NEW ECONOMICS FOUNDATION

A RAIL NETWORK FOR EVERYONE

PROBING HS2 AND ITS ALTERNATIVES

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EXECUTIVE SUMMARY

This report looks in considerable detail at the economic and strategic case that underlies the planned construction of new high-speed rail lines between London, Birmingham, Manchester and Leeds (HS2). It also looks at how the benefits of investing in the nation's rail network could be shared more widely across the UK. However, in the debate about HS2, there is only one set of questions that is commonly asked: Should HS2 proceed, be postponed, be cancelled, or at least be re-routed?

The New Economics Foundation's answer is linked to the evidence. Though HS2 is alluring as a project and enjoys cross-party support, the strategic case that underpins it is unconvincing and leaves the scheme looking like an expensive answer in search of a question.

It is impossible to ignore the reality: Contracts for phase 1 are soon to be let and the government may have already spent more than £4 billion on the project. Furthermore, judging HS2's efficacy is made more difficult in the absence of a wider rail, transport, or economic strategy, and against a backdrop of poor management and coordination across the network. There is also a lack of available detailed data about passenger movements because it is collected by private enterprises and therefore 'commercially confidential'.

It is also important that the starting point of any debate about HS2 be the right one. Too often reports arguing against HS2 have started from the principle that it is too expensive and that it would be better to invest in cheaper infrastructure or not invest at all. This is the wrong point of departure as our railways suffer from massive under-investment in every UK nation and region. Putting that right will cost very significant sums of government capital. But in a time when the government needs to rediscover its fiscal role and invest more in productive assets, such as transport, that should not be a major barrier.

The problem with HS2, however, is that it is the product of decades of government retrenchment from the fiscal realm and strategic planning, and of a fragmented rail network, with multiple private sector and public stakeholders. It is also the product of an economy in crisis, an economy desperately trying to unhook itself from London-centricity and all its malcontents, but actually compounding

the problem by starting the project in London.

Following a shambolic 18 months on the railways, with disastrous timetable changes, the wrong kind of weather, and the cancellation of planned electrification schemes, the government has launched a 'root and branch' review. However, the review is missing some key roots and branches, two of them being HS2 and the latest package of maintenance and upgrades agreed with Network Rail. These have been deemed out of scope but should be included.

There are two fundamental problems with the railways in the UK that, in the interests of ensuring immediate and long-term value for public money, need addressing before the much-needed major investment is committed. The first is the absence of an overarching rail or transport strategy, which leaves HS2 looking like the solution to a problem that has not yet been defined. It is what many in the rail industry call an engineering-led project rather than something that enjoys strong strategic or economic justification. The second fundamental problem is the chaotic ownership and management structures that will almost certainly lead to the squandering of investment capital.

ABSENCE OF STRATEGY

Strategic clarity – such as the importance of ensuring investment in rail infrastructure rebalances from the south-east to other nations and regions, and the imperative to cut carbon emissions dramatically across all transport networks – is imperative number one. In its absence, it is difficult to draw strong conclusions on the efficacy of investments, but they should almost certainly start in the regions of the UK that are investment-starved in general, and that have lost out to London in transport spend by a factor of up to four-to-one. Continuing to focus transport investment on London will ultimately further compound the problem.

In this context, does the UK need separated high-speed rail lines or more capacity for rail journeys that are integrated into the existing system? Either way there will be trade-offs.

If we build a separate, high-speed network, then we add another tier to the UK's transport infrastructure. This means very fast point-to-point journey times, but limits connectivity, partly due to the relationship between speed and connectivity, and partly because of cost. For instance, HS2 will not link into Birmingham New Street because it would cost a large sum of extra capital to drive new, high-speed lines right into Birmingham while sending the HS2 trains onto the classic network into New Street would slow services down. However, developing Curzon Street as a bespoke high-speed station sacrifices connectivity and requires new second- and third-tier infrastructure to link it into other rail lines and modes.

If we augment the existing network, which the second part of this report explores, then connectivity will be relatively seamless, but services will be slower overall, although end-to-end journey times may not be that much greater. In this way, investment can serve more places and passengers, but at the expense of developing something that introduces a whole new tier of very fast rail travel.

The current government and its two predecessors have chosen the separate high-speed option. It is likely that this is the wrong decision in the current UK context, where we know vast swathes of the nation are being economically and logistically left behind. That does not mean new rail lines are not necessary, but that all of our focus and attention should be on the reconnection of places that have been

excluded from the recent economic and political story of the UK.

NEF finds that HS2 does the opposite of this. Not only is it primarily aimed at benefitting long-distance business travellers, but according to HS2 Ltd's own, most recent appraisal of the scheme, 40% of the passenger benefits that underpin HS2's economic case will accrue to London. In 2017, London was worth 23.1% of UK gross value added (GVA). In 1997, London's share was 18.4%. So even if London increased its share of UK GVA over the next 20 years at twice the rate of the past 20 (an extreme scenario), then it will still be worth less than 30% by 2037. By this measure, HS2 will deepen existing regional inequality. In other words, an absence of strategy serves to reinforce hegemonic economic imbalances.

A further finding of this report is that, using the data available on passenger movements across the network, it is clear that the interlinked problems of congestion and crowding on the rail network are mainly due to commuting. HS2 will not primarily be a commuter line, but it will free up capacity for more services for commuters, especially at the southern end of the West Coast Main Line (WCML) between London Euston and Milton Keynes. Over longer distances (i.e. beyond commuter distances), only around half the seats available on services on the west coast are filled. So while extra commuting capacity will ease the problem, HS2 seems like a very indirect way of providing it.

The issues of regional imbalance and London-centric commuter congestion and crowding are inextricably linked. While rail infrastructure does not in itself pattern economic development, it is an enabler. Unless a strategy to shift transport investment away from the south-east is accompanied by a concerted economic plan to rebalance the economy, one will simply reinforce the other; HS2 will end up a self-fulfilling prophecy, mainlining more and more passengers directly into the capital's centre.

It could, however, end up being even worse. So far, Parliament has only consented to Phase 1 of HS2, which takes the line as far as Birmingham. Phases 2a and 2b will connect the new high-speed line to the WCML and East Coast Main Line (ECML), respectively, via Crewe, Manchester, and Leeds.

Recently, because of growing concerns about HS2's escalating cost, Secretary of State for Transport Chris Grayling has given assurances that the absolute sum of money available for the both phases is the current cost projection of almost £56 billion. However, if Phase 1 costs overrun, as already seems likely, and no further money is available, what will this mean for Phase 2? At best, there will be an awkward decision awaiting a future government. At worst, the line could stop short, not even connecting core northern cities.

Freight also deserves a mention. The volume of goods carried by UK railways is growing again after contracting due to the demise of coal production and consumption. HS2 could free up space for around three extra freight trains per hour on the WCML, but due to the uncertainty about exactly how the extra capacity will be timetabled (no post-HS2-modelled timetables have yet been published by the Department for Transport (DfT)), this is no slam-dunk for freight. Plus with tens of new high-speed passenger trains per hour occupying the existing mainlines north of Leeds and Manchester, HS2 could give with one hand and take with the other.

Seventeen per cent of road transport emissions are due to freight. Arguably, carrying more goods should be at the very centre of any new rail strategy, with the benefit that new freight lines

would be cheaper to build and could be routed more conveniently due to their relatively slow speed. New freight pathways across the rail network could also be focussed around a plan for the economy and rail strategy that could be as non-south-east-centric as passenger services.

LACK OF COORDINATION

The government's root and branch review will focus significantly on the way the rail network is organised and governed. It is unlikely, however, that this will go as far as to challenge the existence of privately operated rail franchises. And yet not only is this needed because of the sucking out of profit – in 2017/2018, Virgin Rail and Stagecoach paid £51.2 million in dividends to shareholders for their joint operations on the WCML[1] – but also because multiple vertical and horizontal layers in the rail industry almost certainly lead to higher investment costs and poor coordination.

As an example of this, in our research we have used a factor of more than £4 million per single-track kilometre as the unit cost of electrifying existing lines because that is what the literature suggests it has and may cost. However, in two recent Scottish projects, the cost was less than £1.5 million per single-track kilometre. The geography, population density, low distances between settlements and the intensity of use of existing lines in England almost certainly mean we can expect infrastructure to cost more. But rail experts have told us that some of this high cost is due to poor organisation and coordination across the network, which also leads to job and skills disruption. This must be eradicated.

Though seemingly on a small scale related to this, the private operation of passenger services limits public access to key data sets needed to make accurate assumptions about strategic need. Due to a 2013 judicial review, the DfT has released aggregate data showing the numbers of passengers on departing and arriving trains at key stations in the UK on sample days. But details of how many board specific services and where they leave trains are held back as commercially confidential. Similarly, the handbook produced to help forecast future UK rail demand is subscription only, costs almost £15,000 for access, and requires organisations to go through a vetting process. If rail is a public service, then all of this data should be available publicly.

CONCLUSIONS

NEF concludes that HS2 should once again be opened up to independent scrutiny. We examine both the economic and strategic cases in detail and find that both are open to question.

Relatively small variations in assumptions in HS2's economic justification, such as construction cost overruns, use by more leisure and fewer business travellers (whose time is almost certainly over-valued), or generally lower ticket sales, brings the ratio of benefits to costs down close to parity. This would be judged as 'low' or 'medium' value for money under UK Treasury rules and would not normally gain consent.

However, consent can be given if there is a very compelling strategic case. With HS2 there is not. In NEF's view, the decision to focus on an almost entirely separate, ultra-high-speed network and begin building it in the south-east of England misses opportunities to connect more people and places and concentrates the benefits in London. Its benefits to rail freight are also questionable and dependent on subsequent timetable changes on the WCML; there has as yet been no government estimates of post-HS2 timetables.

£4 billion has already been spent, but this sunk cost is not a reason to spend a further £50 billion or more of public investment. Before further cost is sunk in HS2, a full and independent inquiry is needed – the government's root and branch rail review could perform this function if its scope and method were broadened and taken out of the DfT.

We also conclude – with absolute certainty – that the existing rail network as a whole needs significant investment; it is not a choice between HS2 or nothing but a question of strategically purposeful investment everywhere. Critically, this should benefit the widest number of passengers possible and not just the relatively wealthy, those travelling long distances for business, and those in London.

While London commuters face crowded trains each morning and evening, they are far from being the only daily standing passengers on the network. Arguably northern cities face commuter congestion and crowding that is just as acute and, given all of the very obvious arguments about the need to rebalance the economy, it is regions such as the north of England, the Midlands, south Wales, and central Scotland that should benefit from large sums of government investment first.

Based on a review of existing literature on proposed improvements or on actual costs of comparable projects elsewhere on the network, we make some estimates of the costs of a comprehensive programme of incremental investment in the existing network. These would bring widespread benefits and ease the passage of more freight, totalling almost £55.2 billion.

RECOMMENDATIONS

NEF proposes a **national rail investment fund to provide a guaranteed supply of finance to strategically important schemes over the next decade**. This should aim to bring benefits to travellers everywhere, support economic rebalancing and resurgent economies in many smaller cities and towns, create good jobs and aid rapid transport decarbonisation, especially through electrification and freight modal shift to rail.

HS2 should be the subject of an urgent and independent review. If the government will not commit to including this in its root and branch review, then opposition parties should demand it. Ideally this would be passenger-led, with a chair appointed primarily to represent passenger interest. All data and insight on current a future passenger usage should be made available if such a review were commissioned.

Future investment should be guided by a **national rail strategy** that is firmly linked to an over-arching vision for the economy. This should be developed with the involvement of all key stakeholders and not just private sector operators, including rail workers and unions, freight users, regional and local authorities and their strategic transport agencies, and passengers. It is hard to imagine that a significant rebalancing of investment from south-east to north and transport decarbonisation will not be significant factors in this.

This report advances **a comprehensive programme of investment across the whole rail network**. This includes a series of critical projects for northern rail connectivity, which we estimate will cost £18.9 billion. It also

includes wide-spread electrification; the re-opening of several lines that could provide a cheaper means of increasing capacity; and comprehensive upgrades to the ECML, WCML, and Midland Main Line MML. We estimate the total cost of all these schemes at around £55.2 billion.

Some of these investments will be necessary almost regardless of future direction and purpose. While strategy is devised, we recommend that interventions, such as the long-promised electrification of the entire Newcastle to Liverpool Trans-Pennine route or the reopening of a fourth east–west link in northern England, linking Manchester to Sheffield via Woodhead, are prioritised.

Related to this, we note that welcome changes to the DfT's appraisal methodology are not sufficient and, as Diane Coyle and Marianne Sensier (2018) put it in their paper for Cambridge University's Bennett Institute,'… although evidence-based appraisal is important, infrastructure investments also need to be based on a strategic view about economic development for the whole of the UK.' As part of the development of a new strategy for rail, **appraisal methodology should be aligned with new strategic goals**.

There is no doubt that the skew towards particular types of passenger produces results that prejudice self-fulfilling prophecy investments in London and the south-east. Value for public money is important, but this concept should have strategy at its heart. While it is possible to argue that HS2 has a passable ratio of benefits to costs, this is only so because of the way the current methodology evaluates different people's time and is blind to spatial inequality.

We also argue that **the railways should be viewed as an industrial sector** in their own right and that, in the interests of capturing more of the value of the industry and its supply chains in the UK, they should be the subject of a sectoral industrial strategy.

Finally, as the government moves through its root and branch rail review, it should leave no stone unturned. It should include the **opening up of data concerning passenger movements across the different franchises** that will allow anyone interested in understanding the current operating patterns of UK railways and future projections full access to insights on a par with all private sector entities.

INTRODUCTION

The UK rail network is in dire need of investment. While growth in the total number of journeys taken on the network shows signs of slowing and actually fell in 2017/2018 for the first time since the recession of 2009/2010, long-term trends suggest growth, on top of a doubling of journeys since the mid-1990s. By how much demand for rail travel will grow is dependent on a range of factors related to population, the economy and use of other modes of transport and there is a debate among transport policy experts as to the efficacy of the forecasts upon which the case for HS2 is based.[3]

Many commuter services around major cities are overcrowded, and there are many pinch points and capacity challenges across the network. Trains are less punctual than they were a decade ago and their Public Performance Measure (PPM – a combination of punctuality and reliability) has been in decline since 2011. 2018 marked a low point with around 85% arriving within 5 (for regional services) or 10 (for long-distance services) minutes of their scheduled time compared to 91% in 2011.[4,5]

The harsh tail of winter and the long, hot summer of 2018 served up a wide range of technical challenges, but also coincided with disastrous timetable changes on several lines, including Govia Thameslink and Northern. This has drawn from government the timely promise of a root and branch review of UK railways.[6]

Such a review is welcome, as an over-arching strategy for the railways – or moreover a wider surface transport strategy to integrate different modes across a national network and rapidly decarbonise – is currently absent. Concern is growing about the fragmented and multi-layered system governing rail travel and hence about the efficacy of investment in the current system. However, not all of the roots and branches of the network's problems will be open to scrutiny as the DfT has ruled HS2 and Control Package 6, Network Rail's already-agreed 5-year programme of maintenance and upgrades, out of the scope of its review.

The review will hopefully reopen some recent decisions – perhaps most notably that in the summer of 2017, planned electrification schemes were cancelled,[7] including in south Wales and on the MML. Though at the time the DfT argued that new bi-mode

(diesel and electric powered) trains were superseding the need for line electrification, a subsequent inquiry by the National Audit Office (NAO) found that the main reason for the shelving of plans was cost.[8]

Analysis of the investments that have been made in the railways and in other surface transport infrastructure suggests that they have tended to benefit London and the south-east of England to a much greater extent than other regions, especially the north.[9,10] This is set to continue. Recent analysis from IPPR North of planned transport infrastructure spending data suggests that London will receive £4155 per capita, compared to just £1600 in the north as a whole.[11]

In this context, the early 2017 enthusiasm of policymakers for a significant, national investment in HS2 – a scheme that will link northern cities with the West Midlands and London via an entirely new, ultra-high-speed line – is welcome. The bill consenting to Phase 1, between London's Euston station and Birmingham, was passed by Parliament with a majority 451 to 50.

