Smart Growth – from Sprawl to Sustainability Jon Reeds, Green Books, 2011.

The environmental and land costs of over-reliance on private cars are already huge. A continuation of low density development reliant on road-based transport will lead to a much greater loss of countryside than will be affected by a few selected new rail links and new development focussed around stations.

For England as a whole, there is no spatial plan, and regional spatial plans and targets have been scrapped. Their abolition was driven in part by a desire to 'cut red tape', but their absence (and that of any consistent spatial planning at the sub-regional level) is no encouragement to inward investors that seek certainties and an understanding of the prospects for specific locations, when contemplating major development.

Set-backs caused by a lack of proper planning in rail electrification projects in 2014-16 have led to reluctance on the part of Government to continue with a rail enhancement capital programme. Having lifted the rail sector from the hopeless arrangement of annual budget-setting that characterised the British Rail era (1948-1997), and instead put in place five-year programmes with independent regulatory oversight, enhancements are now being considered again by Ministers on a case-by-case basis (while, meanwhile, the road sector has finally caught up with the rail reforms and enjoys a 5-year strategic plan).[2]

The need for a 5-year delivery plan set in the context of a longer term strategy for rail has never been more palpable. The absence of both strategy and plan puts at risk local, regional and national ambitions: it carries an economic cost.

We risk becoming over-reliant on the delivery of HS2. The ambition to re-balance the national economy needs much more than HS2; whole regions – the South West, East Anglia, South Wales, for example – cannot be left to struggle with second-rate and over-stretched transport infrastructure. And it is better if HS2 is not treated as a stand-alone project given its wider potential.

Our aim has been to examine what further improvement in connectivity, capacity and capability should be expected from rail transport. And what should be done for those areas and places that too often are ignored in transport and other policies: the economic periphery, the places left behind?

The plan that emerges is the result of a set of strategic choices, informed by the evidence from a rich volume of studies. Unconstrained from a focus on a specific region or corridor, we have been able to look in greater depth at the policy drivers; consider customer needs and in relation to train service arrangements before contemplating infrastructure needs; and then look carefully at candidate investment projects and (crucially) the interactions between them. In short, we have been engaged in the lost art of planning.[3]

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2. Rail network operation, maintenance and renewal (as opposed to enhancements) remains funded on a 5-year basis and with a budget (at £48bn) generally considered to be realistic. But the separation of enhancements from renewals, makes costing this plan, where much of the investment inevitably centres on upgrading existing lines, , at this stage impractical.

3. See *Great British Plans – who made them and how they worked*, Ian Wray, Routledge, 2016.

As for any business, plans need to be made the subject of ongoing revision as fresh information emerges, as priorities shift. While flexibility is needed, so too are the inescapable choices that have to be made sooner or later as assets need replacement and updating. Part of the task was to identify these key choices.

The Planning Imperatives and Prospects

In Chapter 1 we introduced a set of smart planning principles. The logic that suggests a starting point of examining customer needs and travel markets leads to the simple point that possible services need to be formulated before considering infrastructure investment.

In the last 3–4 years, regionally set ambitions have emerged and rail service priorities have changed as a consequence. The function of HS2, for example, has been expanded: its benefits will be greater than envisaged at the outset.

In chapters 2, 3 and 4 we considered national and regional policy imperatives, market trends and passenger requirements, as well as those of freight. Concerns over capacity, connectivity, productivity, regional economic disparities, social inclusion and health inequalities, international trade, carbon reduction and air quality, reliability, resilience and reduced safety risks all drive the need for a long-term rail strategy for Britain.

Measures of productivity across Britain are closely related to measures of peripherality. The country is highly centralised on London (and within London, on its central area) and this is why it is rail – rather than other modes – that is so crucial, not just to London, but also to helping achieve a more balanced spread of economic activity across the nation.

Rail plays a particularly important role for cities, which, in general, is where high value jobs are concentrated. So expanding cities is critical for national economic growth, and this means in turn that the capability of the rail network has to be regarded with this in mind. As the country approaches Brexit, connectivity to international gateways for trade (in goods and services) must also be improved to support new trading initiatives.

Also integral to economic success, as the work of the Government's Social Mobility Commission makes clear, are questions of well-being and health, and access to work opportunities and regionalised health care. The Commission identifies better public transport as one of three policy levers to tackle the problems of communities that have been 'left behind', prompting a question we have addressed in this report: what contribution can the rail sector make to enhance social mobility?

Rail use has been growing at over 4% per annum for around 20 years. Recent levelling off in the pace of growth has occurred primarily in the congested South East, where service quality levels have suffered in the last 2-3 years. But here major new rail schemes (Crossrail, Thameslink) are coming to fruition over the next two years, providing transformational connectivity gains and service uplifts. And elsewhere growth has remained strong.

A young population cohort, over the same 20-year period, has been reducing its use and ownership of cars and turning to rail. The prospects for rail remain strong. Reinventing its appeal for family travel is a challenge ahead in respect of this new non-car owning cohort.

We looked at meeting individual passenger needs, and how the railway system as a whole has to be responsive to customers in a helpful and coherent way. It also needs to be made fully accessible and readily negotiable for a diverse set of people and travel needs. HS2 can be used as a catalyst for helping the railway system as a whole shift to a new level of passenger-friendly arrangements in simplified, possibly zonal, fares and ticketing systems, in supporting people negotiate interchanges and in providing relaxing and enjoyable journeys.

Freight on rail brings measurably valuable benefits (fewer large trucks on our roads) but is receiving diminishing levels of grant support (down to c£10m annually). Railfreight grants, we concluded, should be increased substantially. The strengthened freight grant regime can be used to encourage changes that will ensure better overall use of available network capacity (use of electric traction; longer freight trains; avoiding busy cross-city sections needed to handle growing commuter demand). It can and should also support new and expanded freight services that need to be focused on those corridors where more and longer freight trains can be accommodated, and where new strategic freight interchanges can be provided (London – astonishingly, has no intermodal (road-rail) freight terminal, other than a limited facility in Barking). From 2026/7, HS2 will relieve the West Coast Main Line in England and create a growth opportunity for railfreight which will be greatly reinforced if, as we recommend, the Felixstowe-Nuneaton cross-country route upgrade is completed. Elsewhere, some relatively modest new lines are needed to solve problems of rail access to ports.

From these starting points, we set out to:

- frame a national strategy (chapter 5);
- examine the HS2 corridors, the services that would run on HS2 and the opportunities created on parallel lines (see chapter 6);
- study the rail services and developments needed in the regions and devolved nations across Britain (see chapters 7 and 8);
- consider what should be done to re-connect places left behind (in chapter 9).

Connectivity at a national level

HS2 provides extra capacity and improved connectivity between our largest cities. Its network shape – as a 'Y' – means that there is scope to add further services to the two network arms. There is more spare capacity (on current HS2 service plan assumptions) on its eastern limb.

An examination of current rail connectivity between the 38 English Local Enterprise Partnership (LEP) areas - and their equivalents in Scotland and Wales - revealed some surprising gaps, as illustrated in Chapter 5. Using some of HS2's spare capacity could help make good these weaknesses, but better connectivity can also come from upgrading existing lines as well as from new high-speed infrastructure – the latter only likely to be justified where capacity constraints cannot be overcome by lower cost measures.

A key area of connectivity weakness is between English provincial cities (and Cardiff) and Scotland. Some new services – such as Trans Pennine Express's Liverpool-Scotland service are already planned, but others should follow. This points to a need to relieve critical sections of line that will become bottlenecks and uplift line-speeds where feasible and viable, including beyond the northern limits of the new HS2 infrastructure. We identify a target of a 3h15 London-Glasgow/Edinburgh rail journey time (with equivalent speed-ups for links between Scotland and provincial cities in England), and believe this could be achieved by 2033, allowing a substantial switch from short-haul air travel to rail, bringing a major carbon reduction bonus.

HS2 Service Parameters and Plans

When fully developed, it is planned that HS2 will carry 18 trains/hour over the 'stem' of the Y-network – an intensity of use that has not yet been achieved on existing high-speed networks elsewhere. It is a good ambition, but a degree of prudence prompted us to use a more cautious assumption of a maximum of 16 trains/hour for this report.

There are three key consequences:

(i) it would not be possible to accommodate the full set of London services on HS2 as set out in HS2 Ltd's plans;

(ii) with a slightly lower throughput, the current plan that has every (or possibly all bar one train/hour) HS2 train stopping at Old Oak Common can be re-visited. A four train/hour stopping pattern would be a good option, similar to other intermediate HS2 stations, and it would allow most HS2 trains to save (say) 4 minutes on their journey times to/from London;

(iii) a reduction in the impact of Phase 2b on the capacity requirements at Euston from 2033 (when other changes at Old Oak proposed in the strategy in Chapter 8 are taken into account).

The consequential need to remove some London trains from the services in the HS2 service plan raises the question of which destinations gain most from HS2 and which least – and if there are any good alternatives available. This led us to the view that **upgrading the East Coast Main Line (ECML)** should become a high priority alongside the implementation of HS2. It is a key strategic choice. It would allow Newcastle-London timings to match closely those achievable via HS2. The aim would be to match the customer service offer using the ECML as would have been provided if the journey was made via HS2.

