High Speed Rail

Response from the Engineering the Future alliance, with agreement from:

- The Institution of Engineering and Technology
- The Royal Academy of Engineering

July 2011

Engineering the Future is pleased to have the opportunity to input into the Department for Transport's consultation on a new High Speed Rail line for Britain.

We support investment in low-carbon transport infrastructure as a necessary contribution to meeting the Government's targets for reducing carbon emissions. Electrified rail is one of the few methods of decarbonising long-distance travel and high speed, high capacity rail can help achieve modal shift from other transport options through the provision of faster, frequent and more reliable journeys.

Our conclusion, however, is that there are a number of engineering and economic issues that need further scrutiny before reaching a decision on the High Speed 2 proposal.

This response has been submitted jointly by the Institution of Engineering and Technology and the Royal Academy of Engineering

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Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK's 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.

High Speed Rail

July 2011

- This response is submitted by the Institution of Engineering and Technology (IET) and the Royal Academy of Engineering (RAEng).
- It draws on the expertise of professional engineers in the transport sector and was prepared by the IET's Transport Policy Panel in consultation with Fellows of the Academy with expertise in relevant fields.

1. Executive Summary

1.1. We welcome this consultation on High Speed Rail. In principle, we support investment in low-carbon transport infrastructure as a necessary contribution to meeting the Government's targets for reducing carbon emissions. Electrified rail is one of the few methods of decarbonising long-distance travel and high speed, high capacity rail can help achieve modal shift from other transport options through the provision of faster, frequent and more reliable journeys. It would be too easy in these difficult financial times to dismiss the possibility of a major rail infrastructure project as unaffordable – a decision which future generations might come to regret.

1.2. However before the project is developed further, the challenges of funding, planning, interoperability and the impact on local communities all need to be balanced as part of a full package and a full and detailed assessment of this package conducted. We are concerned that the current consultation conflates several issues: the full route, and each phase of that route, sustainability and blight. Therefore, it does not constitute the full assessment needed.

1.3. Furthermore, many of the questions in the consultation are ones to which we could not respond without in-depth research, knowledge of the alternatives considered or access to the socio-economic modelling that has been undertaken. Therefore, we have not responded to the consultations questions as given. The main issues we feel it important to address are given in the remainder of this section and elaborated in subsequent chapters.

1.4. The case for High Speed 2 relies on the assumption that reduced journey time is of economic benefit and will reduce the North-South divide. No evidence is advanced for these assumptions and some examples cited, such as the regeneration of the Lille region, are special cases that are not relevant to the situation in the UK.

1.5. The economics of a high-speed line cannot be considered in isolation from the system as a whole. By transferring passengers from services on conventional routes to a high speed line, the economic return of other lines will be degraded. In order to make a proper response it would be necessary to understand what plans there are for other routes and their financial implications.

1.6. High Speed 2 will take 15 years to build. During that time, there will be a need for capacity improvement on existing inter-city routes. However, with the prospect of High Speed 2, it is not clear how this would impact on such investment or how the rolling-stock leasing companies (ROSCOs) might be persuaded to invest in new rolling stock which would have greatly reduced residual value after 2026, when the new line would be opened.

1.7. A financial comparison of the type made in this consultation requires two comparators – a “do nothing” option and a “do minimum” option. The comparators used in the consultation are inconsistent and do not represent the best realistic alternatives against which the High Speed 2 proposals should be judged.

1.8. It is claimed that High Speed 2 will reduce overall UK carbon emissions. Appendix 2 of the consultation document records that “The greatest potential benefit for High Speed 2 in terms of carbon emissions is associated with people using it in preference to air travel.” However, passenger predictions suggest that only a minority of those using High Speed 2 would switch from car (7%) and air (6%). On the basis of these figures and the additional trips implied by the reallocation of slots on the WCML for commuter traffic, we cannot see any justification for the claim that High Speed 2, as proposed, will reduce emissions.

1.9. There are several areas of the design of the line where the justification for particular choices is not evident. For example, the infrastructure design speed of 400 km/h seems to have been chosen without much justification, in terms of either cost or energy use. Similarly, environmental mitigation by the use of more tunnels and cuttings than might be needed on a lower speed line appears not to have been analysed adequately.