However, support for HS2 – never strong among the wider public[12,13] – is waning in political terms, in part due to concerns over escalating costs, but also for a variety of other reasons. These include its limited connectivity with other parts of the rail network, its south-east bias, its impact on other lines, and its likely passenger profile, with perhaps a majority of those using the service travelling for business purposes.

Recent press reports have also focussed on the viability of Phases 2a and 2b, which extend high-speed lines beyond Birmingham to Manchester, Leeds, and York. While open to a variety of interpretations, Secretary of State for Transport Chris Grayling's recent suggestion that the northern phases of

UK TRANSPORT FACT FILE[14]

- There were 1.71 billion passenger journeys in 2017/2018 on UK railways, up more than 100% compared to pre-privatisation.
- The average distance travelled on the railways is 29 miles, compared to the average car journey of around 9 miles.
- Almost 70% of 2016/2017 rail travel journeys took place in London and the south-east, whereas 8% were long distance, that is, between regions.
- Rail usage fell slightly in 2017/2018 for the first time since the 2009/2010 recession, but is growing again – albeit slowly – in 2018/2019.
- Though, by all measures, UK rail travel has grown faster than other modes of transport, car, van, and taxi usage is still around 10 times greater in terms of distance travelled.
- Total freight carried on the railways has not increased in recent years due to the decline of coal for power generation; roughly twice as much construction and consumer freight is now transported by rail compared with the late 1990s.[15]
- Domestic air travel has not grown significantly over the same time period, with 19.57 million passengers taking domestic flights in 2000 compared to 22.07 million in 2015.
- Flights between London (LHR, LGW, and STN) and Edinburgh, Glasgow, and Inverness account for around 25% of all UK domestic passengers.[16]

the line are 'not yet in the bag' is true in the sense that only Phase 1 has so far achieved Parliamentary assent.[17]

If the political debate around HS2 becomes more negative, then Phase 2 is vulnerable because it has not yet been approved.[18] Moreover, if as Mr Grayling says, the total capital expenditure available to HS2 Ltd (the government-owned company set up to deliver the project) remains fixed at its current level and Phase 1 (the stretch from London to Birmingham) costs overrun, then Phase 2 which links northern cities may be in jeopardy. Even in real terms, the projected costs of the project have almost doubled since first appraised in 2011 (see section 2.2). Some – even government commissioned – recent assessments and the international literature on such projects suggest that cost overruns are likely. Phase 1 without Phase 2a, which takes the ultra-fast line as far as Crewe makes little strategic or economic sense. But Phases 1 and 2a without 2b, which links Greater Manchester and Yorkshire into the new network, would be even more nonsensical.

Having reviewed the strategic case for HS2, the result of which we lay out in Section 1, it is our view that the justification for the whole scheme as currently planned is weak and must be revisited as a matter of urgency. But without interconnection to some of the main cities of the north of England, the relatively weak strategic justification for HS2 would be destroyed entirely. And yet cost escalation seems likely, and is forecast by credible and, in some cases, DfT-commissioned studies. If Phase 1 costs more than currently forecast, then a tough decision awaits a post-2022 government about whether to dig deeper into the public purse and proceed, or whether to cut losses and make the most of a very fast, new London–Crewe line.

It is also worth noting that while this report focuses on the strategic and economic case for HS2, concerns about escalating costs, northern connectivity, and the intractable problems of commuting into and out of the UK's major centres of population, it is hard not to observe that, in the absence of a wider, long-term strategy for UK railways, such judgements will always be narrow and partial. It seems to us that, if a root and branch review is worth undertaking, it should not only consider the role of HS2 in the wider rail network and the whole pattern of investments in the UK railways, but it should also consider how these compare and connect with local and regional public transport, how they help take passengers and goods off higher carbon forms of travel, and how the whole network is governed to ease and speed everyone's experience.

1. HS2'S STRATEGIC CASE

There is no over-arching strategy for the UK rail network. Moreover, due to the privatised nature of train franchise operation – and because access to detailed passenger data from train operators is denied due to commercial confidentiality – it is difficult for researchers outside of government and network operators to build an accurate picture of where the problems on the network lie, when they occur, and therefore whether or not HS2 addresses them. It is imperative that, in the process of reviewing the railways, this data is opened up to public scrutiny, especially as it is acquired in the process of delivering a public service on publicly funded franchises.

What is clear, however, from a review of the available evidence, is that that the congestion (ie the number of trains on a given section of track) and crowding (number of people on a given train) issues on the UK rail network are concentrated around major UK cities and focussed on peak travel times, especially the evening peak. While one, new rail line can never address the totality of these issues, which are distributed across the UK, the key question is to what extent does HS2 deliver, especially given its high cost (the sensitivities of which are explored in Section 2)?

HS2 has two stated strategic objectives:[19]

- **The capacity objective** is to create sufficient capacity to provide for long-term demand for rail travel and improve rail network resilience and reliability, ensuring that people and goods are able to make the journeys they want.
- **The connectivity objective** is to improve journey times, making travel quicker, easier, more punctual, and more convenient for people and goods, including supporting end-to-end journeys with effective integration and interchange between transport modes and with good connections, including with major airports, for international travel.

By 2036,[20] the DfT and HS2 Ltd say the line will carry more than 300,000 passengers per day,[21,22] reducing their journey times between Birmingham and London to 49 minutes and between Manchester and London to 67 minutes.

In the lengthy approval process, there has been significant debate about the accuracy of the passenger growth forecasts that underpins these projections.23 To get to the levels forecast for HS2 in 2036 requires average annual growth rates of

between 2.2% and 3.0%, depending on the route.[24] Plus demand forecasts have been revised upwards in recent years. As Andrew Tyrie MP, then chair of the Treasury Select Committee, pointed out in a letter to Chris Grayling, without these revisions the project would fall into the 'low' value-for-money category.[25]

The rate of growth of journeys on the UK rail network has slowed from a peak of around 8% in 2011/2012 to around 4% in 2016/2017. In 2017/2018 (due, according to the DfT, to a combination of bad weather, disruptive engineering works, and industrial action), the number of journeys fell for the first time since the 2008/2009 recession, by 1.4%.[26] Most of this fall in numbers took place in London and the south-east. The growth trend has since returned.

The majority (57%) of rail journeys are for commuting and it is commuters who have driven the growth in rail journeys over the past decade; their number has grown by more than 50%.[27] Fewer than 10% of rail passengers are business travellers, though in HS2 projections, inasmuch as it is possible to glean, around half of its passengers are expected to be travelling for business purposes (which also drives up the projected benefits of the scheme as business travellers' time attracts a high value in DfT models; Section 2.1).[28]

As the Independent Transport Commission (ITC) notes:

> *…it is evident that policy making in a wide range of fields outside transport can strongly affect passenger rail demand. Land use and planning policy changes, particularly when these influence the location of residential and employment growth, should be examined for their likely influence upon travel patterns and rail demand. In addition, the development of employment policies and industrial strategy, where these are designed to change the industrial structure of the economy, should take into account the likely impacts upon demand for rail as well as other modes.*[29]

In other words – in a theme we return to throughout this report – it is important that rail investment accompanies a wider transport strategy that is, in turn, linked to an economic and industrial strategy. As ITC also shows, growth in commuting in recent years has been driven significantly by changes in the nature of work – agglomeration in cities, for instance – in relation to where people live and also by planning policy. Changes in these trends, which in themselves are wholly or partly policy-driven, will lead to changes in rail demand.[30]

To undertake a detailed assessment of rail demand at NEF – and to provide a critique of the assumptions made by the DfT in its forecasting, including exogenous trends in the wider economy and in policy – we would need access to the Passenger Demand Forecasting Council (PDFC) handbook.[31] The Handbook is only available to PDFC members and associate members; associate membership costs £4,385 per year for a minimum of three years and has to be approved by PDFC executives.

The PDFC is a function of the Rail Delivery Group, which is the successor to the Association of Train Operating Companies (ATOC) brought into being following the 2011 McNulty report into rail value for money.[32] In effect, data concerning current and future passenger trends, culled from public sources such as the National Travel Survey, is in private hands and while there is plenty of literature available exploring various aspects of the handbook,[33] as passenger forecasting is of national strategic importance and concerns public service, it should be publicly available, as should detailed data on passenger movements.

Despite the growth in rail commuter journeys, HS2 will not primarily be a commuter line as it will visit few stations, emphasising high speed over longer distances, though it could expand commuter distances (ie people living in Birmingham could commute more easily into London). The DfT and HS2 Ltd cite overcrowding on the WCML as one of the primary reasons for investing in HS2, focussing on both the number of intercity trains and the number of available seats on these trains.[34]

The logic of HS2 is that it will provide more opportunities for longer distance travellers and thereby free up capacity on the existing lines for more commuters, easing crowding. However, as the Stop HS2 campaign has suggested, the extension of this logic is that, once HS2 is up and running, there would be fewer intercity trains on the core lines – especially the WCML – which will mean less frequent trains to stations in the Midlands and north-west that are not served by HS2.[35]

Just as with passenger forecasts, detailed data about passenger flows is not available. Following a 2013 judicial review, the DfT now publishes aggregate passenger data into and out of UK stations, which shows where there is crowding on trains at the their point of departure or arrival.[36] For instance it shows that 'on a typical autumn day' in 2017, trains arriving or departing Euston station between 07.00 and 08.59 carried more passengers than there were seats.[37] However, it also shows that across the rest of the day, seats significantly outnumbered passengers and, in total across the day, 81,557 passengers arrived or departed on trains with a capacity of 134,871 seats.[38]

The daily capacity peak in almost all locations is, unsurprisingly, across the morning and evening rush hours, commensurate with the growth in commuting. Many of the commuter services arriving at or leaving London stations in these periods are crowded in standard class, though ticket pricing can also create extreme crowding on services that fall either side of designated peak hours. Eight of the DfT's most recent top 10 overcrowded trains, from data compiled in autumn 2017, leave or arrive from one of London's stations, with the critical load point (ie the point of maximum crowding) being at the London station.[39]

In the strategic case for HS2, the narrative focusses specifically on commuter services into and out of Euston, the London mainline station providing the most frequent and direct services to the West Midlands and the north-west of England. While many services into and out of London are undeniably crowded and carrying significantly more than 100% capacity, the stations at which there are higher passenger number and more and more frequent crowded arrivals and departures are Waterloo, London Bridge, and Victoria. HS2 will not have an impact on crowding at these stations or in congestion on lines to the west, south-west, south, or east of London.

Only one of 2017's top 10 most crowded trains is a Euston service (the 17.46 West Midlands Trains service to Crewe, operating under the brand London Northwestern Railway). In the absence of detailed passenger data from the train operator, we can only estimate the pattern of crowding on this train, but it is highly likely to be typical of many of the other services leaving Euston over the evening peak time, especially as it is fast to Milton Keynes Central. A significant number of people on West Midlands Trains to Birmingham New Street and Crewe, or Virgin Trains to Birmingham or further afield are homebound commuters who disembark at Milton Keynes or before, or perhaps go as far as Rugby.

EVENING COMMUTER SERVICES FROM EUSTON TO MILTON KEYNES

NEF conducted an informal census on the platform of Milton Keynes Central during the evening peak period of Wednesday, 19th December 2018. This was unscientific and involved rough visual estimates of passengers using Virgin and London Northwestern Railway trains disembarking versus those remaining on trains heading further north.

The large majority of Milton Keynes commuter services in the evening peak time are London Northwestern Railway services. Many of these services go on to Birmingham, Crewe, and Liverpool; however, generally only around 4 of the 12 carriages leaving Euston continue, taking more than two hours. Most of the seats are therefore taken up by returning commuters. We found:

The train leaving London at 17:13 had around 290 people getting off at Milton Keynes (12 coaches).

The train leaving London at 18:13 had around 340 people getting off at Milton Keynes (12 coaches).

The stopping services which take longer to get to Milton Keynes are typically pretty empty when they arrive and only drop around 50 people.

There are a number of Virgin Trains heading north out of Euston, but only some of them drop passengers in Milton Keynes.

The 18:43 had 11 coaches (4 first class) and about 330 got out at Milton Keynes (the capacity of Pendolino Class 390 trains is around 390).

The 19:10 and 19:20, the first off-peak services, had 10 and 11 coaches, respectively. Again around 330 left at Milton Keynes.

There other Virgin Trains that stop in Milton Keynes going north are advertised as only picking up passengers. The 18:13 arrival in Milton Keynes and the 18:50 arrival only picked up a small number of people. But notably, both only had 9 coaches (3 first class) and did not look completely full.

On all of these services, the majority of passengers were seated in standard class. The first class sections of all trains (99 seats on a 9-car Virgin Pendolino, 136 for an 11-car unit) were only partly occupied.

All of the top 10 most crowded trains in the UK are crowded because they carry commuter passengers. The same is suggested by the data that is publicly available and by NEF's informal census. Even if they are longer distance or intercity services, in all ten cases, the critical load point is over a relatively short, commuter distance at a peak morning or evening hour.[40]

In autumn 2017, the most overcrowded train was a TransPennine Express service that left Glasgow at 04.22 bound for Manchester Airport. But its critical load point was not until 08.24 when the train reached Wigan – within commuting distance of central Manchester – where after it was 212% full until Manchester Oxford Road. The DfT notes that, because of timetabling constraints, this train no longer stops at Wigan. The service is therefore unlikely to appear in the top 10 in future surveys.

TABLE 1: THE 10 MOST OVERCROWDED PEAK TRAIN SERVICES IN MAJOR CITIES IN ENGLAND AND WALES, AUTUMN 2017

RANK	CITY	CRITICAL LOAD POINT	TIME AT CRITICAL LOAD POINT	TRAIN OPERATING COMPANY	SERVICE DETAILS	NUMBER OF CARS	STANDARD CLASS PASSENGER CAPACITY	STANDARD CLASS PASSENGER LOAD	PASSENGERS IN EXCESS OF CAPACITY	STANDARD CLASS LOAD FACTOR
1	Manchester	Manchester Oxford Road	8:24	TransPennine Express	04:22 Glasgow Central to Manchester Airport	4	191	403	212	211%
2	Manchester	Manchester Oxford Road	16:19	TransPennine Express	16:00 Manchester Airport to Edinburgh	4	191	387	196	202%
3	London	London Kings Cross	16:16	Great Northern	16:16 Kings Cross to Royston	4	239	475	236	199%
4	London	London Bridge	8:20	Southern	07:16 East Grinstead to London Bridge	12	640	1220	580	191%
5	London	London Euston	17:46	West Midlands Trains	17:46 London Euston to Crewe	8	412	769	357	187%
6	London	London Bridge	8:24	Southern	07:27 Reigate to London Bridge	12	669	1191	522	178%
7	London	London Waterloo	8:19	South Western Railway	07:32 Woking to London Waterloo	12	720	1267	547	176%
8	London	London Bridge	8:44	Southern	06:54 Bognor Regis to London Bridge	12	669	1175	506	176%
9	London	London Blackfriars	8:20	Thameslink	06:57 Brighton to Bedford	12	638	1115	477	175%
10	London	London Waterloo	7:49	South Western Railway	07:02 Woking to Waterloo	12	720	1235	515	172%

If the growth trend in rail journeys continues, then more capacity on the network will undeniably be required. NEF and many of those we have spoken to are hugely in favour of more high-speed rail in the UK as part of the solution to this. But it is important to be clear on the structure of the problems this introduces.

The **train crowding capacity problem** is therefore almost certainly primarily related to the growth in commuting, which in turn is related to nature of the UK economy, with economic activity heavily concentrated in major urban centres and increasingly sucked into London. While more services and lines (hence Crossrails 1 and 2) will provide relief to these problems, they are intractable as they are linked to London-centric and central business-district-focussed growth strategies (which are often simply an absence of strategy). Easing crowding on these services by displacing long-distance

travellers onto a bespoke line will have an impact, but based on the publicly available data and our own, informal census, on the WCML, it will have a marginal impact on crowding and would not even part-fill HS2 services.