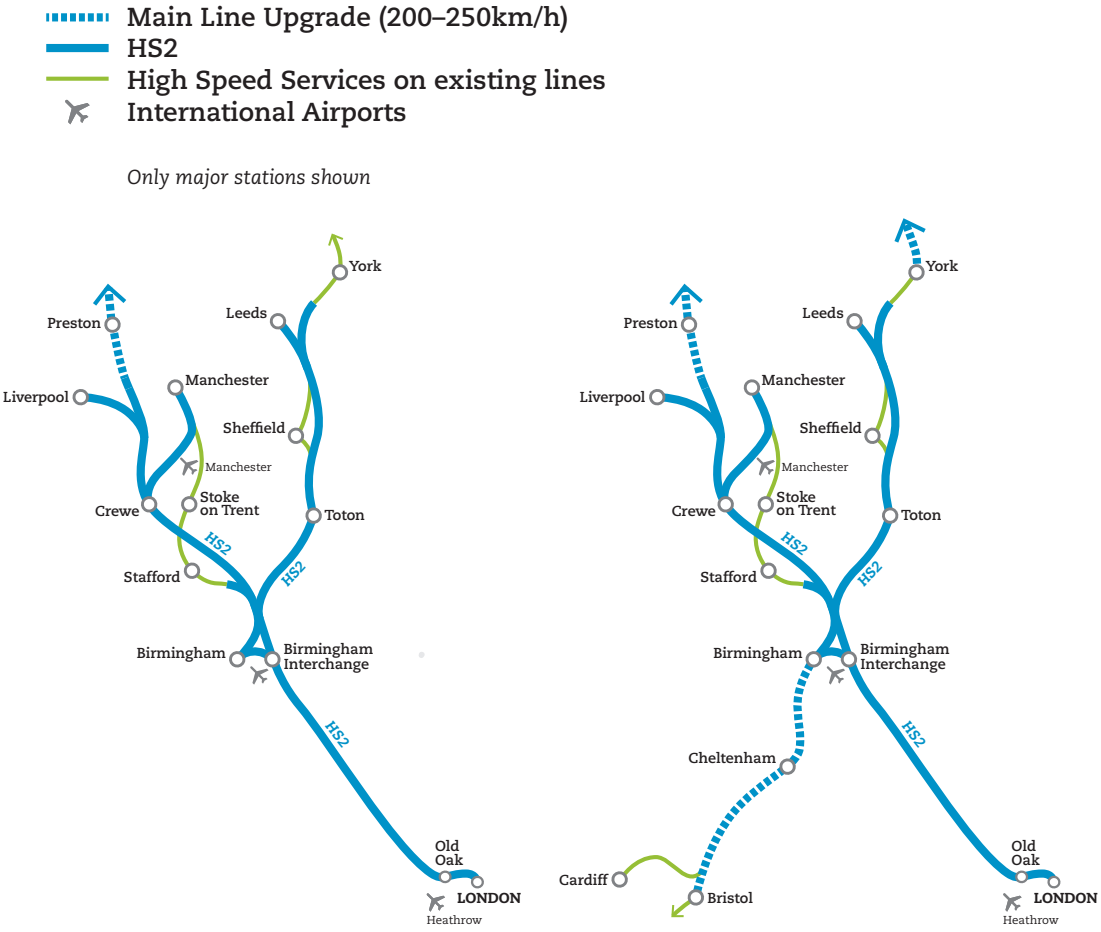
Newcastle (and York/Humber and the North East) would benefit directly from HS2 by an increased provision of 'cross country' services to a set of British cities to which journey speeds are currently much slower than they are to the capital.

We therefore propose a key change in planned 2033 service routeing, with Leeds-London trains retained on HS2 and Newcastle-London trains remaining on an upgraded (and more direct) East Coast Main Line. If instead the current service assumption survives, with all the main long-distance London services taken off the ECML and switched to a route via HS2, then the case for further investment in the East Coast Main Line – much of which could be made over the period to 2029 – would be jeopardised.[4] On the other hand, with long term certainty over its retained intercity role, investment in the ECML is very likely to be justified, north and south. The investment needed requires an expansion of the current plan as provided for in the 'East Coast Connectivity Fund'.

This enables another key conclusion benefitting cross country services: HS2 should be configured as an **'X' rather than a 'Y' shaped network**. This is illustrated in Figure 10.1. The new 'limb' of HS2, to the south west from Birmingham, is achieved by means of an additional HS2 junction in the West Midlands and an upgrade of the line from Birmingham – Bristol Parkway (including its electrification and provision for operation at speeds of at least 125 mile/h) to create a sub 1-hour journey time. This enables benefits from HS2 to extend to South West England and South Wales.

4. Noting that the case for investment in the ECML north of York is unaffected by these considerations.

Figure 10.1: **Changing HS2 from a 'Y' to an 'X'**



A number of new connections are being considered for HS2 Phase 2, and their consideration has to be driven by thought-through train service plans. We outline how the Northern Powerhouse Rail connections may be developed in the Manchester area, while we suggest additional connections to HS2. At the London end of the route, we explain how current plans to add platforms at Old Oak Common for services from the Chiltern line could and should be elaborated into a through east-west connection, linked eastwards via the North London Line to HS1, providing wide connectivity gains. This strategic rather than piecemeal development creates the possibility of at least some parts of the country other than London and Kent being able to have direct access to Eurostar services at Ebbsfleet and Ashford, as well as providing valuable new cross-London connectivity. If, in addition, a second west-side route could be added to the Elizabeth line, by means of a connection to the West Coast Main Line at Old Oak as proposed a few years ago by Network Rail and Transport for London, this could further strengthen Old Oak's value as an interchange.

The new HS2 stations will act as attractive hubs, and we set out how some of the places that have been ignored to date in connectivity plans – such as Mansfield – can be connected to them.

Overall plan – 2040

Consideration of regional plans, together with our own analysis, has allowed us to identify a number of opportunities for new or improved rail services that would significantly enhance connectivity for local and regional trips and permit much better access to the national rail network, including from places 'left behind'.

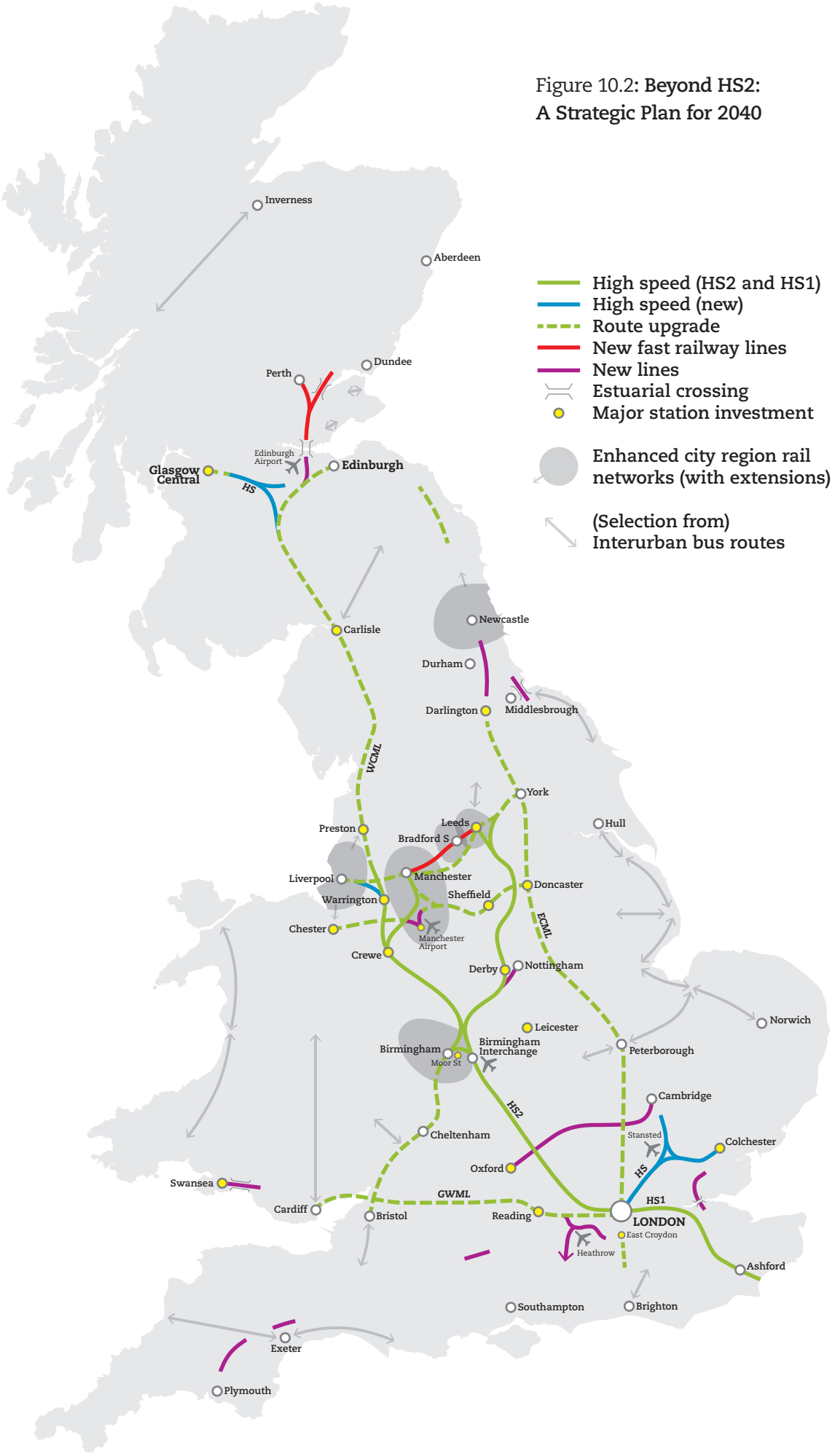
Our approach is comprehensive. No major cities are excluded, and neither are any regions, however sparsely populated or remote. The plan builds on HS2, adds two more high-speed rail lines, and also outlines a much wider set of changes and developments to create the comprehensive connectivity gains we believe the country needs to prosper. It relies on upgrades as well as new build. These needn't be disruptive to implement – as was found with the four-tracking scheme along the Trent Valley in the 2000s and the Stafford area improvements that followed. It will create a world-leading network, linked through a series of hub stations, either with their Victorian heritage suitably upgraded, as we know can be achieved – see the examples of St Pancras, Edinburgh Waverley and Paddington – or the more radical transformations such as those at London Bridge and Reading. It is illustrated in Figure 10.2.

Overall, this 'Beyond HS2' plan, to be fully implemented by 2040 provides[5]:

- 101 miles of new high-speed railways (300km/h+);
- 127 miles of new fast railway lines (200-250km/h);
- 97 miles of other new lines (of which the Okehampton-Tavistock re-opening and Bedford-Cambridge (EWR) comprise 60% of route mileage);
- 838 miles of route upgrades (of which the three main lines (West Coast, East Coast and Great Western) comprise 66% of route mileage);
- six enhanced city region rail networks (for Birmingham, Bradford, Leeds, Liverpool, Newcastle and Manchester);
- new rail links at three international airports (Heathrow, Manchester and Edinburgh);
- new services on the West Coast and East Coast Main Lines, using capacity released by HS2;
- a programme of investment at 16 stations to create an overall network of 44 national hub stations;
- studies for two new estuarial rail crossings and plans for one (Lower Thames);
- two new port access routes (for Tilbury/Gateway and for Liverpool) and completion of the Felixstowe – Nuneaton strategic freight route;
- a programme to create a set of nominated national mini-hubs to fill gaps in the rail network with commercially-operated high quality interurban buses, connecting with rail with integrated ticketing.