HS2 is, however, also conceived of in relation to an assumption of significant continued growth in rail passenger numbers. But if many trains leaving or arriving at Euston across a typical day are less than half full, as the available data suggests, then HS2 must create additional journeys, even in relation to those in passenger growth forecasts, if its trains are to carry 300,000 people per day.

If these were displaced from roads or domestic flights, then the strategic case for a bespoke high-speed network maybe stronger, but according to the DfT's own forecasts, when the full network is complete, only 1% of passengers are likely to be people who would have flown, and only 4% people who would have driven. By contrast, it is expected that 69% will have been displaced from the classic rail network and 26% would not otherwise have travelled at all.[41]

Critically, though, a change in economic strategy, including a serious focus on spatial north-south rebalancing of the UK economy, would have a significant impact on passenger forecasts.[42] A successful rebalancing of the economy between English regions would also probably be the only viable, long-term way in which the ever-growing pressure on London commuter services would be ultimately eased.

The **network capacity problem**, caused by a maximum number of trains on the same lines on parts of network is linked to this, too; on the WCML, for instance, commuting into and out of London, Birmingham, and Manchester causes congestion along the length of the line. But in addition, the three core, north–south lines linking London, the Midlands, the north, and Scotland, all suffer from 'technical' pinch points such as a narrowing of lines from four tracks to two and regional and freight services crossing without grade separation.

Further, beyond the three north–south lines, network capacity and crowding problems are just as profound. The most important and acute example of this is travelling east–west–east across the north of England. Not only on the railways, but by all modes of transport, journeys between Manchester, Liverpool, Leeds, Sheffield, York, and Hull at peak hours are suffering major crunch points and demand just as urgent attention as the three core lines running north-south. In the meantime, Wales and other English regions such as the south-west and north-east are relatively 'rail poor' and need additional infrastructure to support economic development.

WHY HS2 MAY NOT SOLVE KEY PROBLEMS ON THE EXISTING NETWORK: AN EXAMPLE

The south end of the WCML is a four-track railway, with a pair of fast lines, used by 100/110/125 mph fast passenger trains, and a pair of slow lines used by stopping and semi-fast passenger services and freight.

During the day, there are typically 12 trains an hour each way on the fast lines (more at peak periods), with no possibility of freight operation. So all freight trains, which mostly operate at 75 mph (some only at 60 mph), have to use the slow lines (in practice, the 75 mph intermodal trains often end up going more slowly because they catch up with stopping passenger services).

HS2 releases a chunk of fast-line capacity as, after it opens, many intercity services will transfer to the new line. But unless the business case for intercity on the WCML collapses, there could still be something like eight fast passenger services an hour, providing fast commuter trains to Milton Keynes and Northampton, and residual intercity services to places such as Coventry, Wolverhampton, Nuneaton, Tamworth, Lichfield, Stoke-on-Trent, Chester, and north Wales.

These relatively fast services are likely to be spread across the hour in each direction to give Milton Keynes a 15-minute frequency (dealing with the commuter crowding problem). There may still be too many fast services to allow freight trains to run on the fast lines; they will continue to have to thread their way through the slower passenger services.

This is not necessarily how the additional capacity on the WCML would be used, but for freight to be the main beneficiary (and not London commuters), a strategic decision would be needed along with timetables that reflected this and made space for freight. This is not in itself a flaw in HS2, but an insight into the strategic challenges of the network and of the need to set any new investment of the heft of HS2 into a wider strategic approach.

HS2 will contribute to the easing of London's commuting problem, primarily for services on the WCML using Euston, but also when connected to Leeds and York on the ECML and MML. It will do less to ease crowding on services to and from northern cities; the regional distribution of the passenger benefits of HS2, published in HS2 Ltd's most recent scheme appraisal (2017), suggests that less than one-third accrue to the north of England, largely to be divided between the six cities (Manchester, Liverpool, Leeds, Sheffield, York, and Hull).[43]

What we can, therefore, say about HS2 and the capacity objective is:

1. The capacity crunch that HS2 is most equipped to address is essentially created by London commuters using Euston – it will displace longer distance travellers from these services and free up space for commuters. Projections by HS2 Ltd and also the nature of the scheme – its relatively few stops and limited interconnection with the rest of the network – suggest it will have limited impact on capacity issues elsewhere. Plus it cannot address commuting capacity to the west, south-west, or south of London.

2. Bearing in mind the other capacity issue of congestion on the core main lines, because HS2 will stop infrequently, it can only achieve its effect on London commuting

if it also has the effect of reducing intercity services on these lines (ie to free up services to for those travelling into and out of London). This has significant implications for longer distance services linking towns and cities not on the new HS2 line; these include places such as Northampton, Coventry, Stafford, Stoke, Preston and many others that are often deemed as 'left behind'.

3. Even if HS2 has a significant impact on commuting into and out of London, Birmingham, Manchester and Leeds by freeing up capacity on the core lines, many other equally acute crunch points across the network – most notably between the cities of the north, will only be addressed by further interventions in those places. This includes the routes HS2 trains will take once they leave the new lines and travel on to Glasgow or Edinburgh on the classic lines.

We therefore think HS2 is likely to fail to address most of the main capacity issues on the existing rail network. That is not to say that additional rail lines will not be needed. In the context of taking traffic off the roads and competing with domestic aviation, more and faster rail journeys are highly desirable. But during the preparation of this report rail experts have told us that it is an 'engineering-led' and not a strategy- or market-led project.

This means:

- It is a victim of its design, being focussed on shaving minutes off journey times rather than providing interconnection to offer genuine and seamless augmentation to the existing network.

- Its use of Birmingham Curzon Street is a clear example of this. Chosen to help maximise time savings and also as a focal point for Birmingham regeneration, Curzon Street is around 10 minutes' walk from Birmingham New Street, which is the main station for the WCML. Passengers travelling to or from towns and cities in the north-west that are not served by HS2 will have to make an interchange, erasing some of the time saved by using HS2.

- En route, HS2 misses a host of population centres, such as Northampton, Coventry, Derby, and Nottingham in the Midlands; Doncaster, Barnsley, Bradford, and other destinations on the north-eastern fork; and Stafford, Stoke and Crewe to the north-west. It stops short of York, Wigan, and Liverpool, defaulting to the classic lines and its only other interconnection with the existing network is on its loop via Chesterfield and Sheffield and on the branch-off at Litchfield.

- Rail experts have told us it will reduce capacity into and out of Euston, which may also affect the number and diversity of WCML services.

- Its sheer speed and hence the necessary straight-line nature of the route, and the need to construct five brand new stations are all factors in its very high cost. A more strategically focussed design compromising some speed for more and better interconnection would almost certainly be cheaper and likely to solve more capacity problems. It would also reduce the line's demand for electricity, which is also high due to its very high speed.

Because of the engineering-led nature of HS2 as currently designed, not only are we building a very expensive new line that addresses few of today's network-wide capacity problems, but we are also missing an opportunity to boost the capacity of the network as

TABLE 2: REGIONAL BENEFITS

An illustrative distribution of benefits according to where a long-distance trip starts and finishes within the PLANET Framework Model, for the modelled year 2037

REGION	FULL NETWORK	PHASE 2A INCREMENT	PHASE 2B INCREMENT
London	40%	43%	36%
South East	3%	3%	3%
West Midlands	12%	1%	5%
North West	18%	39%	13%
East Midlands	4%	1%	7%
Yorkshire and Humber	10%	3%	17%
North East	4%	0%	6%
Scotland	5%	4%	7%
Other (East England, South West, Wales)	3%	5%	4%
Total	**100%***	**100%***	**100%***

* Totals may not always equal 100% due to rounding

a whole by offering passengers more opportunities to come on and off the new network and interconnect.

Bearing all of this in mind, while NEF is very much in favour of government-led investment and of investment in low-carbon forms of transport, HS2 should now face renewed scrutiny from policymakers. If its weak rail-strategic justification is not enough to trigger this, then its economic strategic shortcomings should give rise to very significant questions, especially from northern leaders.

We explore the economic case for HS2 in Section 2, but in a section on strategy it is worth dwelling on the regional distribution of HS2's benefits.

According to HS2 Ltd's figures, 40% of the new line's passenger benefits – largely time saved by a faster and more punctual connection – accrue to London. Only 18%, 12%, and 10% accrue respectively to the north-west, the West Midlands, and Yorkshire and the Humber.[44] Even in the case of Phase 2b, more of the passenger benefits (36%) flow to London than to any other nation or region of the UK.

In 2017, London was worth 23.1% of UK gross value added (GVA). In 1997, it was 18.4% (NEF calculations using ONS[45]). So, even if London increased its share of UK GVA over the next 20 years at twice the rate of the past 20 (an extreme scenario), then it would still be worth less than 30% by 2037. By any reasonable assumption, HS2 is not only reinforcing existing regional imbalances, it is further exaggerating them.

It is likely that the stated wider economic impacts (WEIs), inasmuch as they might exist,[46] would follow a similar pattern. In effect, then, the risk is that HS2 merely reduces commuting times to London and expands the zone from which people commute into the capital.

In a UK in which London is still powering ahead of every other region in economic terms – with GVA growing by 3% in the capital in 2017 compared to an average of 1.9% elsewhere and 0.7% in Yorkshire and the Humber[47] – HS2 is the antithesis of economic rebalancing, further concentrating economic activity and the benefits of government investment in London.

In our conclusions, we reflect further on the strategic context for HS2, but as this section of the report shows, the closer we look at the challenges facing the network and the economy, the less HS2 as currently configured addresses these challenges, and the more it seems like an expensive answer in search of a question.

2. THE BENEFITS AND COSTS OF HS2

All the current problems with the rail network and evidence of two decades of privatisation suggest that significant state investment is now needed. This report makes a clear case for at least the sum of money currently approved for HS2 to be spent on improving capacity and connectivity across the network; more than this may be needed to deliver a rail network that serves most people's interests.

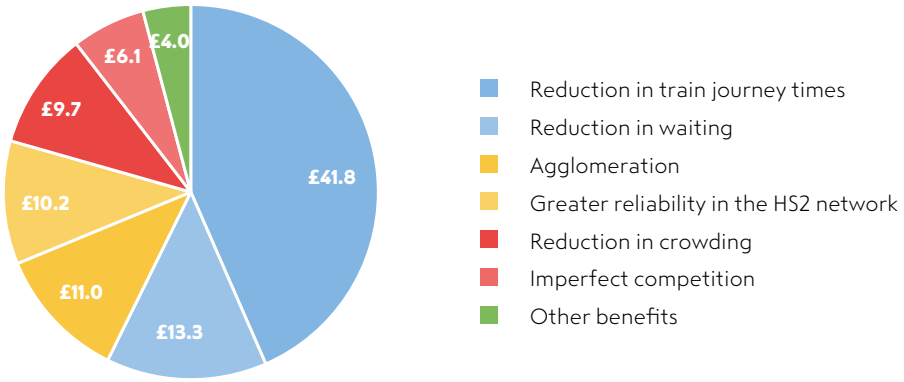
Cost-benefit appraisals of large-scale infrastructure projects, such as HS2, should always be treated with caution as they involve making assumptions that can be contested and projecting costs and benefits out over very large periods of time. But equally, the government is obliged to make value-for-money assessments of investments using public funds and goes to considerable lengths to do so. It is also worth noting that the DfT is also currently considering responses to a consultation on its appraisal methodology, which many have criticised for producing results which reinforce existing economic inequities and imbalances. In 2017, the DfT published a Rebalancing Toolkit[48] for transport appraisal, but it is not clear if or how this has been used in practice.[49]

Value for money should not, however, be the only consideration in weighing up the efficacy of such investments. If strategic rationale is compelling and clearly linked to wider transport and economic strategy that has public backing, then sometimes lower value-for-money projects would be justifiable. So while below, we look at and are critical of the value-for-money case on HS2, if it were accompanied by a clearer strategic justification, then a medium or low ratio of benefits to costs might be justifiable.

2.1 BENEFITS

The economic case for building and running HS2 takes the form of DfT and HS2 (using DfT models) cost-benefit analyses, with the benefits to the UK being weighed up against the capital and operating costs of the project. It is very complex and difficult to construct accurate cost-benefit analyses and far easier to provide a critique of their weaknesses. However, HS2's value-for-money case relies heavily on a few key benefits: a very high valuation of business passenger's travel and waiting time saved. strong forecasts of

FIGURE 1: MAIN CATEGORIES OF PROJECTED BENEFITS FROM HS2 (BENEFIT AMOUNTS IN £BN)



passenger growth. and agglomeration benefits from connecting cities.

The latest version forecasts that the benefits of HS2 will be worth £96.3 billion.[50] The largest share of benefits accrues to passengers in terms of reduced waiting and journey terms.

Reduction in train journey times is by far the largest category of benefit, being estimated at approximately £42 billion in the most recent economic case for HS2.

HS2 will, without doubt, reduce journey times. However, this benefit also depends on increases in demand for rail trips to ensure HS2 trains are relatively full.

Fares on HS2 are yet to be determined and the DfT says they will be comparable to the existing WCML services; indeed HS2 and the existing west-coast franchise will be bundled together in one package, which risks eliminating price competition. By comparison, the current annual ticket price for HS1, connecting St Pancras and the Channel tunnel, is £6,452 (Ashford to St Pancras), whereas an annual season ticket for Cambridge to London – a roughly equivalent distance – on the ECML is £4,952.

It is also expected that many of those using HS2 will be business travellers, whose time in DfT economic models is valued at more than three times that of commuters. This valuation approach could lead to over-optimism in the projection of HS2's benefits if businesses willingness to pay for an hour of their employees time is lower than expected (this is currently based on survey data).

Equally, there is a case to be made that a valuation of £32.16 per hour of business time is too high in absolute terms. The average weekly wage in the private services sector (excluding bonuses) is £462 as of July 2018, whereas a rate of £32.16 per hour over a 35-hour working week equates to £1,126 per week.[51] This means that WebTAG values an employee's time (when it is saved on a train journey) at almost 2.5 times what an employee is paid for that time.

It is also unclear whether the high hourly valuation of business time takes full account of an employee's ability to work productively while on a train. It could be that investing in the quality of service on trains – including ensuring most passengers are able to be seated and enjoy continuous wifi connection – would be very much cheaper and could reduce the cost of travel time rather than reducing travel time itself.

Reductions in waiting (£13 billion), **greater reliability** (£10 billion), and **reduction in crowding** (£10 billion) also form a significant part of the projected benefits of HS2, and are valued in a similar way to time savings.

Waiting is particularly important. In the DfT models, this excludes time attributable to late trains and values waiting time at twice that of time spent on the train, though, from a review of the literature, this could be an over-estimation.[52]

A second category of benefits from HS2 is the WEIs. These differ from transport user benefits in that they accrue to the wider economy, rather than directly to passengers. This means that WEIs are more theoretical in nature and therefore more open to question.

The largest category of WEIs forecast for HS2 is **agglomeration benefits**, which account for £11 billion of estimated benefits. These are intended to represent an increase in productivity that could occur as a result of increased interconnection between the places served by HS2 (ie bringing places closer together through the availability of a faster transport link).

The agglomeration impact is calculated by forecasting the increase in interconnectivity (ie how accessible the jobs in other parts of the HS2 network are to people living at a given point on that network), and multiplying by a standard elasticity (which represents how the increase in interconnectivity translates into higher productivity). There are potential issues with this approach:

- Although economists have explored the issue significantly, the relationship between transport infrastructure and productivity is unclear, mostly untested and hence contested.[53,54,55] Therefore, the DfT's assumptions may be seen as speculative at best.

- The department's WebTAG method of calculating wider economic impacts rely on Graham *et al*,[56] and use a model that imposes restrictions on the relationship between agglomeration and firm productivity. When these assumptions are relaxed, the strength of the key agglomeration effect falls by 95%.[57] We reflect this in our sensitivity analysis below.

- Even if the calculated agglomeration benefits in the DfT's modelling of HS2 are valid, there are more in Phase 2b than in Phases 1 or 2a. The full agglomeration benefit could only be achieved if all phases are built.

- The extent to which large-scale spatial transport infrastructure – between regions – should be prioritised for agglomeration-type effects, versus intra-regional infrastructural investment is also increasingly contested.[58]

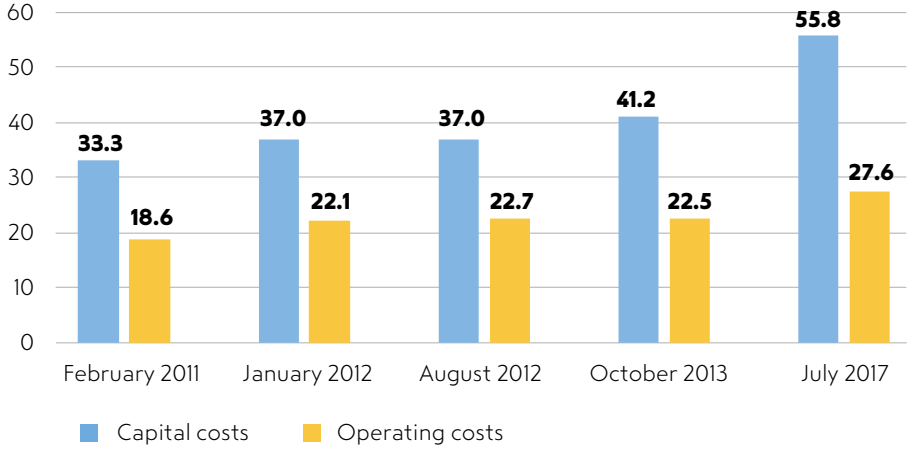
- If productivity is a key aim of transport infrastructure, then it should be focussed on where the UK's productivity problem is at its most acute. Workers in the north-west produce 2.7% less per hour than the UK average; in Yorkshire and the Humber there is a gap of 5.8%.[59] HS2 will not begin serving Manchester and Leeds until 2033.

2.2 COSTS OF HS2[60]

2.2.1 Capital cost

The projected costs of HS2 have escalated steadily, and it has become clear that initial estimates made when the scheme was first appraised were inaccurate. The estimated capital costs for the Y network (including Phases 1, 2a, and 2b) have risen by 84% in nominal terms since 2011 and by £22.5

FIGURE 2: THE EVOLUTION OF HS2 TOTAL COST PROJECTIONS (£BILLIONS, IN 2015 PRICES)



billion in real terms to their current level of approximately £56 billion.[61]

Research into past infrastructure projects of the scale of HS2 has found a near universal tendency for significant cost overrun. Flyvbjerg[62] goes as far as to christen this the 'iron law of megaprojects… over budget, over time, over and over again'.

This trend towards cost overrun is consistent over the past 70 years and has not improved. In practical terms, Flyvbjerg finds that cost overruns of 'up to 50 percent in real terms are common, over 50 percent not uncommon'.[63] Specific examples of high-speed rail projects showing cost overruns of 60% (for the Dutch Rail Line South) and 100% (for the Japanese Shinkansen-Joetsu line).

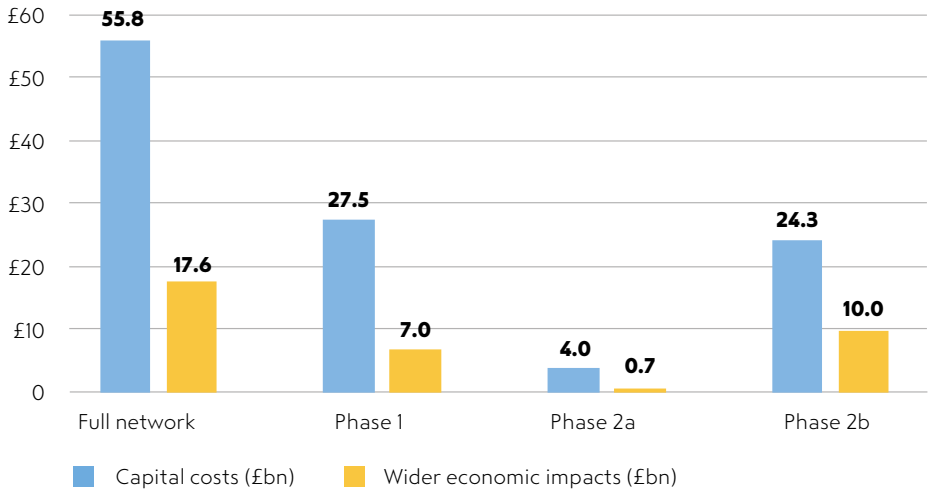
A further example of the cost overrun curse of mega projects appears to be London's Crossrail. Due to open in late 2018, the new line running east–west across the capital and originally awarded £14.8 billion, reportedly now may not be in operation until 2020 and will end up costing £17.6 billion.[64]

The cost of HS2 appears likely to continue to rise. In a report (subsequently leaked) prepared for the Infrastructure and Projects Authority, Paul Mansell, a leading expert in project management, judged that HS2 was highly likely to overspend in relation to its already inflated £56 billion cost. Mansell estimated an overspend of between 20% and 60%, which implies a total capital cost of between £67 billion and £89 billion. He also expected this overspend to create 'a very high opportunity-cost impact across other government Departments', as HS2 would drain budgetary funds from other public spending priorities.[65]

A further estimate of the costs of HS2, reportedly commissioned by the DfT, has also suggested that the current cost projections are an underestimate. Written by Michael Byng, a retired civil engineer who devised the standard costing methods used by Network Rail, the report suggests Phase 1 alone could cost almost £50 billion and the total project more than £100 billion.[66]

The government argues that HS2 has been given a budget and must stick to it.[67] But if costs escalate – and the project is considered too big to fail – then this or a future government will face a choice between increasing the overall sum allocated to the project, or eating into the budget for Phases 2a and 2b to complete Phase 1.

FIGURE 3: HS2 CAPITAL COSTS AND WIDER ECONOMIC IMPACTS BY PHASE (£BILLIONS, IN 2015 PRICES)



HS2 Ltd now quotes all capital costs as either whole scheme or by breaking out Phases 2a and 2b. In fact, Phase 1 is the most capital intensive, with projected costs of £27.5 billion and a benefit-cost ratio (BCR) of 1.7, compared to Phase 2a, which is projected to cost £24.3 billion at a BCR of 2.1 (both excluding wider economic benefits).

2.2.2 Ongoing operating cost

The estimated cost of running HS2 once it is built has risen by over 62% (nominal – 48.4% in 2015 prices), from an initial projection £17 billion in 2011 to a current estimate of £27.6 billion. It is unclear from the reports covering the latest *Economic Case* how this operating cost would evolve over time (during the appraisal period of 2017 to 2093).

However, for illustration purposes, if these operating costs are assumed to be the same every year from 2033 (the expected opening date for the full HS2 network) to 2093, the total figure of £27.6 billion equates to £1.1 billion every year. To put this in context, Virgin Trains West Coast had operating costs of £874 million in 2014/2015,[68] in which case, given the high possible operating costs, particularly energy costs, of such a fast line aimed at premium travellers, it is questionable whether HS2's operating cost projections are high enough.

If HS2 achieves its strategic aim and thins out passenger numbers on the three existing core north–south lines, then it will inevitably make the more marginal services on these lines – serving places such as Coventry, Stoke, Doncaster, Wakefield, Leicester, Stockport, Wolverhampton and a range of others not on or close to the HS2 lines – less cost-effective.

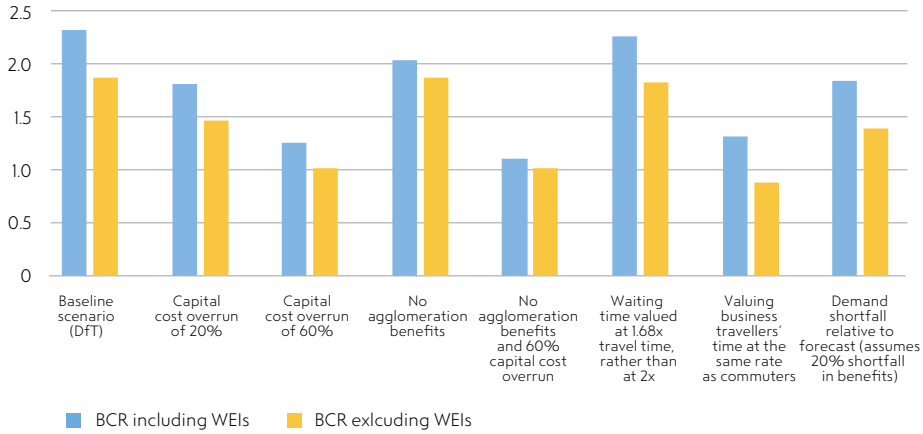
2.3 OVERALL VALUE FOR MONEY OF HS2

The BCR (the metric used by government to assess overall value for money on such projects) for HS2 is estimated to be 1.9 without WEIs or 2.3 with WEIs, falling into the medium (1.5 to 2.0) or high (2.0 to 4.0) categories in value-for-money terms.

In recent years, more than 90% of projects funded have a BCR in the high or very high (4.0 and above) categories (Figure 4); HS2 would already be at the lower end of approved projects.

The BCR is, of course, sensitive to changes in costs and benefits. If capital costs overrun or benefits worsen,

FIGURE 4: BCRS UNDER DIFFERENT SCENARIOS



HS2's value for money deteriorates. For instance if costs are 60% higher, as Paul Mansell's leaked report suggested, or if business travellers' time is, in reality, only as valuable as commuters' time – then the BCR falls into the low-to-medium category.

There is some international precedent for low BCRs in high-speed rail projects, with the Madrid–Barcelona line having been subject to an ex-post cost-benefit analysis (ie after construction was finished). The line, which had been forecast to return more than it cost, in practice achieved a BCR of between 0.6 and 0.7, rendering it poor value for money.[69]

Her Majesty's Treasury recommends that project appraisers 'scale' their value for money categories according to likelihood. Based on NEF's sensitivity analysis and taking into account the projections around cost escalation and the uncertainty in the calculations of WEIs, **we suggest that a medium BCR (1.5–2.0) is very likely and low BCR (1–1.5) likely.**[70]

One important observation in Figure 4, is how sensitive the BCR is to changes in how travellers' time is valued or to eventual demand for HS2. In these scenarios, HS2's BCR drops to poor in the worst case scenario if all travellers' time valued at commuters' rate without WEIs, and to medium in the best case if demand is 20% lower than forecast and WEIs are included.

Another factor, which without access to DfT models NEF cannot test, but that would probably have a significant effect, is ticket prices. If demand and therefore revenue from ticket sales and ticket prices are lower than expected, not only might the BCR worsen further still, but it may be difficult for HS2 to cover operating costs.

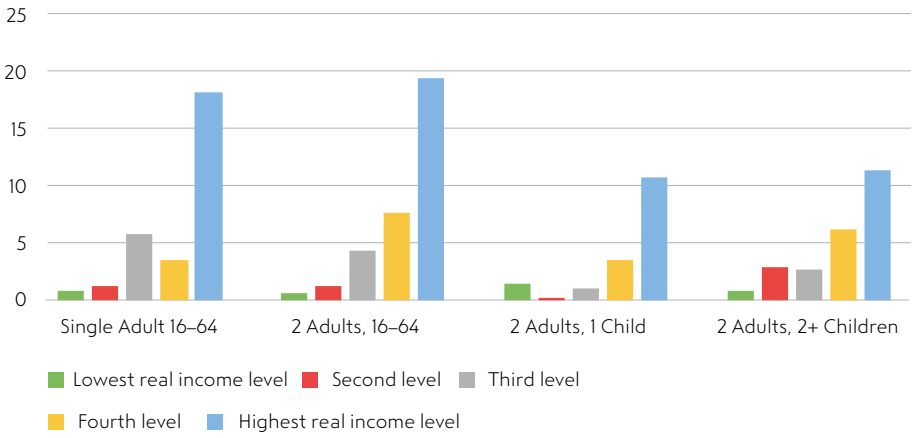
2.4 DISTRIBUTION OF HS2'S COSTS

2.4.1 Differences in use of rail by income quintile in the UK

According to Network Rail, long-distance rail passengers tend to be from better-off income groups.

Among households of a single adult, the top 20% by income made 20 times as many long-distance rail journeys for business during 2010 as did the bottom 20% by income. For households of two adults, the difference was even wider (the richest group took 24 times as many trips as the poorest), whereas for households with children the richest group took 7 to 12 times as many trips of this kind as the poorest group. As ticket prices for HS2 may well

FIGURE 5: NUMBER OF LONG DISTANCE BUSINESS TRIPS BY RAIL PER HOUSEHOLD (2010), BY HOUSEHOLD COMPOSITION



be higher than those for the classic network, this effect can be expected to be more pronounced.

The DfT's demand model for HS2 assumes that between 56% and 64% of journeys between London and Birmingham, Manchester, and Leeds are made for business purposes.[71] It is not entirely clear what the average level of income for HS2 passengers is across all model versions, but some versions of the DfT demand model are based on commuters having an average household income of £60,091 and leisure travellers having an average household income of £45,583 (both in 2010/2011 prices).[72]

These figures are derived from actual data on long-distance rail passengers from the National Travel Survey 2002–2010.[73] If this assumption is broadly representative of the income level used in other versions of the demand model, this indicates that the average passenger expected to use HS2 has a household income far above the UK average. The median household income for the top 10% of UK earners in 2010–2012 was £60,700,[74] suggesting that the HS2 demand model forecasts that its average commuting passenger will be in the top 10% of the income distribution.

EVIDENCE FROM FRANCE

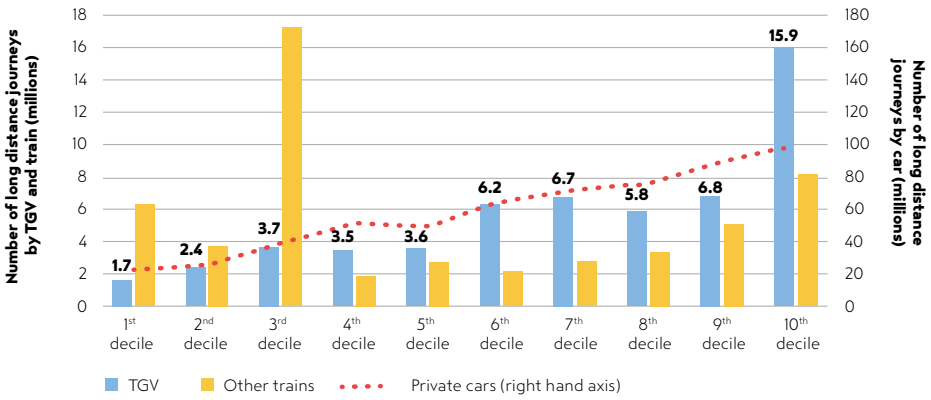
France has an extensive network of high-speed rail (the TGV network), much of which has been in place for more than 15 years.

Just as we have seen for rail travel in the UK, in France the majority of long-distance[75] high-speed rail journeys are taken by those who earn the most. People in the top 10% of incomes made 28% of all high-speed rail journeys of 80+ km in France in 2008, with this richest 10% taking nine times as many trips as the poorest 10%.[76]

There is also evidence that long-distance rail travel is segmented by income in France, with the rich using high-speed services more heavily and people on middle and lower incomes relying more on other, conventional train services. While more than half of long-distance TGV trips were made by the richest 30% of French people in 2008, more than half of long-distance trips on conventional trains were made by the poorest 30%.

There appears to be a growing recognition in France that high-

FIGURE 6: NUMBER OF TRIPS OF >80KM TAKEN ON HIGH-SPEED RAIL (BLUE), CONVENTIONAL RAIL (ORANGE) AND IN CARS (RED, RIGHT AXIS) BY INCOME DECILE (1ST = LOWEST, 10TH = HIGHEST) IN FRANCE IN 2008, MEASURED IN MILLIONS[77]



speed rail projects do not benefit all parts of society equally, and that this distributional aspect is a key consideration when choosing which projects to go ahead with. French law requires that major infrastructural projects are assessed a priori for their impact on all relevant stakeholders, with a positive assessment resulting in a 'declaration of public utility', essentially a green light for construction to commence.