5. See Annex B for details.

Figure 10.2: **Beyond HS2: A Strategic Plan for 2040**



High-speed rail corridors

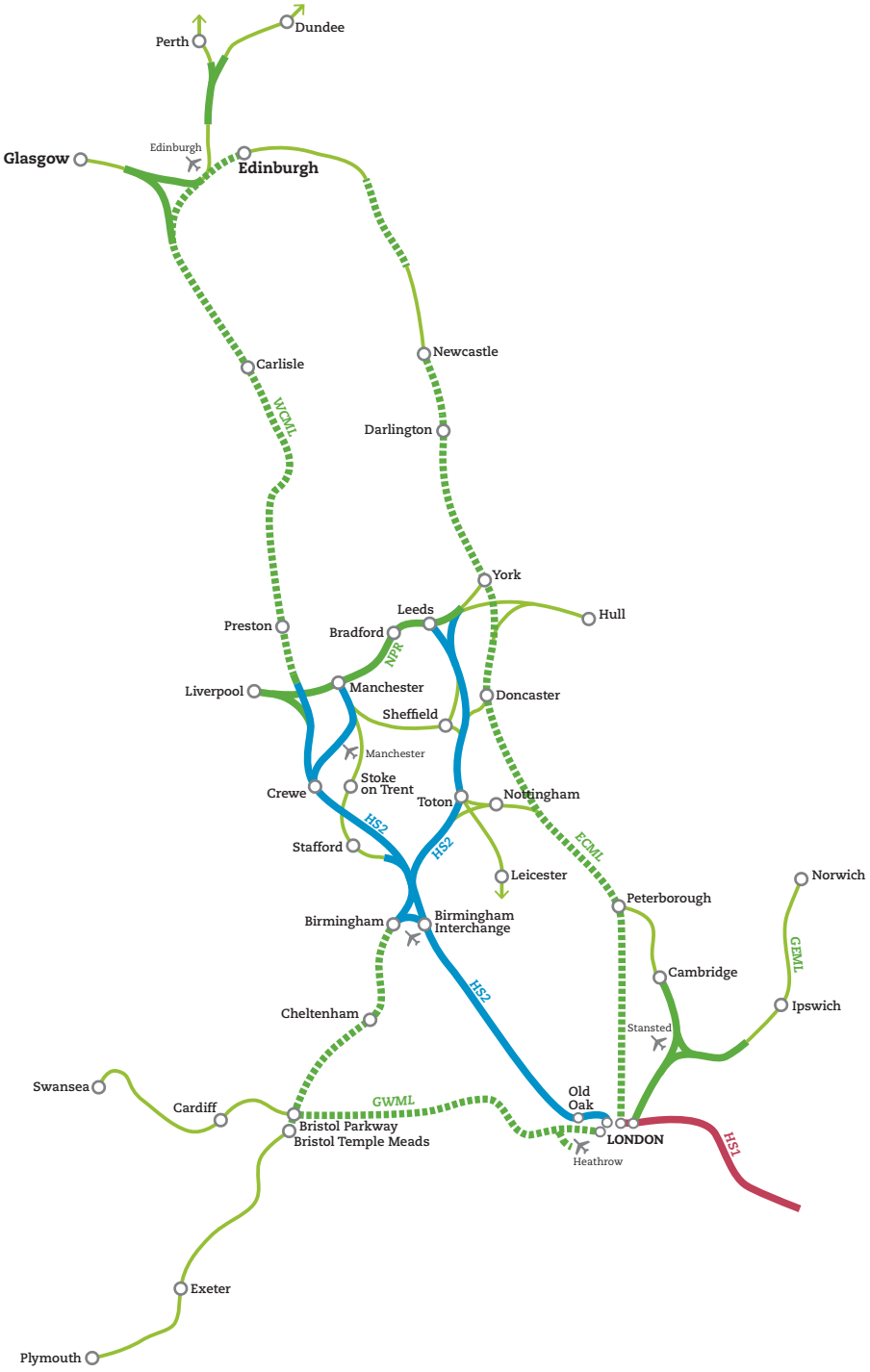
Developing additional connections for HS2, and strengthening the pattern of train services that will use it, is one part of the strategy. Working up plans for the use of released capacity is another: at present this core benefit from HS2 is left unspecified. Yet just as development plans around HS2 stations are already being spurred by progress made towards building HS2, so too other places can get equivalent benefits from the released capacity and improved services that HS2 makes possible. But for this to happen, the pattern of use of released capacity needs to be committed. Planning rail services ahead reduces uncertainty and has an economic dividend.

We looked across the country as a whole to identify where else large-scale network capacity short-falls (of the type that triggered HS2) are foreseeable and so where new high-speed lines would be the best approach.

One such corridor is across the Pennines, between Leeds and Manchester, as currently being studied by Transport for the North and Department for Transport together. Arrangements for transiting across Leeds and Manchester are likely to be critical – and we conclude a new east-west tunnel is likely to be needed for Manchester. The topography of the Pennines may be challenging, but the distances are quite short, so, as the Secretary of State for Transport has said, the solution is unlikely to be a new high-speed route (over 250 km/h). This applies too for the proposed re-creation of a direct railway line between Edinburgh and Perth, which could halve journey times between these two cities and speed up connections to Inverness and Aberdeen/Dundee as well. In Figure 10.2, therefore, these routes are shown as new fast railway lines.

Other corridors, such as the Great Western Main Line, lend themselves to further progressive route upgrades rather than a new high-speed line. This line, together with the relevant parts of the East and West Coast Main Lines, as shown in Figure 10.2, need to be enhanced to meet growing demand pressures. A common theme is likely to be the deployment of new digital ETCS train control technology to optimise train throughput and performance reliability – and to accommodate higher speeds. Where new sections of line are justified to provide sufficient route capacity, the opportunity for operation at speeds in the 125-150 mile/h range should be considered.

Figure 10.3: **High Speed Rail Network**



Only major stations shown

In two areas, the limitations of network geography combine with an expected growth of demand and a complex mix of rail services and so can be identified now as justifying the construction of new high-speed lines. We therefore include two completely new high-speed lines in our overall 2040 plan:

(i) a route from London to Stansted (target journey time: 15 minutes), where the line would split, with one route continuing towards Cambridge, the other towards Colchester. This would provide major capacity relief to the Great Eastern Main Line, so allowing much faster Norwich-London journey times, reducing the cost of accommodating Crossrail 2 along the Lea Valley, and providing a valuable new fast cross-country route, Ipswich-Colchester-Stansted-Cambridge, capable of onward extension from Cambridge;

(ii) a route from Rutherglen to Carstairs, with a spur to the line via Shotts, in Scotland, taking high-speed non-stop services off a busy multi-junction commuter rail route and creating in combination with other measures shown in Figure 10,2, a set of connectivity improvements across Scotland and on cross-border routes.

We also assume that a new high-speed connection into Liverpool from HS2 would be built. The high-speed rail elements are shown in Figure 10.3.

Further high-speed lines might be developed for the post-2040 period, for instance northwards from the new high-speed line towards Cambridge if the capacity created in the East Coast Main Line is fully used up, and over some northern parts of the West Coast Main Line, driven by the twin ambitions of fast intercity journeys, competing against short-haul domestic air flights, and the need to accommodate local services and freight.

Developments needed by 2030

Some local capacity pressures and connectivity short-comings that could have a bearing on overall network development are more pressing, and arise well before 2040. We would highlight:

- the constraints in the Croydon area on the Brighton Main Line (for which design/development work is now funded);

- the need to connect the Black Country to the new HS2 station in Birmingham at Curzon Street (new rail connections are needed along with an intensification in the use of the Moor Street-Snow Hill cross city connection);

- the pressures on the Castlefield corridor in Manchester, where a north-south connection has (at last) been provided for an expanding network of city region services, but which also has to accommodate long distance inter-regional trains. We have identified the role that a western link to Manchester Airport can play in freeing up the key network constraint at the existing terminus station and reducing conflicting train movements at Piccadilly station in the medium term (by 2029). This could be followed by a tunnelled link westwards from the new HS2/ Northern Powerhouse Rail platforms at Piccadilly to Ordsall.[6]

There is a pressing need to enhance several major city-region rail networks. Funding programmes that were available to city authorities in earlier years to support the creation of, for example, the Tyne & Wear Metro and Liverpool's 'loop and link' networks no longer exist. Yet without better city region rail networks, not only will their economic development be held back, but the benefits of investment in HS2 will be constrained. We have identified six city regions where investment to create better cross city rail links would bring huge benefits, and shown the specific measures needed. Together, these amount to projects of national significance. There are equivalent developments needed in London too, but those we have identified do not carry the high price tag associated with Crossrail 2.

An even more basic requirement arises in the South West, where questions of network resilience (in practice, whether the main line beyond Exeter to Plymouth and Cornwall is open or not) need to be addressed not just by the reactive mitigation measures now planned along the Dawlish coast, but also by the creation of an inland route that matches (or betters) current journey times, and the plan provides for this, along with measures to speed up Taunton-London journey times.

The importance of connectivity with international gateways – ports and airports – led to a number of specific proposals (Figure 10.2 again refers):

Ports

- for London Gateway/Tilbury and, potentially, the freight terminals in North Kent, a new freight link between Pitsea and Wickford, together with a new south-east connection to the Great Eastern Main Line to create a freight route around London for freight movements that conflict with expansion of London Overground services; this route would also provide valuable and missing north-south rail connectivity in Essex and could be usefully combined with a new lower Thames rail crossing to connect the towns and cities of Essex and Kent by train without needing to travel via central London;

6. This scheme would bring multiple benefits: it would allow the 20-minute Liverpool-Manchester (Northern Powerhouse Rail) target journey time to be achieved; it would free up Manchester's Castlefield Corridor to support an expanded city-region rail network; it would allow some HS2 services from the south to be extended beyond Manchester Piccadilly and continue northwards.

Creating six new city region rail services and networks

The cities of Bradford, Manchester, Leeds and Birmingham have established, but inefficient city region rail networks. Newcastle and Liverpool, on the other hand, have established metro-style operations, where there is scope to extend the reach of the local service network and expand labour markets accordingly. In each city, there are plans or prospects for new fast/high-speed rail links for intercity travel. Effective hub stations in each city will need to feed local, city-region rail passengers into the new fast/high-speed stations – in much the way that London Underground does for London's intercity stations.

Except for Leeds and Newcastle, there is the problem legacy (and opportunity) of multiple stations, making some cross-city travel problematic. This is acute in Bradford, and needs to be solved if Northern Powerhouse Rail is to be routed to serve the city. In Manchester, the Northern Hub has overcome the isolation of Victoria and Piccadilly stations but the line between them has to carry a mix of longer distance inter-regional demand as well as city region flows. In Birmingham, there is an under-utilised cross-city route between Snow Hill and Moor Street/Curzon stations.

While Leeds has a well-sited single city centre station – into which HS2 platforms will be combined – it has few local services operating on a cross-city basis. As a result, platforms are occupied by terminating trains, and the scope to expand services is constrained by a lack of platform capacity.

In all six cities there is the need, prompted by HS2 (and in the north, Northern Powerhouse Rail) to create new or improved city region rail networks. These would have shared characteristics: cross-city electrified routes, able to support a number of city region radial lines with high, metro-like, service frequencies providing access to the new high-speed networks, and reaching places that are in need of a connectivity boost.

- for the new port at Liverpool and across the Pennines, the upgrade of the line through Ormskirk to Preston and a re-instated connection at Lostock Hall to connect eastwards via Blackburn to the Calder Valley line and destinations in Yorkshire, Humber and the North East;

- and although not shown in Figure 10.2, for clarity, the completion of the Felixstowe-Nuneaton strategic freight route.