An assessment of this kind for the proposed new high-speed lines from Bordeaux to Toulouse and Dax was published by a public commission of inquiry in March 2015. It found that the new lines were likely to disproportionately benefit the rich and the large cities, at the expense of rural areas. Respondents to the commission felt that the new lines would primarily benefit 'managers, businesspeople and politicians' egos' and stated that they would prefer to see the funds used for local transport services, as well as social spending, health and employment assistance.[78] This was one of the factors contributing to the commission's overall rejection of the plans for the new high-speed rail line, after extensive stakeholder interviews and a review of the evidence.

2.4.2 North-south (spatial) inequality

The UK has some of the highest levels of regional inequality in Europe. This is true both between regions (eg the median income in the south-east is 25% higher than the median income in the West Midlands[79]) and within regions (eg the average male life expectancy varies by up to 6.5 years between different local authorities in the north-west). HS2 fails to address either of these forms of spatial inequality, and is likely to entrench them.

The nature of high-speed rail is such that in order to realise time savings from travelling at a higher speed, the trains cannot stop at regular geographic distances. This is reflected in the proposed route for HS2, which avoids all but the largest conurbations on its way from London to Manchester and Leeds. This excludes large parts of the country from the projected benefits of the new line, except in the sense that they will still have to pay for its construction and operation.

It is made clear in the DfT's economic case for HS2 that more of the benefits of the scheme will accrue to London than any other part of the country. The most recent assessment finds that 40% of the transport user benefits of the full

TABLE 3. LAND OWNERSHIP IN AREAS ADJACENT TO HS2 STATIONS BY COMPANIES REGISTERED OVERSEAS

STATION	OVERSEAS PROPERTY OWNERS NEARBY
Birmingham Curzon Street	No non-public sector owners shown
Birmingham Interchange	No non-public sector owners shown
Chesterfield	To the west: Property owners from Denmark, Luxembourg, Gibraltar, Jersey, the Isle of Man
East Midlands Hub (Toton)	No non-public sector owners shown
Leeds	To the east: Property owners from Jersey, Liechtenstein, Luxembourg To the south: Property owners from Guernsey, Anguilla, Luxembourg To the north: Property owners from Jersey, Guernsey, the Isle of Man, the Bahamas, Luxembourg
London Euston	To the west: Property owners from Jersey, the Channel Islands, the Cayman Islands, the British Virgin Islands, Panama, the Seychelles. To the east/south: Companies registered in Cyprus, the British Virgin Islands, Panama, Jersey, the Marshall Islands
Manchester Airport	To the west: Property owners from the British Virgin Islands, Jersey
Manchester Piccadilly	To the west: Property owners from Luxembourg, Jersey, Guernsey, Gibraltar, the Isle of Man To the north: Property owners from Japan, Luxembourg, Jersey, Guernsey, Gibraltar, the Isle of Man
Old Oak Common	To the west: Property owners from Luxembourg, Jersey, Guernsey, Gibraltar, the Cayman Islands, the British Virgin Islands.
Sheffield Midland	To the west: Property owners from Germany, Luxembourg, Jersey, Guernsey, the Cayman Islands
Stafford	To the west: Property owners from Luxembourg To the east: Property owners from Denmark, Luxembourg, Gibraltar, Jersey, Guernsey, the Netherlands Antilles,
Wigan	To the east: Property owners from Jersey, the Cayman Islands, the British Virgin Islands To the west: Property owners from the Isle of Man
York	To the east: Property owners from Sweden, the Cayman Islands To the south: No ownership data shown

network will go to London, with other regions lagging behind: the north-west receives 18% of these benefits, the West Midlands 12%, and Yorkshire and the Humber 10%.[80]

Given the unbalanced nature of the UK economy, with London's relative supremacy in many service sectors, it is unlikely that northern cities could out-compete their London-based equivalents, even if northern firms benefitted from lower costs in terms of rent and wages.[81]

2.4.3 Private capture of public benefits

It is not just the direct (ie travel-related) benefits of HS2 that accrue disproportionately to higher income groups. Several studies of the impact of HS1, HS2's forerunner, have found that areas in the direct vicinity of its stations experienced a significantly higher rise in property prices.[82]

HS2 is likely to have the same effect, with a large chunk of the public value created by the new infrastructure being captured as profits by landowners, landlords, and property developers in areas such as Piccadilly in Manchester, Birmingham's Curzon Street, and central Leeds. As the project will be funded by all taxpayers, this value capture will provide another route for wealth transfer from poorer households to the already wealthy.

There is a shortage of publicly available data on land ownership in the UK, so it is difficult to show a full picture of benefit. A substantial (albeit incomplete) picture of land ownership in England has been assembled by Guy Shrubsole and Anna Powell-Smith for the 'Who owns England?' project.[83] This mapped dataset shows that there is considerable land ownership in the vicinity of HS2 stations by companies that are based in global tax havens. This means that any property and land uplift that occurs at these sites as a result of HS2's construction will leave the UK economy altogether.

Table 3 shows the jurisdictions of some of the companies that own land directly adjacent to the stations served by HS2 (this includes places where HS2 will stop directly, and others close enough to the line to benefit significantly, for example Stafford, Wigan, Sheffield, Chesterfield).

Pagliara *et al*[84] found that the significant increase in property values created by the opening of HS1 occurred within a radius of 500 metres from St Pancras station.

3. BUILDING A BETTER RAILWAY

It is an apposite moment to be focussing on what the UK's rail network should provide and to whom. Four factors are driving this debate:

1. The escalating costs of and questions concerning the efficacy of HS2 throw into sharp relief the need for investment in the network in terms of modernity, improved connections, greater capacity, and as a place to create secure, well-paid work.

2. Following a summer of discontent and disruption, especially affecting travellers in the north and south-east,[85] and in the light of the failure of the government to re-franchise the ECML, The Transport Secretary has announced a root and branch review of the railways in UK,[86] though HS2 and the spending proposed for Control Period 6 are outside of the scope of this work.

3. Political pressure is growing on the current government, franchisees, and others as a result of Labour's proposal to renationalise the network and the popularity of this proposal among the travelling public.[87]

4. The need to rebalance transport expenditure from London and the south-east to everywhere else, and especially northern and south-western England and Wales.

NEF proposes a National Rail Investment Fund over 10 years, accompanied by a guiding strategy with the following key elements. Investments must:

1. **Support the aim of a rebalanced economy, with investment benefit and rail industry capacity reinforcing the shift of core economic capacity into regions other than London and the south-east of England and especially the north-west, north-east, and Yorkshire and the Humber.**

2. **Build around the concept of innovation and fully networked**

journeys, including physically with other modes of transport and also virtually, to allow passengers to use train journeys as they would a home office or mobile work station, bringing down the cost of journey time.

3. **Create good, skilled jobs both on the network and in supply chains, with the aim of anchoring the future of UK railways – and increased productivity – within the skills of its workforce.**

4. **Reduce CO_2 emissions. Railways are inherently more carbon efficient than other modes of transport but this environmental dividend can only be fully realised if much more of the network is electrified and capable of accommodating more freight.**

Of course, value for money must play a significant part (a further priority should be driving down costs of investment, for instance in interventions such as electrification, which are extraordinarily high in the UK), but this is difficult to judge when the appraisal process for such schemes is skewed towards certain types of project, over-values business travellers time, favours the south-east of England over virtually everywhere, and tends to define strategy rather than the other way around.[88]

Much of the support for nationalising rail – which is shown in public opinion polls and reflected on all sides of politics – is born out of a deep frustration at the poor performance and lack of accountability of rail operators in the UK and a concern about rising costs. A guiding principle of a new strategy for the railways must be to make investment and operation accountable to taxpayers and passengers via Parliament, local authorities, and the devolved governments of Scotland and Wales.

While by no means definitive, the following sections sketch out the elements of such a strategy and look at the range of investments – and their estimated costs – needed across the UK's rail network. This is done with a focus on trying to rebalance the benefits of modernised, rapid, and well-run railways.

3.1 AN INDUSTRIAL STRATEGY FOR THE RAILWAYS

A key part of a future strategic plan for the railways could – in the context of the UK government's Industrial Strategy White Paper – be a 'sector deal'. But a sectoral industrial strategy for the railways must recognise the scale, importance, and nature of rail travel in the UK.

The UK rail industry, and related supply chains, is 'associated with around 600,000 jobs' from those driving trains and managing stations to those managing and maintaining the track, those supplying the industry, and those whose businesses are reliant on the railways.[89] There are around 20,000 miles of track, more than 2,500 stations, and 40,000 bridges and tunnels. Passengers make around 1.7 billion journeys by rail.[90]

The scale of investment needed in the UK rail network means it must take place within a wider vision for the industry and the economy. Through the rolling programme of 'enhancements' in its control programme spending packages, Network Rail is continually improving UK rail travel, but CP5, which comes to an end in 2019, has run significantly over budget and delivered less than was anticipated.[91]

There are few industries that employ more people or upon which more people rely directly on a daily basis. From the workers in Bombardier's Litchurch Lane factory in Derby to the

100 million people who enter or leave Waterloo Station, the UK's busiest, per year the economy relies heavily on the performance of the railways. And while the relationship between a rail line, productivity, and economic growth may be open to question, railways, and the supply chains and services that surround them, are an important and highly productive economic sector in their own right.

In *Building a Britain Fit for the Future,* the government's Industrial Strategy White Paper, rail is seen primarily as an enabler of other industries and a means of supporting the economy to meet the strategy's four 'grand challenges'.[92] However, aiming to develop and grow our railways industry as a whole and as an industrial sector in its own right – firmly linked to a wider, integrated strategy for transport – will almost certainly help deliver the industrial strategy.

Railways can deliver directly against three of the four grand challenges.

1. **AI and data**: Railways, and the technology that runs and guides them, are ripe for innovation, especially in the UK. Development of smart (digital) railways that control traffic in moving rather than fixed blocks, allowing more trains to travel safely together on the same lines, could effectively boost productivity. While most European railways are currently ahead of the UK in this regard, a keen focus on innovation in signalling and train management, and rolling stock manufacture, would not only benefit the UK network, but could bring wider industrial benefits.

2. **Clean growth**: Carrying more freight and passengers by rail and replacing car and HGV journeys, but also doing so with a lower carbon, electrified rail network, innovation, and smarter train management, should be an important part of the UK's clean growth story.

3. **Future of mobility**: Integrating the railways with other modes of transport and providing the facility for passengers to remain networked while on board, innovating in train design and in the technology that manages and guides traffic on the lines should all be part of the future vision of mobility in the UK.

The Business, Energy and Industrial Strategy (BEIS) department has recently published a proposed 'sector deal' for the railways; rail is envisaged as a user and driver of digital technology, a provider of good jobs with existing and new skills, and a place where a focus on cost reduction will bring benefits.[93] This is a positive step in recognising that, within the context of the industrial strategy, the rail sector is important enough to warrant a specific focus.

An industrial strategy for the railways must be developed in a way that is closely linked to the structural and organisational crises the industry is currently facing, with too much complexity, underperformance, and very high unit costs for improvements.[94] In developing a vision for and approach to the UK railways as an industrial sector, the government must also consider a dramatic simplification of the way railways are governed and a focus on strategic investment around this vision and approach.

Just as with other natural monopolies in the UK economy, the purpose should be to provide **public benefit**. The concept of public benefit includes value for money, which is particularly important as the majority of rail investment is paid for by the public purse. A comparison of the projected costs of HS2 Phase 2 and those of

high-speed rail projects in other European countries, commissioned by the DfT, found that HS2 will cost almost three times the average.[95] While some of this high cost is due to the specific conditions of the UK, with the high density of existing development and land prices, the report argues that the fragmented nature of the UK rail industry and its supply chains are significant factors.

A further aspect of providing public benefit is the **creation of good jobs**. Key parts of the union movement have supported HS2 because of its promise to support 30,000 jobs, half of them by 2020.[96] The Trades Union Congress (TUC) has signed a framework agreement with HS2 Ltd around the creation of a safe, diverse, and inclusive workforce with a strong voice.[97]

This commitment is in HS2's favour, but as is the case with HS2's other benefits, job creation is necessarily concentrated along the line, with an inevitable draw towards the south-east. Investing in a major programme of upgrades across the network would create employment opportunities in a wide range of locations which, in the context of strategic industrial transformation, should all be specified as good, unionised jobs.

The skills colleges set up to train workers in readiness for HS2 are in the meantime struggling to fill their courses and facing a funding shortfall.[98] This is worrying news for the industry as a whole and suggests a very different approach is needed, one which seeks to embed civil engineering, construction, manufacturing, and other rail-employment-related skills in a wide range of colleges, clustered around innovation centres for the railways.

The primary aim, though, that will pull through skills training, should be the return of the full manufacture of rolling stock to the UK. The era of rail privatisation has seen a significant decline in rail manufacturing jobs and although some firms, such as Hitachi, have recently invested in train assembly, the aim should be full manufacture accompanied by a programme to skill-up a new generation of engineers. Especially in the context of Brexit, a rail sector deal should guarantee that a significant proportion of new orders are placed with UK manufacturers to stimulate this demand. The focus in NEF's comprehensive investment package on the north of England, where manufacturing capacity is still significantly located, should help with this aim.

A third, **environmental dividend** focus would seek to build on the rail industry's intrinsic environmental benefits, by driving out the use of fossil fuels across the network, including on local and regional rail services and in freight, and replacing more carbon-intensive journeys, such as short-haul flights. A strategic focus on the railways should accelerate innovations in rail hardware and software and in the way the network is run and managed to reduce its environmental impact, with a particular focus on climate change. This could lead to the development of world-leading innovation in low-carbon, low-impact rail.

SUPPORTING RAIL INNOVATION CENTRES ACROSS THE UK NETWORK

A sector deal for the rail network, both within the context of national industrial strategy and through local deals, should focus on support for innovation and new design across the industry, focussing on creating jobs through innovation centres in certain locations:

Derby was always a centre of rail development and innovation, especially in the BR years, and remains a major centre for businesses established to provide goods and services to the rail industry. Balfour Beatty has recently launched a new Rail Innovation Centre at its Raynsway Facility and while Bombardier's factory recently won a good pipeline of orders, it has also reduced the size of its workforce in recent years.

Doncaster is another location synonymous with the railways. It is also undergoing something of a renaissance, with Hitachi Europe and one of the two new High Speed Rail Academies now offering training courses. There is also a cluster of smaller companies around the rail industry, making Doncaster ripe for accelerating innovation and supplying a programme of upgrading the whole network.

Newton Aycliffe in County Durham, close to where George Stephenson assembled the Locomotion 1, is another, relatively new rail industry centre in the UK. It is the site at which Hitachi assembles the new intercity express trains; the replacements for the ageing fleet of intercity 125 trains on the classic network. Hitachi has created 420 jobs, but only assembles finished trains; the majority of the parts are made elsewhere.

Eastleigh is the railway base for Siemens in the UK, recently winning a multi-million pound contract from Network Rail to upgrade the UK's fleet of freight trains and a further contract to upgrade rolling stock on South West Trains.

Other rail innovation centres could include names equally synonymous with the industry and needing new industry, including Crewe, Darlington, and Glasgow. Funding should also be increased to Network Rail's testing facilities at Melton Mowbray in Leicester and Tuxford in Nottinghamshire.

In addition, focussing on freight terminals and ports, a sector deal should seek to set targets for increasing the volume of freight that is shifted from road to rail and for the reduction of CO_2 emissions further still through the electrification of freight pathways and innovation in train design, signalling, timetabling, and management. We propose restoring the Rail Freight Facilities grant as a first step towards a new, strategic vision for rail freight.[99]

3.2 CONNECTING NORTHERN CITIES

As part of a wider economic strategy, there is a very strong argument for better rail connections within northern conurbations and between northern cities; reducing the journey times and improving what is currently often a poor experience for passengers, but also taking traffic off congested Trans-Pennine roads. The trend of under-investment outside of London and the south-east (the implication at least of a slew of recent studies) must be reversed.