Airports

- at Heathrow, the creation of joined-up connections to the west, south and south-east that will support the operation of direct airport services from South West England, South Wales and the Midlands without compromising the already critically-loaded route between Airport Junction and Paddington;

- at Manchester Airport, the implementation of the western rail link, opening the opportunity to operate a rich set of new direct airport services and overcoming the capacity constraints of the current terminus arrangements;

- at Edinburgh Airport, where a new north-south connection between the new Gateway station and Curriehill would allow the operation of new airport services both from Glasgow and from the south – over an upgraded West Coast Main Line.

A strong customer focus

The customer imperative is to provide a railway system that works as a coherent whole. New technology will help with ticketing, and in due course, with easier to negotiate ticket and security checks; it will also provide travellers with personalised guidance through complex hub stations. A simplified fares system – we have elsewhere suggested a national zonal design that can be extended to work on feeder transport modes[7] – will be needed too. Friendly and helpful expert staff will still be required. It must become easier for those with mobility difficulties to use the rail system, which lags what's on offer from the bus network. A renewed focus on network benefits, with live travel information and support, is long overdue.

These customer needs apply in the heart of a busy network, but also at its – sometimes neglected – periphery, where dependence on connections and low service frequencies can be especially challenging.

7. Greengauge 21, *Rail in the North: Stepping Stones to a rebalanced Britain*, November 2014.

The Important Next Steps

The policy imperative is to ensure that a start can be made to maximise the use of rail to support growing cities and to help redress the imbalanced pattern of economic prosperity that is such a drain on the national account.

Plans and strategies have become strangely unfashionable. In the modern era, just as when prepared by businesses, they are needed to make sense of strategic investment decisions, and to help see how different constituent parts fit together; to avoid wasteful or duplicate public expenditure, and to get timing and phasing right. And they need to be adaptable.

The existence of an updatable long term plan for rail serves as a reference point for those in engaged in related sectors – in health and housing for instance – as well as in local transport and the highways sector. It also provides the coherence that allows the rail supply sector to invest so that the costs, both of capital projects and ongoing maintenance and operations, can be reduced.

Setting out a 20–25 year vision does not lead to a need to fully fund plans from the outset and its adoption by Government does not imply a commitment that will be a source of future regret. But it does create a basis for others to plan their businesses. It is itself a boost to the economy.

It might be thought a conceit to offer a national plan for the development of the national rail system, unauthorised as it were. The Department for Transport has after all published its strategy for transport investment in July 2017[8]. But this seeks only to set a short to medium term investment framework, not prepare a plan. And the National Infrastructure Commission is charged to produce a National Infrastructure Assessment[9] which is intended to take a view of Britain's long term infrastructure needs and make associated recommendations to Government, but this will be looking broadly across transport as a whole as well as digital requirements, waste and flood and drought risk. The NIC cannot consider proposals that are not deemed to be of national significance.

The Government has also established a centralised 'National Rail Network Enhancement Pipeline', to be entered through approval of business cases, but this offers no guarantee of overall coherence and leaves the risk that the strongest advocates will prevail[10] - those with the greatest capacity and capability to promote business cases – rather than projects that will deliver the best value for money across a wide range of objectives, and that form part of a coherent overall plan.

8. Department for Transport Transport Investment Strategy – Moving Britain Ahead, July 2017.

9. The National Infrastructure Commission set out its draft vision and priorities for action in 2017 in Congestion, Capacity and Carbon: Priorities for National Infrastructure. Its National Infrastructure Assessment is due later this year.

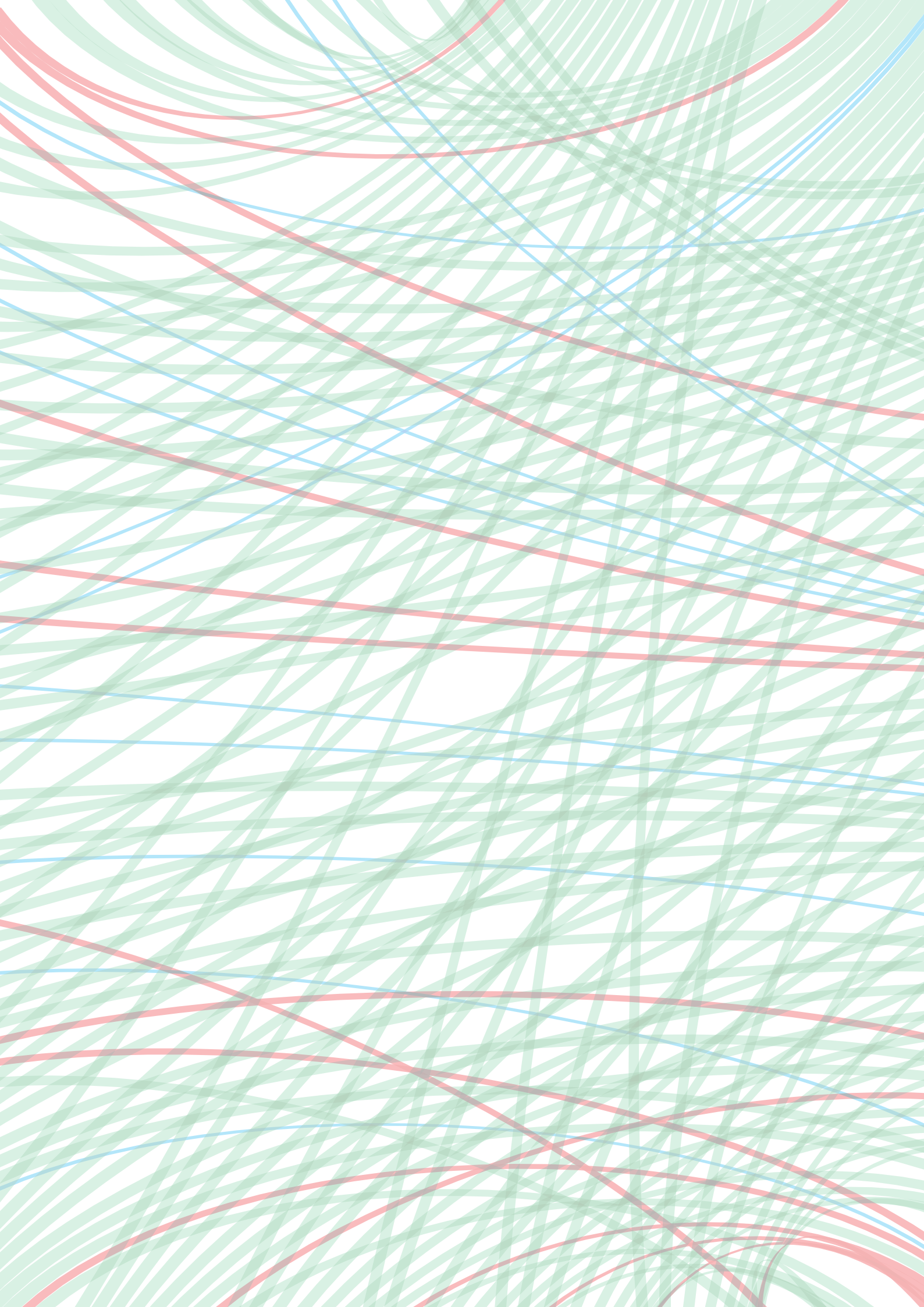
10. Asad Khair, KPMG writing for Transport Times, April 2018.

There is a gap – the rail industry is not charged with producing a long-term plan, and hasn't done so. The Strategic Rail Authority, with its statutory obligation to prepare strategies, was wound up twelve years ago. In the absence of an alternative, we commend rail industry leaders and policy makers to consider the issues we have identified in this report, challenge our findings as appropriate and suggest changes accordingly. Such a plan will help inform the National Infrastructure Commission in its work, as well as the rail industry itself.

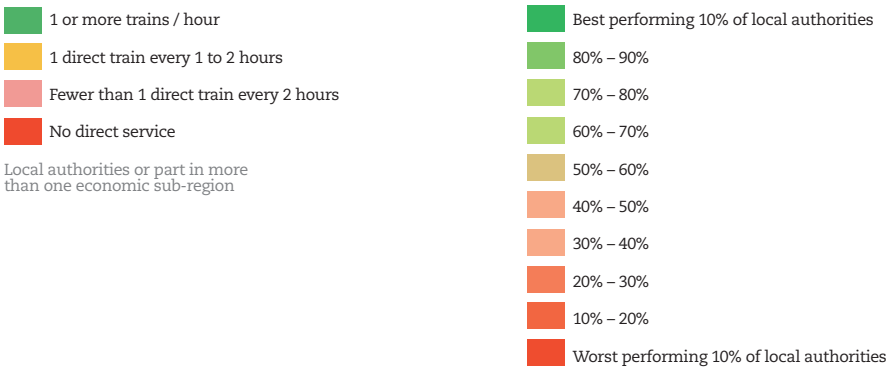
It is clear that ignoring the value of a coherent plan carries a high price:

- the full benefit of HS2 will not be realised;
- places that benefit from released capacity created by HS2 will continue to presume they are at risk of being bypassed, or disadvantaged;
- places not served at all by HS2 will not get the improvements needed to provide connectivity gains – and in the case of the South West – even essential day by day network resilience will continue to be illusory;
- accessing our ports and airports will remain over-dependent on congested road networks;
- areas 'left behind' will remain 'left behind';
- the economic boost that a well thought out strategy provides will be lost;
- the rail supply chain – a re-born industrial sector in the making – will fester, its forward work-load at best uncertain, at worst unknown;
- with investments taken on a case-by-case basis, the scope for programme and project cost savings will be lost, and nugatory expenditure will be a very high risk.

Funding of rail enhancement programmes should be returned to a medium-term programme basis and set in the context of a long term plan. Whatever emerges as the 'guiding mind' for the rail sector needs to assume responsibility for the national rail strategy and for keeping plans coherent and up-to-date. The exciting emergence of 'sub-national' (regional) agencies to formulate plans provides a vital basis for rail to play an expanded and integrated role. But a national-level plan and funding programme is also vital to make them a success.