A particularly high priority is intercity connections across the north of England. Not only are these currently poor on the railways, but the M62 and A628 east–west road links are notoriously overcrowded and, in the case of the latter, prone to poor weather and dangerous conditions, with heavy freight and cars mixing on a single carriageway.[100]

There are three existing routes between the north-west and Yorkshire and the east coast:

1. Calder Valley from Victoria via Rochdale to Bradford and Leeds
2. From Manchester Victoria or Manchester Piccadilly via Stalybridge and Huddersfield
3. From Piccadilly via Hope Valley to Sheffield

None are electrified, all are relatively slow, and all have capacity problems, not helped by antiquated signalling on parts of routes 1 and 3. The one route across the Pennines that was electrified (via Woodhead) was closed in the early 1980s.

The busy Route 2 is actually over-provided with trains (mostly three-car formations, taking up precious capacity), resulting in well-used local stations with strong commuter flows to Leeds and Manchester having a poor and unreliable service.

Passengers beginning their journey in Liverpool have two options to interconnect with these routes.

1. Via Warrington Central to Manchester Piccadilly
2. Via St Helens Junction to Victoria or Piccadilly

The latter is electrified, the former only in part. Both routes from Liverpool use the extremely congested central Manchester section from Deansgate Junction to Piccadilly. Without quadrupling the route, further increases in train movements are impossible, though the DfT's plans for a 'digital railway' will resolve the problems. It is widely believed that they will not.

3.2.1 Options for improvement and new lines

One clear option available to the government is to agree and deliver HS2 Phases 2a and 2b. However, these schemes are designed to interconnect Manchester and Leeds with Birmingham and London and not with each other. The reference case modelled journey time from Leeds to Manchester Piccadilly is 119 minutes[101] or almost 2 hours. On the TransPennine Express (via route 2), this journey currently takes a minimum of 47 minutes and is usually around one hour.

Transport for the North has proposed a new high-speed link between Leeds and Manchester Piccadilly and, via a section of HS2 Phase 2b, Manchester Airport and Liverpool.[102] This is known as HS3 and is included within proposals for Northern Powerhouse Rail (NPR), which would also see upgrades to the Trans Pennine and Hope Valley routes as far as Newcastle and Hull, respectively. The total cost of

the new line and upgrades is estimated to be almost £70 billion. This level of ambition and the demand for northern investment is welcome and, though emerging in nature, the proposals appear sound. And though currently linked to the arrival of HS2, many aspects of the proposals would clearly stand without it.

There is already a fourth east–west northern route. The former Woodhead line which is disused east of Hadfield, Greater Manchester, through the famous Woodhead tunnels under the high moorlands of north Derbyshire as far as Penistone where it intersects with the Huddersfield–Barnsley line. The section from Deepcar into Sheffield is now used as a freight branch.

There have been many proposals to re-open the line after it was closed in 1981. It is, for instance, part of the HSUK proposal. The most comprehensive proposal for the re-opening and upgrading of this line, from Manchester through to Sheffield, comes from Grand Northern and combines freight with a new, fast passenger service, reducing the intercity time to around 40 minutes. The estimated cost of reopening and upgrading this route is put at £1 billion by Grand Northern.

There are some practical difficulties with this proposal. The most significant is that Woodhead 3, the last of the tunnels bored under the peaks, which is twin track and already specified for electrification, is currently owned by National Grid and used for high power cables. The other, older tunnels are sealed and in a poor condition and would need re-boring to carry electrified services. In 2013, Stephen Hammond, the then transport secretary, suggested that it would be best to bore a new tunnel if the line were ever to be reopened.

The government has said that around £3 billion is available to invest, primarily in Route 2, the Standedge Route which is in effect the main Trans-Pennine corridor.[103] However, even this would seem to be inadequate to electrify the whole route. Current plans are to leave out the 'difficult' central section including Standedge Tunnel, which is also the most steeply graded and busy, and would benefit most from electrification.

It is important to look at the four corridors together: the major works planned for the Standedge Route will require diverting trains via the Calder Valley line. The disused Woodhead line offers an alternative to a very expensive and environmentally damaging new high-speed line serving Bradford, whose needs could be better met by Bradford Crossrail linking the two city termini to create a new West Yorkshire network.

3.2.2 NEF preferred package for the north.

The opportunities for bringing the cities and major towns of the north closer together with improved rail links presents arguably the most significant strategic rail opportunity in the UK. The NPR proposal is compelling but reliant on the arrival of HS2; the envisaged new HS3 part of the proposal is designed to link together the top two sections of HS2's 'Y' shape.

A lower cost way of achieving better and fast rail connectivity across the north is offered by opting for all of the upgrades put forward in the NPR proposal – many of which overlap with NEF's proposed package – along with examining the feasibility of a fourth link, either by building a new line entirely or by re-instating and electrifying the Manchester–Woodhead–Sheffield line.

This package would offer three electrified routes between Liverpool and Manchester and either Bradford, Leeds, and York or Sheffield, Hull, and Tees Valley. Connecting the north and south via a Bradford Crossrail adds further dynamism and the opportunity for Bradford to thrive alongside Leeds, benefitting from through rail traffic for the first time ever.

In more detail, our package for northern rail is as follows:

1. Reopen the Woodhead line

Even if this cost doubles from the Grand Northern Projections, a fourth east–west northern connection with a possible 45-minute journey time between Sheffield and Manchester and a possible additional one-hour Leeds-Manchester link would be an important strategic move.

2. Electrification of much of the core north of England network

There are already plans to electrify the Trans-Pennine (Huddersfield) route from Leeds to Manchester (estimated to cost almost £3 billion). The Calder Valley line via Bradford must also be electrified as well as Leeds to York, intersecting with the already-electrified ECML. Sections of the line to Hull and Middlesbrough should also be electrified, providing a largely wired northern network. Guide Bridge to Stalybridge should also be electrified to allow electric services to use Manchester Piccadilly from the east.

3. Connect east–west and north–south via Bradford Crossrail

A historical quirk of competing Victorian rail companies has left Bradford with two termini (Forster Square and Bradford Interchange – 0.44 miles apart) and no through link. When *A Case for Crossrail* was launched in 2010, a new link via an elevated section was forecast to cost £140 million.[104] This seems low even in 2018 prices, and the subsequent construction of the Broadway shopping centre has made the elevated route harder if not impossible.

But equally, such a short section of track – even priced at around the cost of an equivalent distance of London Crossrail's costly tunnelled section – would be unlikely to cost more than £280 million, roughly double the projected cost in 2010.

As a consequence, Bradford could become a more significant interchange, offering faster links between Cumbria and the north-west and Yorkshire and the Midlands. With the addition of a re-opened Colne–Skipton line, this would have strategic freight benefits and bring a much better connection to the towns of Burnley, Nelson, and Colne.

Significant improvements to the north-of-England sections of the three core north–south main lines (Section 3.3), which will not only assist with speed and frequency of long-distance services, but also ease travel over commuter and regional distances. It will also bring the **total estimated capital costs of NEF's northern package of interventions to £18.9 billion**, including an optimism bias supplement of 40% (which, as per HMT guidelines, we are adding to all of our cost estimates).

3.3 IMPROVING THE 'CORE' NORTH–SOUTH UK MAINLINES

There are three 'core' mainline corridors running north–south in the UK, linking London with the Midlands, north–west and north–east and Scotland. The lines mostly date back to the Victorian era and are an amalgamation of those developed by separate rail companies in the nineteenth and early twentieth centuries.

- **The West Coast Main Line** (WCML) runs from London's Euston to Birmingham, the north-west, and Glasgow.
- **The East Coast Main Line** (ECML) runs from London's Kings Cross to Yorkshire, the north-east, and Edinburgh.
- **The Midland Main Line** (MML) runs from London's St Pancras to the east Midlands and south Yorkshire.

The WCML and ECML are entirely electrified. The MML is electrified as far as Bedford, with work currently underway to extend electrification to Kettering and Corby. Plans to extend electrification through to Sheffield were shelved in 2017 with the availability of new bi-mode trains that can run using electricity or diesel power given as the primary reason. However, a National Audit Office investigation found that finance was the main reason, as Network Rail had suffered cost escalation on a range of projects and was prevented from borrowing further due to restrictions for public bodies.[105]

Building on work by a range of consultancies and organisations, including on the Atkins modelling of alternative packages for the DfT and proposals from groups such as 51M, NEF has built and provided preliminary cost estimates for a comprehensive package of investments to improve services on all three lines. Our proposed interventions are the most significant yet, including major station upgrades and new links, large sections on which two tracks need to be expanded to four (quadrupling), flyovers are needed to avoid trains crossing paths (grade separation), and platforms and trains need to be lengthened.

DFT/NETWORK RAIL/ATKINS ALTERNATIVE PACKAGES (2013)

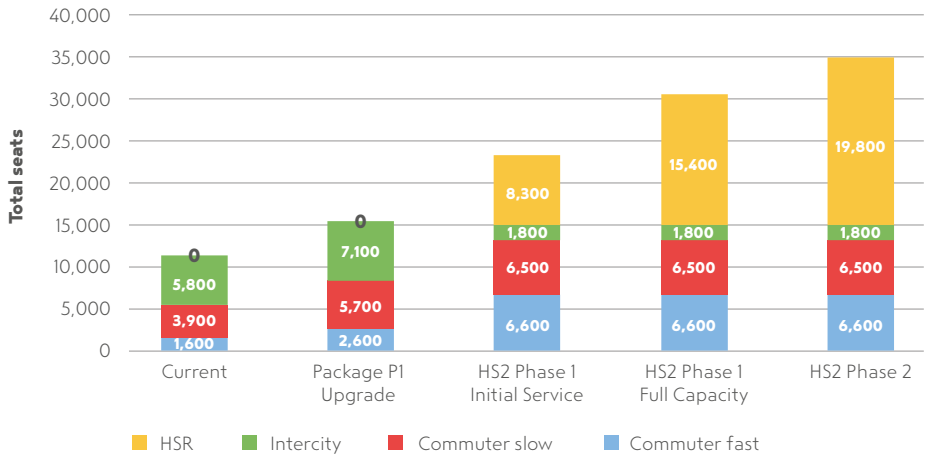
The DfT, working in conjunction with Atkins and Network Rail, developed a set of alternative rail investment packages that could be implemented instead of HS2, as part of the *Strategic Case for HS2*. These involved increases to the number of trains operating on existing lines, as well as infrastructural upgrades to the WCML, ECML, and MML.

These alternative packages focussed on providing additional capacity to the same parts of the country served by HS2, which restricted the set of available options and necessarily included London. While there are capacity issues around travel to and from London, it is likely that alternative investment packages that focus more heavily on areas of the country relatively poorly served by current rail infrastructure would offer higher benefits and value for money.

The alternative package to the full HS2 network that was considered offered a higher BCR (3.1, compared with 2.3 for HS2 at that time) and came at half the capital cost of HS2.

Under the Atkins P1 Package – the strategic alternative to HS2's Phase 1 – the total number of seats across commuter and intercity services

FIGURE 7: ADDITIONAL PASSENGER TRAIN CAPACITY – EUSTON EVENING PEAK HOUR



leaving Euston during evening rush hour increases from 11,300 (the 2013 base case) to 15,400, with almost 3,000 extra commuter seats and almost 1,500 extra intercity seats.[106]

HS2 adds many more seats – with a total of 30,300 leaving London during the Euston evening peak hour (once at full capacity) – but releases 500 fewer seats to the classic network for redistribution between commuters and standard intercity. It does this mainly by switching intercity capacity onto the new line (which is as would be expected). Crucially, HS2 is able to offer increased capacity on classic lines – over and above the 'current' (2013) level – due to necessary improvements around Euston.

The alternative packages were rejected by the government. One of the main concerns of the alternative packages modelled by Atkins was disruption to the rail network during construction. This is an insurmountable issue, though one that can be ameliorated and is not necessarily clear cut between the two alternative ways of adding capacity. Some recent improvements on the core lines have been carried out with minimal disruption; HS2 is itself expected to create very significant disruption into and out of Euston.

A further concern was that the alternative package did not improve journey times as much as HS2. This is inevitably true, by the very definition of high-speed rail, but the BCR for the alternative should already have factored this in. The idea of a BCR is, after all, to weigh up the benefits relative to the costs. As the alternative still offered some journey time improvements on all lines considered, and did so at half the cost, it achieved a significantly better BCR. In light of this, the DfT seems to have been overly quick in dismissing it.

Ultimately, in this instance the alternatives were primarily considered along strategic lines (in terms of how effectively they would meet the goals that HS2 is aiming to meet), with a lack of in-depth economic case analysis.

HS2 aims to release capacity to enable other routes, including existing mainline corridors, to carry additional traffic. However, the potential for making better use of existing lines, with targeted and costed improvements, has been played down. Yet our analysis, backed up by in-depth discussions with rail professionals, suggests that significant extra capacity can be released at a much lower cost through our comprehensive upgrade package.

Our observations are based on expert comments from railway operating professionals, supported by the DfT's own *Strategic Case for HS2*, which identifies some sections of the line suffering from high levels of congestion.[107]

A fundamental issue of the DfT's argument for HS2 is the highly optimistic assumptions for passenger growth over the next three decades. Without these assumptions, the case for an intensive very-high-speed train service from London northwards to Birmingham, Manchester, and Leeds looks threadbare. Some of the current capacity constraints on all three routes could be partially resolved by a combination of infrastructure improvements [selective quadrupling, more grade separation at major junctions, additional platform capacity, modern signalling (the much-hyped 'digital signalling'), electrification (in the case of the MML)] together with train lengthening and in some cases diversions or line re-openings.

An excellent summary of capacity problems and possible solutions from a professional rail perspective can be found in Julian Worth's *The Capacity Conundrum*, published in the October 2018 issue of *Modern Railways*.[108] Worth is in favour of HS2, but many of his proposed solutions are highly relevant.

Major rail investment projects can bring significant benefits, which speed up journeys and release capacity. If managed well, they can bring down the costs currently involved in delivering infrastructure projects in the UK. A good example is the Stafford area improvement scheme, completed by Network Rail in 2016. The full programme comprised three key stages:

1. Upgrading of the slow lines between Crewe and Norton Bridge.
2. Re-signalling of Stafford station and the installation of a down goods loop.
3. Separating the slow lines at Norton Bridge onto an entirely new alignment and creating a grade-separated junction.

The cost totalled a relatively modest £250 million, but the benefits were immediate, permitting:

- Two additional fast trains per hour (off-peak, each direction) between London Euston and the north-west – these paths are to be created by moving the twice-hourly Birmingham-Liverpool services to the slow lines.
- One extra fast train per hour (each direction) between Manchester and Birmingham – pathed for a Class 350.
- One extra freight train path per hour (each direction) through Stafford.

The project was delivered under the Pure Alliance contractual arrangement in which partners (Network Rail and contractors) worked as a single organisation – The Stafford Alliance. It is estimated that this led to cost savings of at least 10%, with further savings forecast.[109] This combination of

focussing on the causes of congestion and bottlenecks and fixing them at a reasonable cost through clear integration between the different agencies and companies involved with the railways is a good model.

In Appendix 1, we list our proposed package for the three core lines, with estimated costs for each, which have been arrived at by reviewing the available literature on real-world costs for a range of measures and projects already undertaken, standardising these and, where appropriate (ie on line electrification or quadrupling) applying a per mile average estimated cost.

The DfT's 2015 supplement to the *Strategic Case* quantified some capacity improvements on the WCML at £2.5 billion, which would include grade separation, quadrupling, signalling, and power upgrades.[110] The technical annex points out that this work would be disruptive. However, again using the Stafford Area Improvement Programme as a model, the programme was accomplished with remarkably little disruption to existing services.

3.3.1 The West Coast Main Line

The DfT Strategic Case for HS2 (2013)[111] (and the subsequent supplement to this, *Demand and Capacity pressures on the West Coast Main Line*, November 2015[112]) identifies several parts of the WCML which are currently experiencing high capacity problems. These include Euston to Milton Keynes and Rugby to Coventry and Birmingham New Street; Edge Hill to Liverpool Lime Street; Stockport to Manchester Piccadilly; and Carstairs to Glasgow Central.