Annex A **Direct rail connectivity between economic sub-regions across Britain and London and other major British cities**



Notes

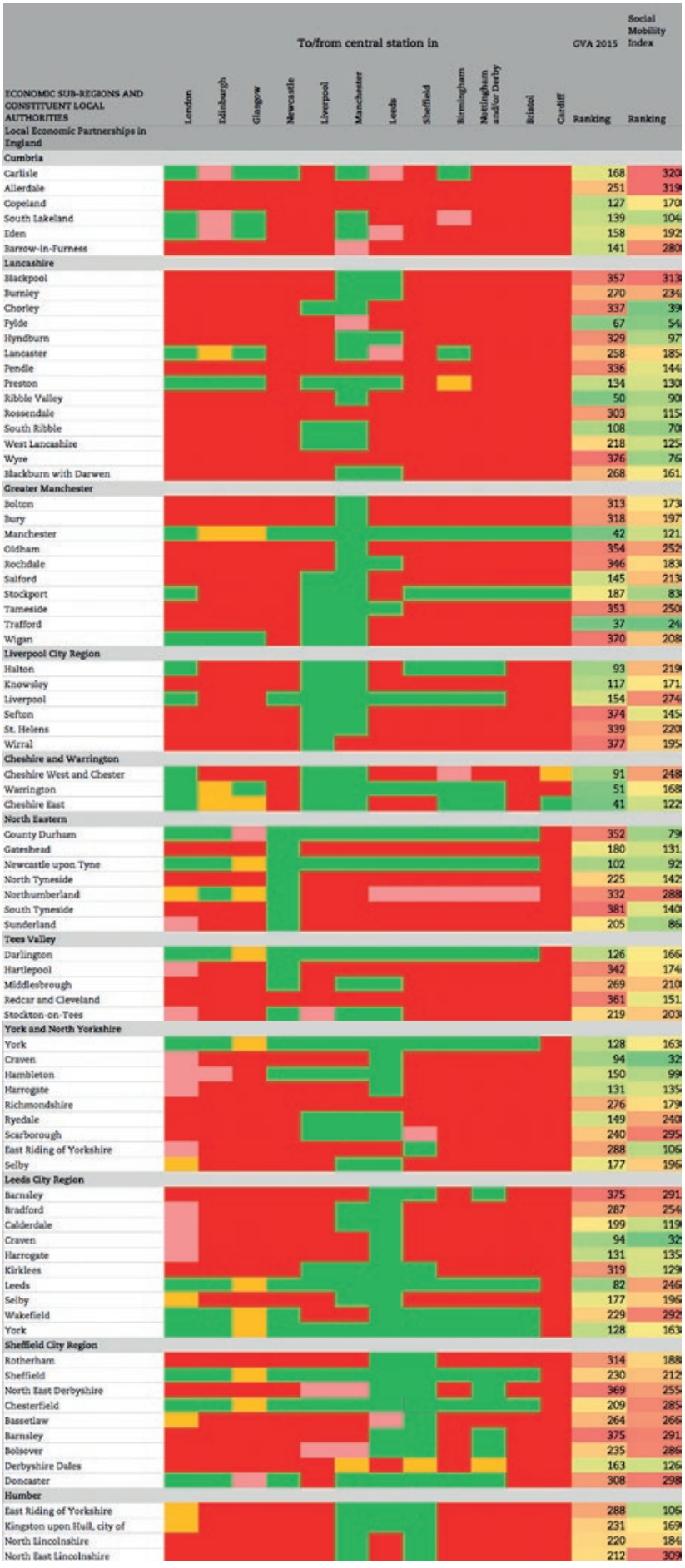
1. The diagram examines the direct rail connectivity of 'economic sub-regions' across Britain with a central station in London and other major British cities comprising the Scottish and Welsh capitals, the English Core Cities and Glasgow. These major British cities are important economic growth centres as well as important rail hubs.

2. We have taken the 'economic sub-regions' to be the Local Economic Partnership areas in England, the two city regions and two more rural sub-national areas in Wales and, in the absence of defined 'economic sub-regions' in Scotland, the areas covered by the Regional Transport Partnerships. Local authorities that participate in more than one 'economic sub-region' are highlighted.

3. Given HS2 will serve both Nottingham and Derby at Toton and the D2N2 LEP is twin centred our analysis has examined each economic sub-region's direct connectivity with Derby and/or Nottingham as well as Derby and Nottingham's direct connectivity with other major cities.

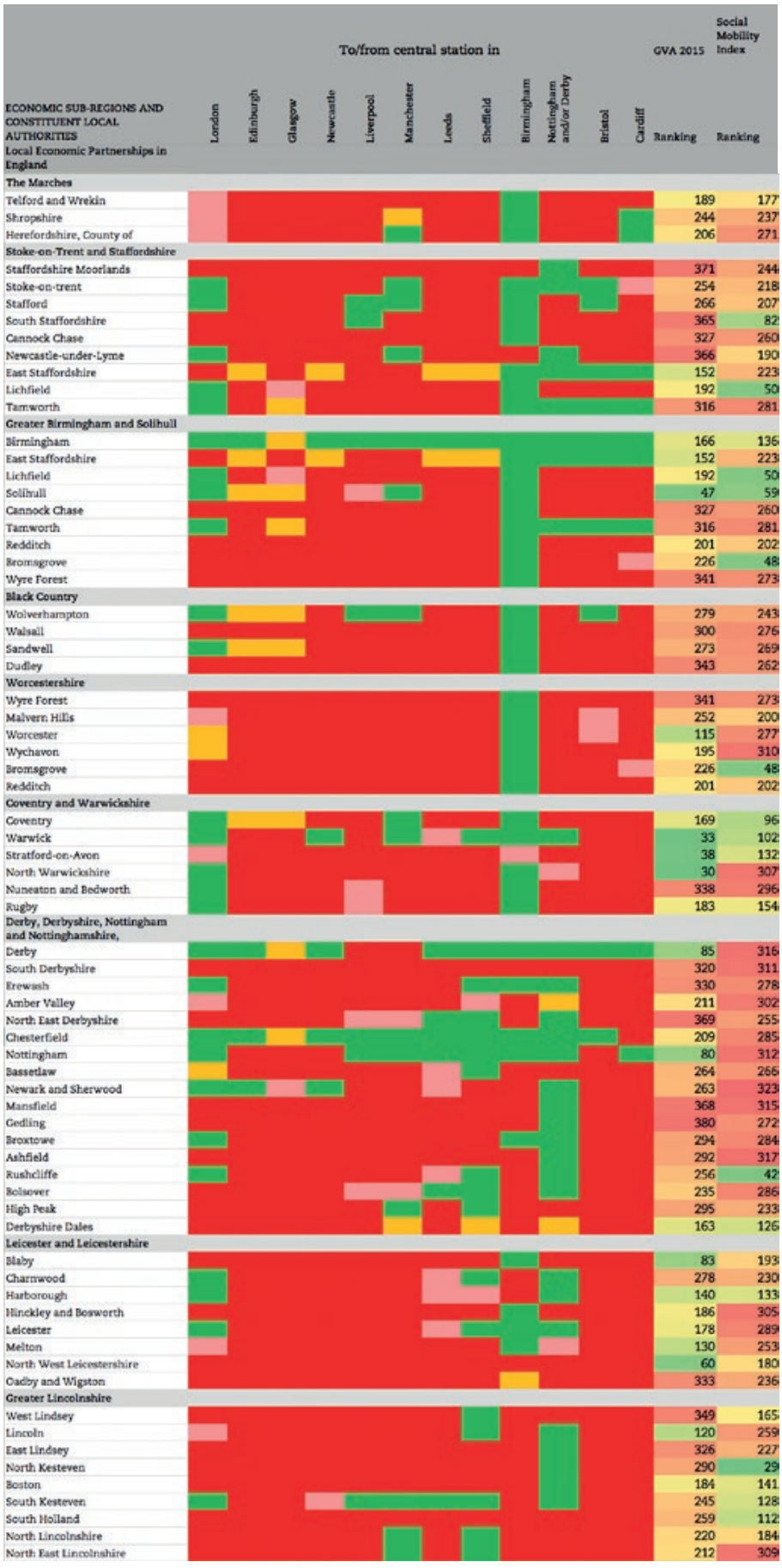
4. Alongside direct rail connectivity we show Gross Value Added per head and social mobility rankings. The GVA per head ranking is for 2015 and ranks all local authorities in Britain. The Social Mobility rankings are those produced by the Social Mobility Commission in its State of the Nation 2017 report. Due to data inconsistencies the Social Mobility Commission produced separate local authority rankings for each of England (excluding the City of London and Isles of Scilly), Scotland and Wales.

The North

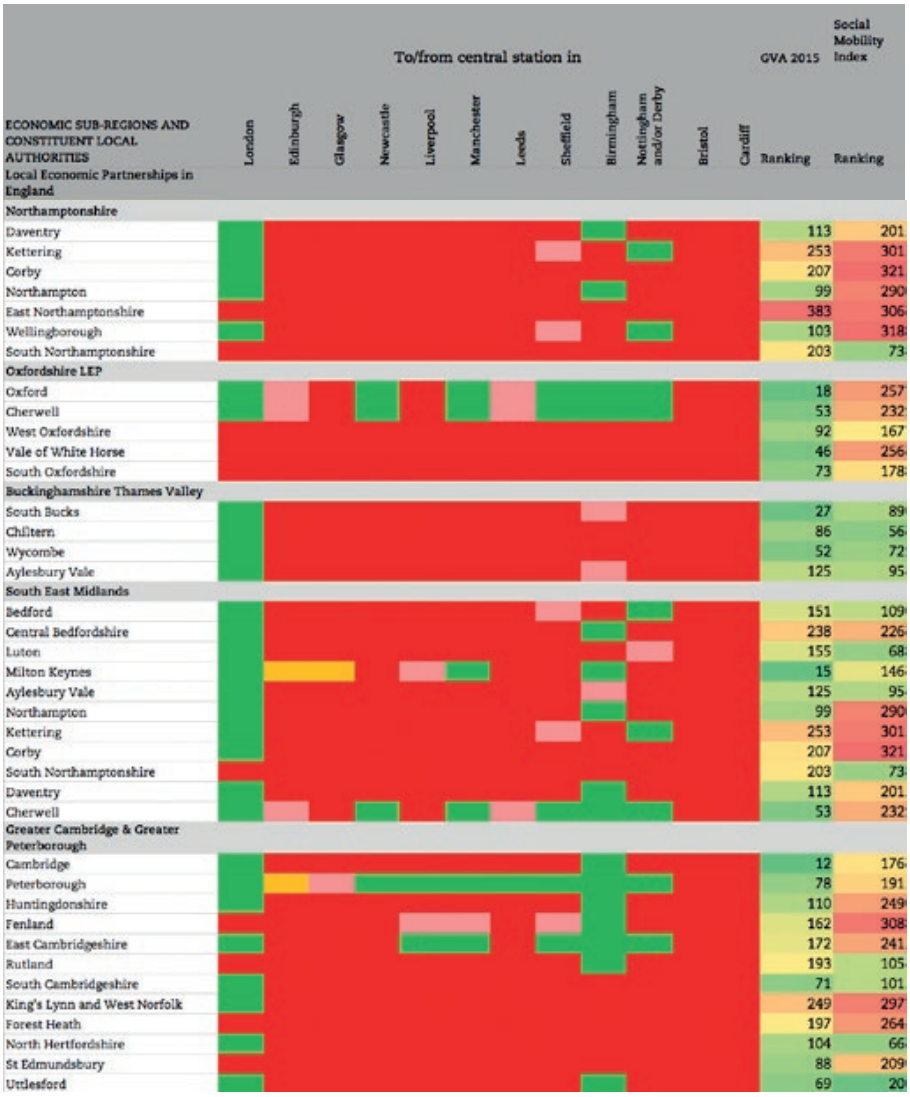


ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES	To/from central station in: London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	GVA 2015 Ranking	Social Mobility Index Ranking
Local Economic Partnerships in England														
Cumbria														
Carlisle													168	320
Allerdale													251	319
Copeland													127	170
South Lakeland													139	104
Eden													158	192
Barrow-in-Furness													141	280
Lancashire														
Blackpool													357	313
Burnley													270	234
Chorley													337	39
Fylde													67	54
Hyndburn													329	97
Lancaster													258	185
Pendle													336	144
Preston													134	130
Ribble Valley													50	90
Rossendale													303	115
South Ribble													108	70
West Lancashire													218	125
Wyre													376	76
Blackburn with Darwen													268	161
Greater Manchester														
Bolton													313	173
Bury													318	197
Manchester													42	121
Oldham													354	252
Rochdale													346	183
Salford													145	213
Stockport													187	83
Tameside													353	250
Trafford													37	24
Wigan													370	208
Liverpool City Region														
Halton													93	219
Knowsley													117	171
Liverpool													154	274
Sefton													374	145
St. Helens													339	220
Wirral													377	195
Cheshire and Warrington														
Cheshire West and Chester													91	248
Warrington													51	168
Cheshire East													41	122
North Eastern														
County Durham													352	79
Gateshead													180	131
Newcastle upon Tyne													102	92
North Tyneside													225	142
Northumberland													332	288
South Tyneside													381	140
Sunderland													205	86
Tees Valley														
Darlington													126	166
Hartlepool													342	174
Middlesbrough													269	210
Redcar and Cleveland													361	151
Stockton-on-Tees													219	203
York and North Yorkshire														
York													128	163
Craven													94	32
Hambleton													150	99
Harrogate													131	135
Richmondshire													276	179
Ryedale													149	240
Scarborough													240	295
East Riding of Yorkshire													288	106
Selby													177	196
Leeds City Region														
Barnsley													375	291
Bradford													287	254
Calderdale													199	119
Craven													94	32
Harrogate													131	135
Kirklees													319	129
Leeds													82	246
Selby													177	196
Wakefield													229	292
York													128	163
Sheffield City Region														
Rotherham													314	188
Sheffield													230	212
North East Derbyshire													369	255
Chesterfield													209	285
Bassetlaw													264	266
Barnsley													375	291
Bolsover													235	286
Derbyshire Dales													163	126
Doncaster													308	298
Humber														
East Riding of Yorkshire													288	106
Kingston upon Hull, city of													231	169
North Lincolnshire													220	184
North East Lincolnshire													212	309

The Midlands

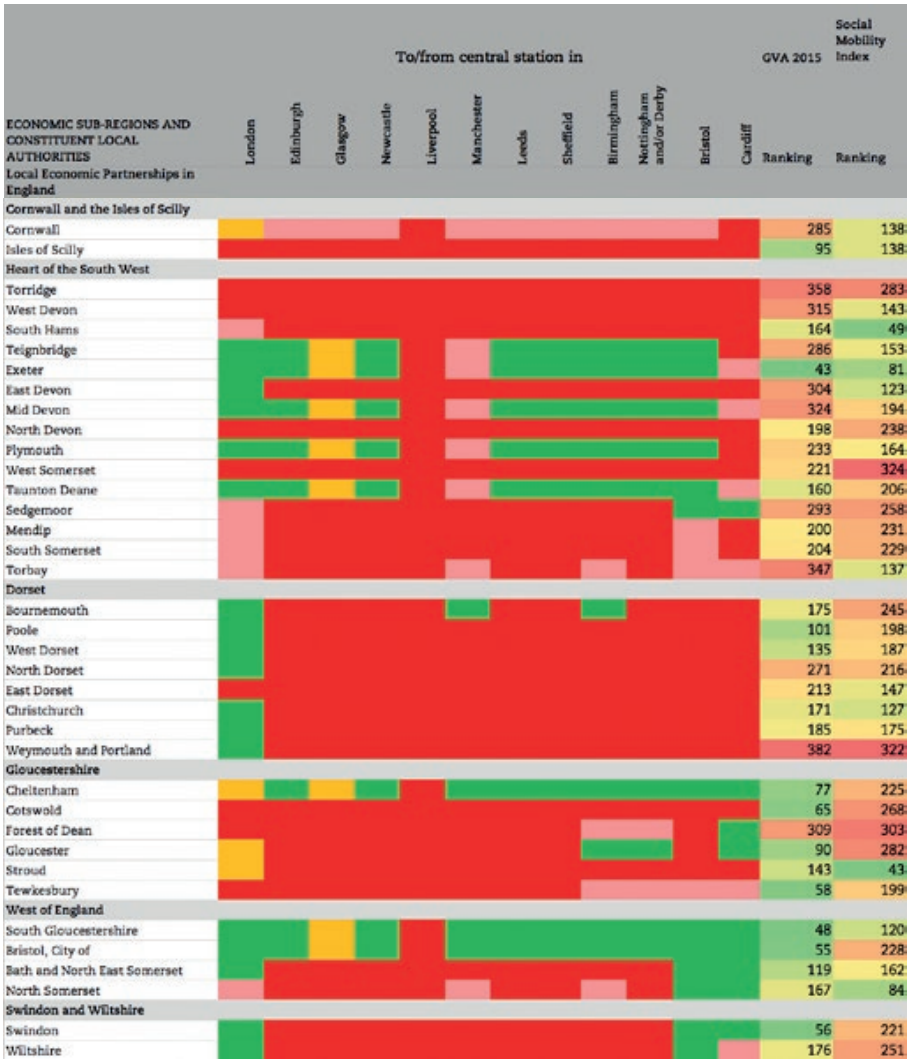


ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in: London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	GVA 2015 Ranking	Social Mobility Index Ranking
The Marches														
Telford and Wrekin													189	177
Shropshire													244	237
Herefordshire, County of													206	271
Stoke-on-Trent and Staffordshire														
Staffordshire Moorlands													371	244
Stoke-on-trent													254	218
Stafford													266	207
South Staffordshire													365	82
Cannock Chase													327	260
Newcastle-under-Lyme													366	190
East Staffordshire													152	223
Lichfield													192	50
Tamworth													316	281
Greater Birmingham and Solihull														
Birmingham													166	136
East Staffordshire													152	223
Lichfield													192	50
Solihull													47	59
Cannock Chase													327	260
Tamworth													316	281
Redditch													201	202
Bromsgrove													226	48
Wyre Forest													341	273
Black Country														
Wolverhampton													279	243
Walsall													300	276
Sandwell													273	269
Dudley													343	262
Worcestershire														
Wyre Forest													341	273
Malvern Hills													252	200
Worcester													115	277
Wychavon													195	310
Bromsgrove													226	48
Redditch													201	202
Coventry and Warwickshire														
Coventry													169	96
Warwick													33	102
Stratford-on-Avon													38	132
North Warwickshire													30	307
Nuneaton and Bedworth													338	296
Rugby													183	154
Derby, Derbyshire, Nottingham and Nottinghamshire,														
Derby													85	316
South Derbyshire													320	311
Erewash													330	278
Amber Valley													211	302
North East Derbyshire													369	255
Chesterfield													209	285
Nottingham													80	312
Bassetlaw													264	266
Newark and Sherwood													263	323
Mansfield													368	315
Gedling													380	272
Broxtowe													294	284
Ashfield													292	317
Rushcliffe													256	42
Bolsover													235	286
High Peak													295	233
Derbyshire Dales													163	126
Leicester and Leicestershire														
Blaby													83	193
Charnwood													278	230
Harborough													140	133
Hinckley and Bosworth													186	305
Leicester													178	289
Melton													130	253
North West Leicestershire													60	180
Oadby and Wigston													333	236
Greater Lincolnshire														
West Lindsey													349	165
Lincoln													120	259
East Lindsey													326	227
North Kesteven													290	29
Boston													184	141
South Kesteven													245	128
South Holland													259	112
North Lincolnshire													220	184
North East Lincolnshire													212	309