However, there are other pinch points on the WCML which, if addressed, could provide significant additional capacity, particularly if combined with longer train formations. Moreover there are other known areas which suffer from restricted capacity which are not included in this *Strategic Case* such as the long stretch from Preston to Carstairs, on which HS2 trains would run at a reduced speed to existing Virgin 'Pendolino' trains, once they had reached the end of the bespoke lines.

A big part of the problems with the WCML are conflicting movements caused by trains crossing busy running lines to go to and from branches.[113] This is particularly notable at:

- Ledburn Junction (for fast commuter trains)
- Colwich (trains to/from Stoke and Manchester)
- Stafford (trains to/from Wolverhampton)
- Crewe (to/from Shrewsbury, Chester, Manchester)
- Winwick Junction (trains to/from Manchester)
- Golborne Junction (trains to/from Manchester)
- Wigan (trains to/from Liverpool)
- Euxton Junction (trains to/from Manchester)

Our comprehensive package of interventions listed in Appendix 1 includes:

- Linking Paddington and Crossrail with the WCML by a new connection between Old Oak Common and Willesden.

- Quadrupling north of Rugby, between Coventry and Birmingham (essential even with HS2), north of Crewe, beyond Winwick Junction, north of Preston and north of Carlisle.
- Introducing grade separation at Ledburn Junction, Euxton Junction, and other places.
- Adding a new track leaving the existing WCML at Rugeley, avoiding Colwich Junction and Shugborough Tunnel, rejoining the four-track north of Stafford.
- Undergoing major reconstruction – as already envisaged in the HS2 project – at Crewe and upgrading Warrington Bank Key.
- Reopening the former goods lines over the Ribble Viaduct into Preston and expanding Preston station/
- Expanding Carlisle station/
- Reopening the Edinburgh–Carlisle line.

The estimated total capital cost of NEF's WCML upgrade package is £16 billion

3.3.2 The Midland Main Line

The DfT Strategic Case for HS2 (2013)[114] identifies capacity constraints between St Pancras and St Albans and Chesterfield to Sheffield. Some services continue beyond Sheffield to Leeds and contribute to capacity problems between Wakefield and Leeds. Note that the MML is unelectrified north of Bedford, although electrification is currently under way to Kettering and Corby.

Our comprehensive package of interventions listed in Appendix 1 includes:

- Completing full electrification of the MML, including the Corby loop.
- Quadrupling north of Wigston into Leicester, between Dore and Sheffield to separate traffic on the Hope Valley line.
- Reinstating services on the Leicester–Coalville–Burton line.

The estimated total capital cost of NEF's MML upgrade package is £5 billion

3.3.3 The East Coast Main Line

The issues on the ECML are as acute as on the WCML, though in some cases more easily solvable. However, there are some major pinch points. *The DfT Strategic Case for HS2 (2013)*[115] highlights major capacity problems between King's Cross and Stevenage: Stoke Tunnel–Grantham and Darlington–Newcastle. In addition, Leeds–Micklefield (on the Leeds–York/Hill corridor) and Wakefield Westgate to Leeds are also shown as having serious capacity constraints. Network rail's route study offers important insights into capacity issues on the route and options to resolve them.[116]

Congestion on the ECML starts at Kings Cross, where removal of tracks has narrowed entry into and exit from the station. Though fully electrified, there are large parts of the line that are twin track and, as with the WCML, congestion is caused at various points by 'flat' junctions, where local, regional, and freight movements cross the mainline.

Our comprehensive package of interventions listed in Appendix 1 includes:

- Re-instating the removed tracks in the approach to Kings Cross and

lengthen some of the platforms (some work is already underway on this).

- Adding, at a very high cost – but probably essential in the long term – new tracks, a new viaduct, and a tunnel at Welwyn.
- Quadrupling from Woodwalton to Huntingdon and Peterborough and on the approaches to Edinburgh.
- Introducing grade separation (flyovers) as needed at Doncaster, north of York and at the junction for the North Berwick line at Drem.
- Adding new twin-track tunnels at Stoke between Peterborough and Grantham to ensure the line can be quadrupled through Grantham. This is costly but necessary.
- Accelerating the removal of 10 level crossings that Network Rail is already planning to remove, which will increase line speeds.[117]
- Electrifying the joint line from Peterborough via Spalding and Lincoln to Doncaster to provide a diversionary route for passenger trains and allow use of the route for electrically hauled freight, further easing capacity problems for the ECML.
- Adding platforms on the 'fast lines' east of the station at Darlington would reduce delays and speed up journey times for ECML services and permit services from Saltburn to terminate at without conflicting with ECML.
- Re-opening the Leamside line (serving east Durham and potentially serving Washington) to provide additional capacity north of Darlington.
- Adding a long dynamic loop in each direction at North Berwick to improve performance and enable the all-stations North Berwick service to become half hourly on weekdays as it already is on Saturdays.
- Provisioning a new 'down' (Edinburgh direction) platform at Dunbar which is urgently needed and seems to be in the pipeline.

The estimated total capital cost of NEF's ECML upgrade package is £9 billion

3.4.4 Other key interventions on the rail network

HS2 does nothing to address regions of the UK currently poorly served by mainline or regional rail services. These include the south-west of England, Wales, and England's north-east, and central Scotland.

Our comprehensive package of interventions for the wider network includes:

- Electrification of the Great Western line to Plymouth and from Cardiff to Swansea, helping with the congestion on the main roads in south Wales.
- Electrification of the cross-country route between Bristol and Doncaster and Leeds, Doncaster to Hull, Crewe to Holyhead, Bolton to Wigan, Oxenholme to Windermere, Bristol suburban line to Avonmouth and Portishead, and the new Oxford to Cambridge line.
- Reopening of the Edinburgh-Carlisle 'Waverley line' from Tweedback to Carlisle, providing a new central Scottish mainline.

- Reopening of the Exeter to Plymouth via Okehampton line, missing out the weather-dependent section of the line at Dawlish.
- Reopening of Leuchars to St Andrews, Thornton to Levenmouth, Alloa to Dunferline and the Buchan lines from Aberdeen to Peterhead, all in Scotland.
- Reopening Bangor to Caernarfon in the north.

The estimated total capital cost of NEF's additional upgrade package is £22.4 billion

All of these proposals would need to be locally driven, using a rolling national rail investment fund; rail can offer a significant boost to smaller towns and isolated communities and reconnect people in the low-carbon economy. But the communities that will benefit and those that will be affected must be involved in the plans, which should be driven by newly formed regional transport authorities, under the control of democratically elected local authorities, including combined authorities where established

3.3.5 Boosting rail freight

HS2, by carrying passengers between northern cities, Birmingham, and London on additional lines, will free up capacity on the ECML, WCML, and MML. Neither the DfT nor HS2 Ltd has been specific about this capacity; timetables would be determined as Phases 1, 2a, and 2b were completed (after 2026 and 2033, respectively). The Rail Freight Group (RFG) estimates that this could lead to three more freight 'pathways' per hour on the WCML, depending on how the spare capacity is timetabled.[118]

The problem with this assumption is that as the RFG acknowledges,[119] in the absence of detailed, post-HS2 timetables, it cannot be taken for granted that any freed-up capacity would be used for freight. If the primary problem is related to commuter crowding and congestion to the north of London, then logically additional commuter services would be timetabled to take up much of the spare capacity, at least at peak hours.

The UK must aim to carry much more freight on its railways to reduce congestion on the arterial road network and dramatically reduce CO_2 emissions.[120] The highest environmental dividend from freight is gained when services are running on electrified lines. This means that, regardless of the additional capacity, the full carbon dividend of shifting freight from road to rail cannot be captured unless the classic lines are electrified.

The frequency of high speed services, their speed, and the relative infrequency of stops make it almost impossible to run freight trains on HS2 during the day, and European experience shows that night-time freight operation is also impractical because of maintenance requirements. The lack of connectivity with the classic network means the typically complex pathways taken by freight trains will not be possible, reducing the utility of the new lines; specifically, there are **no** connections usable by freight trains at the London end of the route.

A 2017 study[121] of possible uses of the additional capacity freed up when HS2's phases are complete in 2033, commissioned by the DfT, modelled timetabling for six different scenarios. Its sixth looked at the additional available capacity for freight and concluded:

> *The opportunities to use the capacity released by Phase 2 of HS2 [i.e. when the whole scheme is completed] on the WCML and ECML for additional freight flows are limited by capacity constraints on other parts of the rail network.'* [122]

If this is correct, then freight's problems will not be solved by building HS2.

Network Rail's *Freight Network Study* (2017) highlights 11 locations on the network where 'key freight corridors' face infrastructure constraints.[123] Of these 11, the freight industry has identified five key priorities:

- Felixstowe to the West Midlands and the north via Ely
- Southampton to the West Midlands and WCML
- Channel tunnel
- Cross London flows including Essex Thameside
- Northern ports and Trans Pennine.

Only one of these (Southampton to the West Midlands and the WCML) has an apparent direct relationship with HS2. However, the study goes on to suggest that, aside from several key interventions on the Northampton loop of the WCML and addressing well-known problems at Stafford and Preston (see above section on WCML and Appendix 1), all of the key constraints are north of where HS2's second phases will reach.[124]

It is almost certainly true that capacity for freight is a current issue, at least at specific nodes across the network, and even more so in a low-carbon future that requires us to carry more freight on the railways. But it is also worth noting that in 2017 Network Rail released 4,702 freight pathways (slots in the rail timetable for freight traffic) per week back to passenger services because they were not being used, citing the decline in coal traffic, better timetabling, and more productive (ie fuller, longer, heavier) trains.[125]

UK rail freight is perhaps the most important strategic consideration on the network. But freight movements are complex and do not follow the same logic or relatively obvious pathways of passenger movements. Currently the important ports of Felixstowe, London Gateway, Southampton, Immingham, and Liverpool are key start points or destinations and vice versa freight terminals at Daventry, Birmingham, Manchester, Dollands Moor in Kent, Leeds, Wakefield, Wembley, Barking, Coatbridge, and Grangemouth.

To decarbonise transport and ensure timely goods delivery, freight must be treated as of the highest priority. A clear priority is gauge clearance to W10 gauge (ie allowing 9'6" high shipping containers on standard height wagons). Without this, rail will not be able to achieve its full freight potential at the west and east coast ports, and/or line capacity will be limited due to the operational inefficiencies inherent in using low floor wagons. Many of the interventions we recommend on the classic network will address the constraints freight faces and overlap with Network Rail's recommended improvements.

We also suggest:

- Ensuring more lines are cleared for the continental W10 gauge to allow more freight from Europe to pass without being reloaded. This would benefit freight specifically.
- Increasing the number of freight terminals in London and the south-east. This is perhaps trickier and requires more of a political push.

- Double-tracking the critical freight pathway between Felixstowe and Ipswich.

- Electrifying any remaining stretches of the network heavily used by freight and which are not covered by our extensive package of electrification.

- Developing and appraising proposals for a long-distance freight spine in the UK, using existing track and re-opened formations including the former Great Central lines for improved north–south connectivity, and possibly using stretches of the Settle–Carlisle and former Glasgow South Western route to Glasgow via Dumfries.

There has been a series of ambitious proposals for freight corridors linking ports across the UK. Perhaps the most audacious and alluring was Central Railway proposal for a north–south link for continental gauge haulage of freight linking the Channel tunnel to Liverpool docks. This was a serious proposal, backed by a company that went as far as raising private capital – in around 2000, it was forecast to cost £5.6 billion.[126] A strategic proposal that seeks to make a significant difference to road freight CO_2 emissions and national freight connectivity deserves serious consideration.

In addition, freight should be a focus of the industrial strategy for rail and of innovation budgets so that the UK can get the most benefit from an enhanced freight network.

As part of NEF's package of interventions, we argue that not only should the Freight Facilities Grant be revived (we have added a placeholder sum of £200 million into our comprehensive package for this), but that freight should benefit from a significant share of the Rail Investment Fund we recommend.

4. CONCLUSIONS AND RECOMMENDATIONS

When finished, HS2 will incontrovertibly lead to shorter journey times between London and Birmingham and onwards to Manchester, Leeds, and York. It will also offer a large number of new passenger seats on a very fast link, which will free up capacity on the classic network, especially on the WCML.

So why then might the scheme still be open to question?

4.1 CONCLUSIONS

In this report, NEF has taken a fresh and impartial look at the economic and strategic cases. As with others inquiring into the HS2 conundrum, this is hampered by lack of access to detailed passenger data. But our conclusion is quite straightforward. Its justification is not strong in either case.

The two most compelling pieces of evidence that should cause policymakers to think again about the scheme are directly related to the two key areas of focus of this report:

1. If government remains determined to keep HS2 within its total agreed budget of almost £56 billion, then if costs on Phase 1 increase, the second phases of the scheme that connect up northern cities may be put at risk or face compromise.

2. Even when wholly finished, with Leeds and Manchester linked to Birmingham and London, it is the nation's capital that will capture more than its fair share of the benefits. HS2 will, according to HS2 Ltd's own economic appraisal, reinforce the London-centric nature of transport investment and growth in gross value added.

It is not that high-speed rail or new north–south links are in themselves the wrong approach to take. But that this scheme, its escalating cost, its drag towards London, its extreme speed, its poor integration with the rest of the network, and its lack of strategic rationale in relation to the railways and transport and its meagre impact on road and air travel do not add up. Within the context of Brexit and stark economic and political inequality, and without clear strategy, HS2 increasingly appears wrong-headed.

A significant part of the problem is that there is little to measure HS2 against

because it is not being appraised, approved, and constructed in the context of a wider rail or economic strategy with a clear set of aims. The DfT's 2017 *Strategic Vision for Rail* identifies some useful themes and challenges (such as tackling the high cost of interventions on the network) but does not articulate what we want our railways to do, where and how and what their interaction with the economy should be; there is not a single mention of freight.[127]

In this context, HS2 is an answer to a question that has not yet been clearly asked; it stands on its own as a largely engineering-led transport project with high and probably rising costs and uncertain, heavily concentrated benefits.

In the meantime, this leaves little probable investment for the remaining classic rail network. Over the next five years, Network Rail, in its CP6, has included a sum of around £10 billion to spend on 'enhancements'.[128] However, this sum of money is indicative. What it ultimately spends will be determined via a bottom-up planning process in which schemes will be demanded by regional authorities and train operating companies and will 'compete' with other infrastructure schemes for Treasury funding.

As *The Case for Expanding the Network*, a recently published Campaign for Better Transport (2019) report, puts it:

> *Government's emerging approach does not provide strategic guidance on the type and location of schemes deemed to be most desirable. Instead, this is left primarily to local authorities and investors to advocate individual schemes, with the Department for Transport (DfT) committed to helping deliver those schemes deemed most beneficial by the private sector.*[129]

Clearly local and regional designation and voice is important; in this respect the bottom up approach is welcome. But without a designated rail infrastructure fund and guiding national strategy that helps determine which schemes are consented and why, the rail network will remain locked in the same piecemeal paradigm in which it has been imprisoned since privatisation. For instance, Transport for the North's recently published *Strategic Transport Pla*n (2019)[130] is a recent example of important strategic thinking from a regional transport body, but will be largely dependent on national spending decisions and, in the absence of a more compelling strategy, is once again hard to judge in isolation.

As we have outlined herein, significant investment in the railways in general and in new rail capacity in particular is very much needed. This should be focussed on rebalancing the economy, supporting and connecting a wider range of places in the UK – especially those smaller cities and towns with poor links and weaker economies – increasing freight capacity, and reducing overall transport carbon emissions. All of these aspects should interlock with a wider transport and economic strategy as transport policy cannot define the shape of the economy, but rather the other way around.

On the economic case, with the likelihood of at least some cost overrun and other uncertain factors such as the wider economic impacts and the uncertainty around demand for the 300,000 daily seats, NEF concludes that the current cost benefit analysis probably represents an optimistic picture. It is most likely that HS2 will achieve a low or medium BCR in reality. Add to this the fact that the cost-benefit case relies on the line serving business travellers and

the possibility of HS2 ending up as largely a rich person's rail line, with commuters consigned to a second-class classic network, all of the opportunities of providing genuinely new connectivity for all likely evaporate.