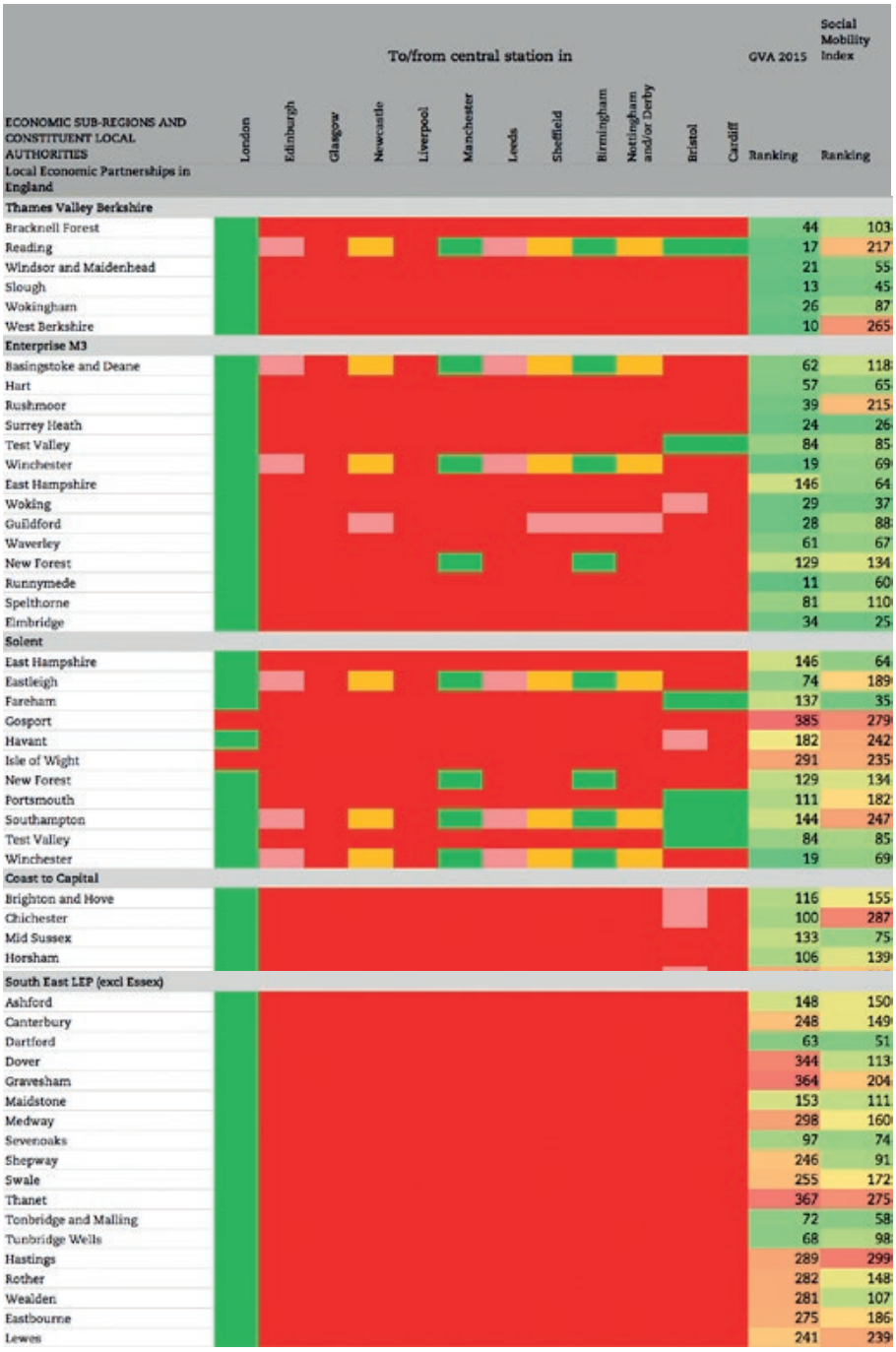
ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in: London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	GVA 2015 Ranking	Social Mobility Index Ranking
Northamptonshire														
Daventry													113	201
Kettering													253	301
Corby													207	321
Northampton													99	290
East Northamptonshire													383	306
Wellingborough													103	318
South Northamptonshire													203	73
Oxfordshire LEP														
Oxford													18	257
Cherwell													53	232
West Oxfordshire													92	167
Vale of White Horse													46	256
South Oxfordshire													73	178
Buckinghamshire Thames Valley														
South Bucks													27	89
Chiltern													86	56
Wycombe													52	72
Aylesbury Vale													125	95
South East Midlands														
Bedford													151	109
Central Bedfordshire													238	226
Luton													155	68
Milton Keynes													15	146
Aylesbury Vale													125	95
Northampton													99	290
Kettering													253	301
Corby													207	321
South Northamptonshire													203	73
Daventry													113	201
Cherwell													53	232
Greater Cambridge & Greater Peterborough														
Cambridge													12	176
Peterborough													78	191
Huntingdonshire													110	249
Fenland													162	308
East Cambridgeshire													172	241
Rutland													193	105
South Cambridgeshire													71	101
King's Lynn and West Norfolk													249	297
Forest Heath													197	264
North Hertfordshire													104	66
St Edmundsbury													88	209
Uttlesford													69	20

The South West



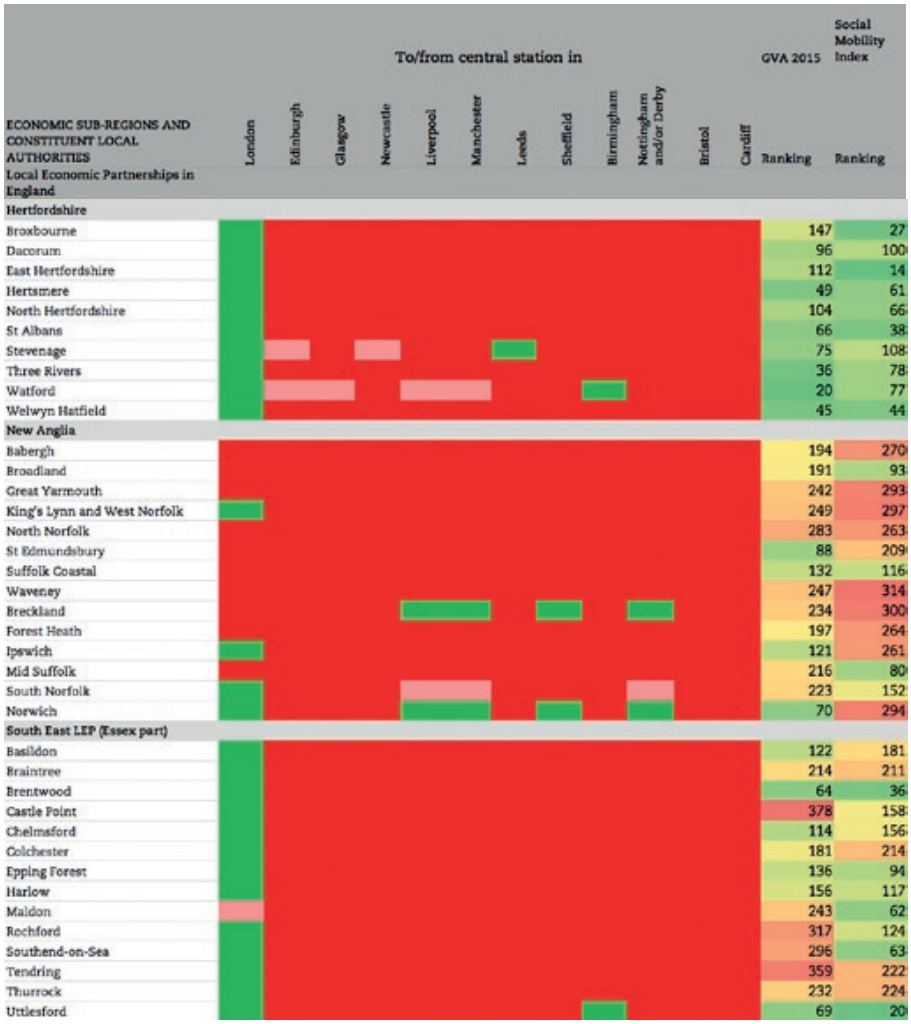
ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in: London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	GVA 2015 Ranking	Social Mobility Index Ranking
Cornwall and the Isles of Scilly														
Cornwall													285	138
Isles of Scilly													95	138
Heart of the South West														
Torridge													358	283
West Devon													315	143
South Hams													164	49
Teignbridge													286	153
Exeter													43	81
East Devon													304	123
Mid Devon													324	194
North Devon													198	238
Plymouth													233	164
West Somerset													221	324
Taunton Deane													160	206
Sedgemoor													293	258
Mendip													200	231
South Somerset													204	229
Torbay													347	137
Dorset														
Bournemouth													175	245
Poole													101	198
West Dorset													135	187
North Dorset													271	216
East Dorset													213	147
Christchurch													171	127
Purbeck													185	175
Weymouth and Portland													382	322
Gloucestershire														
Cheltenham													77	225
Cotswold													65	268
Forest of Dean													309	303
Gloucester													90	282
Stroud													143	43
Tewkesbury													58	199
West of England														
South Gloucestershire													48	120
Bristol, City of													55	228
Bath and North East Somerset													119	162
North Somerset													167	84
Swindon and Wiltshire														
Swindon													56	221
Wiltshire													176	251

The South East



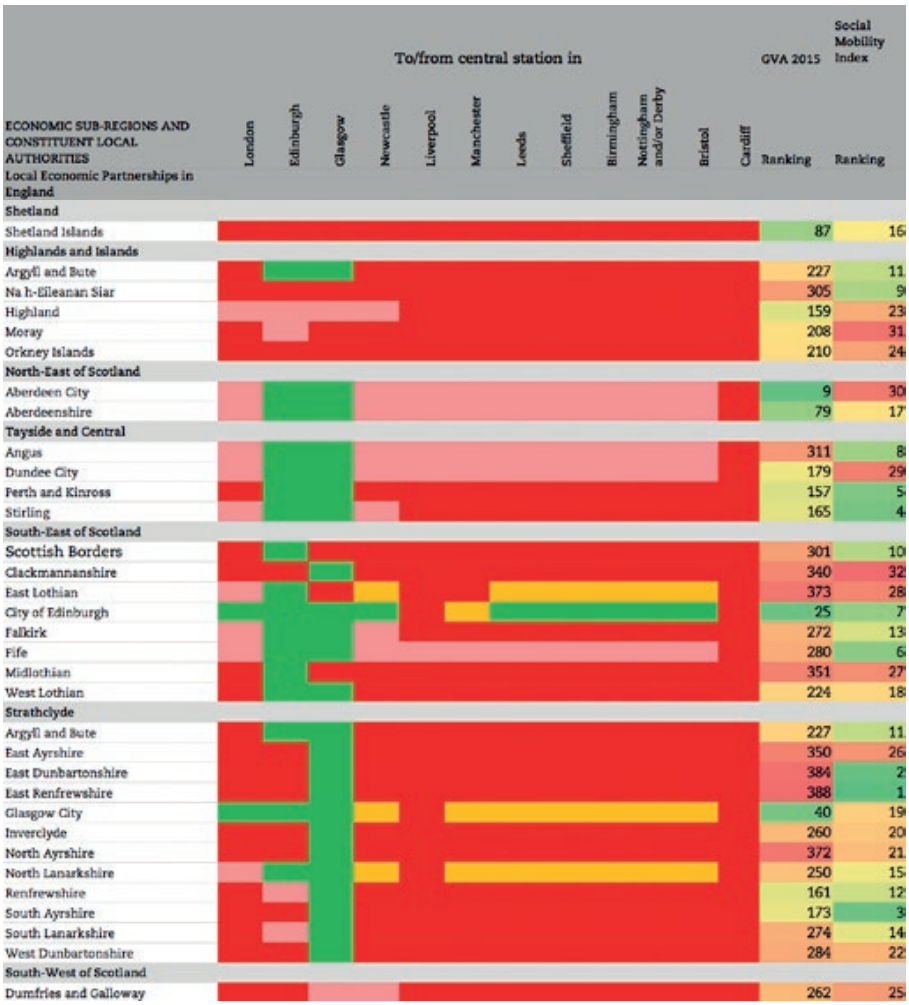
ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in: London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	GVA 2015 Ranking	Social Mobility Index Ranking
Thames Valley Berkshire														
Bracknell Forest													44	103
Reading													17	217
Windsor and Maidenhead													21	55
Slough													13	45
Wokingham													26	87
West Berkshire													10	265
Enterprise M3														
Basingstoke and Deane													62	118
Hart													57	65
Rushmoor													39	215
Surrey Heath													24	26
Test Valley													84	85
Winchester													19	69
East Hampshire													146	64
Woking													29	37
Guildford													28	88
Waverley													61	67
New Forest													129	134
Runnymede													11	60
Spelthorne													81	110
Elmbridge													34	25
Solent														
East Hampshire													146	64
Eastleigh													74	189
Fareham													137	35
Gosport													385	279
Havant													182	242
Isle of Wight													291	235
New Forest													129	134
Portsmouth													111	182
Southampton													144	247
Test Valley													84	85
Winchester													19	69
Coast to Capital														
Brighton and Hove													116	155
Chichester													100	287
Mid Sussex													133	75
Horsham													106	139
South East LEP (excl Essex)														
Ashford													148	150
Canterbury													248	149
Dartford													63	51
Dover													344	113
Gravesham													364	204
Maidstone													153	111
Medway													298	160
Sevenoaks													97	74
Shepway													246	91
Swale													255	172
Thanet													367	275
Tonbridge and Malling													72	58
Tunbridge Wells													68	98
Hastings													289	299
Rother													282	148
Wealden													281	107
Eastbourne													275	186
Lewes													241	239