On this basis it should not be consented unless the strategic case is very compelling. And it is not. As we have shown, while its primary strategic impact will be to free space on the classic network for commuter services to the north of London, it is most likely to further exacerbate the problem of London-centricity, making additional future investment to ameliorate London congestion a near certainty. Its low impact on road transport and almost negligible impact on domestic aviation – both of which could be compelling strategic arguments in the context of climate change – expose HS2 as project without clear purpose.

Coupled with our other observations concerning its poor integration with the existing network, the likelihood that smaller cities and towns not on the HS network will suffer poorer services, and that it does not address the need for more freight capacity across the network, HS2 begins to look like a low priority for government support and for the railways.

Surprisingly, HS2 still has strong support in some northern cities. While in the context of brutal cuts to local authority funding from central government, this is understandable – HS2 is envisaged as a means to regenerate – the London-centric distribution of passenger benefits alone should be enough to cause northern leaders to ask questions.

Policymakers have overwhelmingly supported Phase 1 of HS2 and the scheme has reportedly cost £4.1 billion before construction began,[131] with further expense in the pipeline due to the work that is underway.

But with the political context of Brexit introducing further urgency to the challenge of economic rebalancing – and especially developing a new economic offer for places that have often been referred to as left-behind – and with the opportunity of a root and branch rail review, it is time for a thorough and independent re-examination of HS2. Policy-makers should certainly avoid the fallacy of sunk costs; it would be far more costly to press on with HS2 if it did not align with transport and economic strategy than to write off the costs already incurred.

In the meantime, NEF has put together a comprehensive package of possible interventions across the network that can bring benefits to a wide range of passengers and places and can be planned in parallel or in sequence depending on the business cycle and the needs of government fiscal policy. Using existing literature and some of our own workings and adding a 40% value for optimism bias, we estimate the cost of these at almost £55.2 billion.

Some of these were tested in the Atkins modelling of alternatives to HS2 and fared well and while – necessarily – they deliver fewer additional north–south seats, they offer wider benefits and better value for money.

4.2 RECOMMENDATIONS

Drawing on the evidence we have rehearsed in this report and the conclusions outlined in this section, NEF recommends the following five steps to resolve the HS2 conundrum

1. Initiate a National Rail Strategy and Rail Investment Fund

It is tempting to jump straight to answering the question posed about HS2 at the start of this report: should it go ahead or not? However, it is abundantly clear that good decisions about the future of the network will not be made unless there is a better governing strategy. It is the government's job to determine this strategy, but it should be devised in collaboration with regional transport authorities, local government, industry and union representatives, and – critically – passenger representatives.

One of the key questions any rail or wider transport strategy should answer is how it can support a rebalancing of the UK economy, especially in the post-referendum political and economic context and the urgent need to focus economic policy on the revival of left behind neighbourhoods and communities up and down the UK. As we have shown, HS2 does the opposite of this, even according to HS2 Ltd's own projections, and with the risk of cost overruns on Phase 1, Phases 2a and 2b that link in northern cities could be in jeopardy.

Accompanying the strategy and guided by it, NEF proposes a National Rail Investment Fund to support new lines, the reopening of existing lines, electrification, significant improvements to existing lines, station expansion, freight expansion, and further investment in rolling stock and to support innovation and good job creation. This would roll out over the next decade, bringing immediate benefits, especially to those areas that face major transport challenges and under investment.

The priority for this fund should be to bring forward many of the schemes that have been promised, re-promised and then cancelled over recent years, such as east-west electrification in the north of England and the full electrification of the GWR line to Swansea and the MML. Similarly many of the easy-win line re-openings that we highlight in this report and that have recently been evaluated by the Campaign for Better Transport should be brought forward as part of a wider rail investment package.

NEF's proposed £18.9 billion spend on improvements across the north of England should be appraised as an immediate priority. We also recommend that our wider comprehensive package – which we estimate at £55.2 billion – should form the bedrock of the spending for such a fund.

Because the projects to be funded by Network Rail's CP6 enhancements budget of around £10 billion are to be determined by a bottom-up process, it is as yet impossible to say how much overlap there might be between this planned spend and the NEF comprehensive package. If the NEF package were delivered over a 10-year period, spanning CP6 and one further control period, then, assuming a further £10 billion for this further control period, perhaps two-fifths of the budget required would in effect already be available. It is worth noting too that the enhancements expenditure in CP5 was around twice that currently budgeted for in CP6.[132]

Clearly, if HS2 was reviewed and shelved, as we also recommend, then

the planned capital investment should be switched to support strategic investment across the rail network and in wider transport strategy.

Beyond reinstating the Freight Facilities Grant and improving the line between Felixstowe and Ipswich, we have not estimated costs for investing in freight, which could be considerable given the need to ensure key east–west and north–south routes are electrified, can carry significant increases in goods and can accept continental gauge containers. But it is hard to imagine, given the urgent need for dramatic carbon emissions reduction in transport, that freight would not play a significant part in a new strategy for Britain's railways.

It could even be that, if properly embedded in a wider rail strategy, new north-south lines might best be built with freight in mind. Given the importance of decarbonising transport, any Green New Deal would probably prioritise the development of electrified rail freight and, as freight lines require lower line speeds and technical specification, they would tend to be cheaper and less socially and environmentally disruptive.

2. Commission an urgent, independent review of HS2

While NEF has argued that cost, and even cost overrun, is not alone a reason to cancel HS2, as its strategic case is also weak and may be out of step with any emerging view on how the rail network should support a new economic strategy, then even though Parliament has given its consent to Phase 1, the government should open HS2 up to independent review.

This could be through a revised version of the DfT's promised root and branch rail review. But if the government will not commit to including HS2 in this, and to opening the process up to scrutiny beyond Whitehall, then opposition parties should demand it. Ideally this would be passenger-led, with a chair appointed primarily to represent passenger interest. All data and insight should be made available should such a review be commissioned.

3. Change transport appraisal methodology

While this report recommends that rail investment should be strategy-led, appraisal of value for money will still be necessary to ensure the benefits of all investments are maximised.

There is no doubt that the skew towards particular types of passengers produces results that prejudice self-fulfilling prophecy investments in London and the south-east. The government should look again at the way it evaluates investments and, in particular, at how to do this in line with a new strategy.

4. Develop an industrial strategy for the railways

To accompany the long-term strategy, because of their importance to the wider economy and the volume of jobs that depend on the railways, we also recommend a sectoral industrial strategy. The aim of a rail industrial strategy would be to maximise jobs and the development of supply chains, including new rail manufacturing in the UK, with cost reduction along the value chain.

The primary concept around which a rail industrial strategy should be built should be public benefit: spreading the benefits of investment widely and ensuring that the majority is captured for public good and not private profit.

Part of this is the concept the creation of good jobs. The TUC and individual trade unions have supported HS2 because of its promise of supporting 30,000 jobs, half of them by 2020. But on a network run for public benefit, good jobs should be the norm and not the exception; trades unions should not have to fight to preserve job quality against the profiteering interests of private operators – it should be written into the terms of whichever firms or entities operate parts of the rail network. In addition, innovation centres and skills colleges should focus on equipping a new generation of employees with twenty-first-century engineering and management skills to run, manage, develop, and create the rail network of ten years' time.

Finally, though largely lower carbon than other forms of transport, the railways need to pay an environmental dividend. An industrial strategy needs to drive out fossil fuel use from all parts of the network, be at the forefront of innovation to decarbonise, and manage trains to use the network as efficiently as possible. This approach offers opportunities not only to deliver on ever-tighter UK carbon targets but also to lead the world in green rail travel and freight distribution.

5. Ensure open, transparent data for the rail network.

Finally, as the government moves through its root and branch rail review, it should leave no stone unturned. This should include the opening up of data that will allow anyone interested in understanding the current operating patterns of UK railways and future projections full access to insights on a par with all the private sector entities.

APPENDIX 1: FULL DETAILS OF NEF'S PROPOSED COMPREHENSIVE PACKAGE

BOTTLENECK/ CATEGORY	PROJECT DESCRIPTION	ESTIMATED COST (£ MILLIONS)
IMPROVING THE CORE NORTH-SOUTH UK MAINLINES		
WCML	Euston bottleneck: link from Willesden Jcn to Crossrail	£46.8
WCML	Euston bottleneck: pedestrian route to Euston Sq and other improvements to Euston station	£20.0
WCML	Leighton Buzzard - Wolverton – Rugby - Birmingham: grade separation including a flyover at Ledburn	£278.0
WCML	Leighton Buzzard - Wolverton – Rugby - Birmingham: quadrupling Coventry to Birmingham (currently 2-track)	£1,000.0
WCML	Leighton Buzzard - Wolverton – Rugby - Birmingham: quadrupling Rugby to Nuneaton (currently 3-track)	£1,000.0
WCML	Colwich – Stafford – Norton Bridge: new line leaving near Rugeley and rejoining north of Stafford	£1,411.7
WCML	Colwich – Stafford – Norton Bridge: grade separation at Colwich	£573.5
WCML	Crewe: major reconstruction of the station, including potential flyovers	£1,000.0
WCML	Winsford – Preston: quadrupling and cut offs to the north of Crewe	£2,000.0
WCML	Winsford – Preston: Euxton Junction flyover	£250.0
WCML	Winsford – Preston: Reopen lines over Ribble Viaduct	£200.0
WCML	Preston and north to Carlisle: Two platforms at Preston reinstated	£200.0
WCML	Preston and north to Carlisle: Selective quadrupling, track realignment between Carnforth and Carlisle	£200.0
WCML	Preston and north to Carlisle: New route bypassing Penrith	£2,000.0
WCML	Carlisle and north to Central Belt of Scotland: add one platform to Carlisle station & reinstate one goods line	£11.2
WCML	Carlisle and north to Central Belt of Scotland: dynamic loops and route speed updgrades	£200.0
WCML	Carlisle and north to Central Belt of Scotland: new route from Carstairs to Rutherglen with connection to Edinburgh	£2,000.0
WCML	Carlisle and north to Central Belt of Scotland: reopen the Waverley Route	£1,000.0
MML	Full electrification of the MML	£2,120.1
MML	Quadrupling through/near Leicester	£200.0
MML	More use of 'Beighton Line'	£20.0
MML	Re-instating quadruple track between Dore and Sheffield	£200.0
MML	Full quadrupling between Sharnbrook and Kettering	£1,000.0
MML	Grade separation at South Kirby Junction	£75.0

BOTTLENECK/ CATEGORY	PROJECT DESCRIPTION	ESTIMATED COST (£ MILLIONS)
ECML	King's Cross: additional tracks, longer platforms	£449.3
ECML	Welwyn: new viaduct and one/two new tunnels	£2,000.0
ECML	Welwyn: smart signalling interventions	£200.0
ECML	Quadrupling Woodwalton-Huntington-Peterborough, track stabilised over Stilton Fen, dive-under at Werrington	£236.7
ECML	New Stoke Tunnel, quadrupling Stoke Tunnel-Grantham-Newark, flyover over the Lincoln-Nottingham line	£556.9
ECML	Increasing speed through crossovers at Grantham and into Nottingham line platform, with possible extension of down loop	£20.0
ECML	Removal of ten level crossings on the ECML	£8.0
ECML	Electrification of the 'Joint Line' from Peterbrough via Spalding and Lincoln to Doncaster	£1,044.5
ECML	Double track north of Doncaster, with more loops of suitable lengths, plus some grade separation	£200.0
ECML	York: flyover to the north to segregate Leeds line from Doncaster line, advanced signalling, additional platform at station	£200.0
ECML	Reinstate loops at Cowton between Northallerton and Darlington	£10.8
ECML	Gauge clearance work in order to route freight via Eaglescliffe, and low level platforms at Northallerton for passenger services from Middlesbrough/ Hartlepool	£24.9
ECML	Extra platforms at Darlington	£12.8
ECML	Darlington: separating the Bishop Auckland branch services with a north-facing bay platform on the west side of the station	£23.0
ECML	Reopening of the Leamside Line	£1,000.0
ECML	North of Newcastle: new platform at Dunbar, longer loops for freight at Alnmouth (down) and Tweedmouth (up), electrification of Edinburgh South Suburban line, quadrupling or grade separation at Drem, quadrupling / dynamic loops into Edinburgh	£200.0
ECML	Long dynamic loop in each direction for the North Berwick service	£200.0
ECML	Eastern approaches to Edinburgh: resolving the Calton Tunnels, Portobello Junction and freight routing	£20.0
Total: Improving the Core North-South UK Mainlines		**£23,413.2**
OTHER KEY INTERVENTIONS ON THE RAIL NETWORK		
Electrification	Great Western Main Line: Cardiff to Swansea and Bristol Parkway to Plymouth	£1,865.7
Electrification	Midland Main Line (London) - Bedford – Derby/ Nottingham – Sheffield – Leeds	£218.2

BOTTLENECK/ CATEGORY	PROJECT DESCRIPTION	ESTIMATED COST (£ MILLIONS)
Electrification	Bristol – Birmingham – Derby – Sheffield- Doncaster/ Leeds	£1,437.1
Electrification	Doncaster – Hull	£461.2
Electrification	Liverpool – York (via Huddersfield)	£1,102.0
Electrification	Manchester Victoria - Leeds (Calder Valley Line)	£511.9
Electrification	Crewe - Holyhead	£1,181.7
Electrification	Bolton – Wigan	£112.4
Electrification	Oxenholme – Windermere	£36.6
Electrification	Northallerton – Middlesbrough	£242.4
Electrification	Leeds – Harrogate – York	£409.1
Electrification	Bristol suburban including Avonmouth Loop and Portishead	£229.5
Electrification	New Oxford-Bicester-Bletchley-Bedford-Cambridge line	£1,006.6
Re-openings and new lines	Manchester – Sheffield via Woodhead	£1,000.0
Re-openings and new lines	Manchester – Matlock – Derby	£163.0
Re-openings and new lines	Uckfield – Lewes	£164.1
Re-openings and new lines	Skipton – Colne	£100.0
Re-openings and new lines	Bradford Cross-rail (bringing Bradford onto a through route)	£230.2
Re-openings and new lines	Exeter – Okehampton – Tavistock – Plymouth	£929.4
Re-openings and new lines	Tweedbank – Carlisle	£713.3
Re-openings and new lines	Carmarthen – Aberystwyth	£795.6
Re-openings and new lines	March – Wisbech	£74.0
Re-openings and new lines	Newcastle – Ashington/Morpeth (The 'Blyth and Tyne' route)	£204.3
Re-openings and new lines	Bangor – Caernarfon	£107.4
Re-openings and new lines	Leuchars – St Andrews	£83.3
Re-openings and new lines	Thornton – Levenmouth (existing railway)	£56.0
Re-openings and new lines	Alloa – Dunfermline (existing railway)	£77.2
Re-openings and new lines	Buchan lines (Aberdeen) - Dyce – Ellon – Peterhead-Fraserburgh	£396.9

BOTTLENECK/ CATEGORY	PROJECT DESCRIPTION	ESTIMATED COST (£ MILLIONS)
Re-openings and new lines	Burscough Curves (allowing through trains Liverpool – Ormskirk – Southport and Preston – Southport)	£12.8
Re-openings and new lines	Poulton-le-Fylde to Fleetwood	£18.9
Re-openings and new lines	Penrith – Keswick	£144.2
Integrating modes	Local authority-run bus franchises	£1,250.0
Integrating modes	Station car parking, safe bike storage, access for buses, well designed pedestrian routes to stations	£500.0
Freight	A revived Freight Facilities Grant that would include assistance towards terminal costs, rolling stock and operating costs	£200.0
Total: Other Key Interventions on the Rail Network		**£16,035.0**
Total: All Interventions		**£39,448.2**
Additional optimism bias of 40%		£15,779.3
Total: All Interventions (including additional optimism bias)		**£55,227.4**

Shading indicates our proposed northern package of investments.

ENDNOTES

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