East of England



ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in												GVA 2015	Social Mobility Index
	London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	Ranking	Ranking
Hertfordshire														
Broxbourne													147	27
Dacorum													96	100
East Hertfordshire													112	14
Hertsmere													49	61
North Hertfordshire													104	66
St Albans													66	38
Stevenage													75	108
Three Rivers													36	78
Watford													20	77
Welwyn Hatfield													45	44
New Anglia														
Babergh													194	270
Broadland													191	93
Great Yarmouth													242	293
King's Lynn and West Norfolk													249	297
North Norfolk													283	263
St Edmundsbury													88	209
Suffolk Coastal													132	116
Waveney													247	314
Breckland													234	300
Forest Heath													197	264
Ipswich													121	261
Mid Suffolk													216	80
South Norfolk													223	152
Norwich													70	294
South East LEP (Essex part)														
Basildon													122	181
Braintree													214	211
Brentwood													64	36
Castle Point													378	158
Chelmsford													114	156
Colchester													181	214
Epping Forest													136	94
Harlow													156	117
Maldon													243	62
Rochford													317	124
Southend-on-Sea													296	63
Tendring													359	222
Thurrock													232	224
Uttlesford													69	20

Regional Transport Partnerships in Scotland



ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in												GVA 2015	Social Mobility Index
	London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	Ranking	Ranking
Shetland														
Shetland Islands													87	16
Highlands and Islands														
Argyll and Bute													227	11
Na h-Eileanan Siar													305	9
Highland													159	23
Moray													208	31
Orkney Islands													210	24
North-East of Scotland														
Aberdeen City													9	30
Aberdeenshire													79	17
Tayside and Central														
Angus													311	8
Dundee City													179	29
Perth and Kinross													157	5
Stirling													165	4
South-East of Scotland														
Scottish Borders													301	10
Clackmannanshire													340	32
East Lothian													373	28
City of Edinburgh													25	7
Falkirk													272	13
Fife													280	6
Midlothian													351	27
West Lothian													224	18
Strathclyde														
Argyll and Bute													227	11
East Ayrshire													350	26
East Dunbartonshire													384	2
East Renfrewshire													388	1
Glasgow City													40	19
Inverclyde													260	20
North Ayrshire													372	21
North Lanarkshire													250	15
Renfrewshire													161	12
South Ayrshire													173	3
South Lanarkshire													274	14
West Dunbartonshire													284	22
South-West of Scotland														
Dumfries and Galloway													262	25

Economic Boards and City Regions in Wales

ECONOMIC SUB-REGIONS AND CONSTITUENT LOCAL AUTHORITIES Local Economic Partnerships in England	To/from central station in												GVA 2015	Social Mobility Index
	London	Edinburgh	Glasgow	Newcastle	Liverpool	Manchester	Leeds	Sheffield	Birmingham	Nottingham and/or Derby	Bristol	Cardiff	Ranking	Ranking
North Wales														
Isle of Anglesey													387	12
Conwy													348	21
Denbighshire													323	10
Flintshire													142	17
Gwynedd													257	6
Wrexham													265	19
Growing Mid Wales														
Ceredigion													310	2
Powys													306	9
Cardiff City Region														
Blaenau Gwent													391	20
Bridgend													236	5
Caerphilly													386	8
Cardiff													109	13
Merthyr Tydfil													356	4
Monmouthshire													215	3
Newport													202	7
Rhondda Cynon Taf													355	16
Torfaen													325	15
Vale Of Glamorgan													335	1
Swansea City Region														
Carmarthenshire													362	11
Neath Port Talbot													360	22
Pembrokeshire													334	18
Swansea													267	14

Annex B **National plan components**

Table B1: **New high-speed lines**

Route (preliminary assumptions)		Mileage (approx.)
Stratford -Stansted		30
Stansted-Audley End		12
Stansted-Marks Tey		27
	Sub total	**69**
Rutherglen-Carstairs		26
HS2/WCML-St Helens Jnct		6
	Total	**101**

Table B2: **New fast lines (200km/h)**

Route (preliminary assumptions)		Mileage (approx.)
Newhouse–Shotts		6
Inverkeithing-Bridge of Earn & Cross Tay link		30
Liverpool – Ulleskelf (Northern Powerhouse Rail)		91
	Total	**127**

Table B3: **New lines**

Route (preliminary assumptions)	Mileage (approx.)
Bedford-Cambridge (EWR)	32
Essex-Kent N-S connections	9
Bradford cross city link	1
Manchester Airport western links	3
New chord north of Cowley Bridge and Okehampton-Bere Ferrers	26
Croxley Link	2
Old Oak-Kilburn	2
Heathrow western, south western and southeastern connections	8
Durham bypass	8
Berks and Hants cut-off	2
Curriehill-Edinburgh Gateway	2
Elizabeth Line connection to West Coast Main Line	2
Total	**97**

Table B4: **Route upgrades**

Route (preliminary assumptions)[1]	Mileage (approx.)
ECML King's Cross-Darlington	232
WCML Edinburgh-Carstairs-Wigan	207
Manchester-Huddersfield-Leeds	32
Sheffield-Hazel Grove-Stockport/Altrincham	42
Sheffield-Doncaster (part of)	5
Chester-Altrincham	30
Marks Tey-Colchester	5
GWML Didcot-Cardiff	92
GWML Didcot-Oxford	10
BML Croydon area	2
Bromsgrove-Bristol Parkway	74
Reading-Taunton	107
Total	**838**

1. Note: these are overall route upgrade lengths; in practice, some sections will not need to be upgraded.

Table B5: **Network of National Hub Stations**

Existing[2]	Upgrade invetsment 2020–40
Birmingham New Street	Birmingham Moor Street
Brighton	Carlisle
Bristol Parkway	Chester
Bristol Temple Meads	Colchester
Cambridge	Crewe
Cardiff	Darlington
Derby	Doncaster
Edinburgh Waverley	East Croydon
Exeter St David's	Glasgow Central
Hull	Leeds
Leicester	Manchester Airport
Liverpool Lime Street	Oxford
Manchester Piccadilly	Preston
Newcastle	Sheffield
Norwich	Swansea
Nottingham	Warrington
Peterborough	
Reading	
Southampton Central	
York	

2. Together with 8 London terminus stations: Paddington, Euston, St Pancras, Kings Cross, Liverpool Street, London Bridge, Waterloo, Victoria.

Table B6: **Interurban bus lines** (providing missing rail links) – *selected sample of high quality fully accessible routes only*

Connecting…		Route	Frequency	
Inverness	Fort William	919	8/day	Scottish City Link
St Andrews	Leuchars*	X42	8/hour	Scottish City Link and others
Leven	Kirkcaldy*	X38, X27	Twice hourly	Scottish City Link
Galashiels-Hawick	Carlisle	X95	hourly	Borders Buses
Norwich	Kings Lynn*	X1	half hourly	First
Kings Lynn	Spalding*	505	Every 20 minutes	Stagecoach
Spalding	Boston-Lincoln*	IC5		Brylaine
Boston	Skegness*	IC7	hourly	Stagecoach
Lincoln	Skegness*	IC6	hourly	Stagecoach
Grimsby-Louth	Skegness*	51 and IC9	hourly	Stagecoach
Grimsby	Hull			Various incl. National Express
Peterborough	Kings Lynn*	NRT Table 26A	Half hourly	First
Peterborough	Corby	X4, NRT Table 26A	hourly	Stagecoach
Gloucester	Hereford*	33	Hourly	Stagecoach
Cardiff	Newtown*	T6	Two-hourly	Traws Cymru
Carmarthen	Aberystwyth*	T1	hourly	Traws Cymru
Aberystwyth	Bangor*	T2	Two-hourly	Traws Cymru
Exeter	Bude	NRT Table 135D	8/day	Route 6/6A Stagecoach
Exeter	Weymouth	X53 and others	Twice hourly +	First
Bristol	Wells, Glastonbury & Street*	376	Twice hourly	First, Mendip Explorer
Lewes	Uckfield*	28/29	Twice hourly	Regency Route, Brighton & Hove Bus company
Scarborough-Whitby	Middlesbrough*	X93	Two-hourly	Arriva
Harrogate	Ripon*	36	Every 20 minutes	Transdev

1. NRT – national trail timetable.
2. Services and operators subject to change.
3. Asterisk (*) denotes covered in *Interurban Bus: Time to Raise the Profile*, Greengauge 21, March 2018.

About us

Greengauge 21 is a not-for-profit organisation that researches and promotes the benefits of a better rail network. Greengauge 21 wants to see a national high-speed rail network that is fully integrated with today's rail system, as well as the existing rail network improved and extended to meet the strongly growing demand for sustainability in our national transport networks.

Greengauge 21 launched its Manifesto: the high speed rail initiative – in January 2006. We followed this up with a report High Speed Two: a Greengauge 21 Proposition in June 2007, identifying London-West Midlands as the next step once the HS1 link to the Channel Tunnel was completed.

It was in September 2008 that the Conservative Party announced its intention to implement high-speed rail between London, Birmingham, Manchester and Leeds, using public sector funding. And in January 2009, the Labour Government established HS2 Ltd and published the London-West Midlands Phase 1 route alignment and the initial plans for a wider Y shaped network in a Command Paper of March 2010. The selected route to the West Midlands was subject to a Parliamentary Bill process which led to powers being obtained in 2016 to proceed to construction.

As HS2 plans have unfolded, Greengauge 21 has continued its work independently, with some highlights being a national strategy for high-speed rail ('Fast Forward') and a series of related policy research papers covering areas such as project funding, simplifying fares, and carbon impacts; European experience with high-speed rail; providing new rail links to Heathrow Airport to support its selection as the nation's hub airport; the creation of a second route to ensure the rail network's resilience in South West England; and the role that high-quality interurban bus services can play in making good rail network gaps.

All of these publications can be found, and are free to download, at www.greengauge21.net. We remain profoundly grateful to the Public Interest Group which funded our early major studies.

The authors of this report

The report was written by Deborah Carson, Richard Davies (formerly of BR, the SRA and ATOC), Leo Eyles (of Albion Economics), John Jarvis (formerly Transport Director at the Northern Way) and Jim Steer, Director at Greengauge 21.

Beyond HS2

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