1.10. Our conclusion is that more questions need to be answered to explain the assumptions that form part of the current proposals for a new high speed rail line, to ensure that a full and detailed analysis of the associated costs and benefits can be appropriately evaluated. While High Speed 2 Ltd and the Department for Transport will have had significant input from engineers during the development of these proposals, there are a number of critical engineering questions that have not been addressed in the consultation and which must be considered before the project is developed further.

1.11. To assist with cross referencing our response to the consultation questions, the following guide can be used:

- Section 2 deals with question 1 on enhancing capacity and performance and enabling economic growth
- Sections 3 and 4 deal with questions 2 and 3 on high speed rail and alternatives
- Section 6 looks at question 5 on specifications and principles and section 7 deals with issues covered in question 5 around mitigation and to some extent question 6 on sustainability.

2. Enhancing UK intercity-rail

2.1. We agree with the Department for Transport’s assessment that an increase of capacity is needed if rail is to accommodate modal shift from road in the long distance passenger and freight sector, thus reducing the dependence of Britain’s transport system on fossil fuels. There are, however, wider issues which should be considered as part of rail enhancement in the UK.

2.2. Capacity increases will be required in the next 15 years, whether or not High Speed 2 construction goes ahead. A full assessment of what other comparable countries have managed to achieve with their conventional rail network should therefore be considered. Such an assessment may highlight those improvements being utilised in other countries which could enhance the UK rail network.

2.3. In addition, while the consultation focuses on UK intercity-rail travel, consideration should be given to enhancing door to door journeys, which although not impacting the capacity constraints could help to improve journey reliability. For example, a trip from Shepherds Bush to Salford Quays would see only half the journey spent on the West Coast Main Line, and a more effective way to improve the overall journey time could be to improve the feeder services onto intercity-rail. Complementary investments alongside high speed rail should be encouraged by the Department for Transport.

2.4. The consultation document does make reference to enhanced integration with urban transport networks to reduce end to end journey times, for example through a connection to Crossrail[1]. However a more detailed plan of seamless connections would have been welcome for other urban transport networks along the route, such as those in Birmingham for Phase 1.

2.5. There also needs to be greater clarity on how the government aims to bridge the north/south divide through transport. Other options, such as improving transport infrastructure between the cities of the north could greatly improve the regional economy, and such improvement could be delivered through the enhancement of proposals such as the Northern Hub.

Enhancing Capacity

2.6. There is little doubt that substantial and unexpected growth in rail use has occurred over the last 15 years and alongside this, capacity constraints have developed at certain times and certain sections of the existing rail network.

2.7. The Strategic Alternatives to High Speed 2 Study shows that crowding into London will rise from 57% to 68% by 2043 and the Network Rail West Coast Main Line Rail Utilisation Study shows that between London and the West Midlands 'little room exists for growth, and traffic is constraining timetabling elsewhere'. This is despite pricing being used over a significant period to limit demand.

2.8. We therefore agree that something needs to be done to improve intercity-rail capacity. The question is when these improvements will be needed. The long time frame for the completion of High Speed 2 is such that a range of incremental improvements to the existing rail network, beyond those already planned, will be needed if the forecast rising demand is to be accommodated. The economic evaluation of both High Speed 2 and any alternatives should take account of these parallel improvements to other parts of the network.

Enhancing Performance

2.9. There are many factors which could contribute to enhancing rail 'performance'; a significant one being enhanced rail reliability. The ability to move passengers reliably is of equal importance to increasing capacity. We believe there is a better case to be made for high speed rail on the grounds of reliability rather than capacity.

2.10. As the IET demonstrated in a recent report, relatively small decisions can often have a significant effect on predicted transport improvements and these should be taken into account when developing transport solutions.[2]For instance, good station design and management, coupled with good train door and vestibule design, can add significant benefits by minimising dwell times. Longer dwell times can lead to delays building up across the rail network.

1 High Speed Rail: Investing in Britain's Future – consultation document, February 2011
2 Rebound: unintended consequences of transport policy and technology innovations, The IET, September 2010

2.11. One of the benefits of building a new line is the up-to-date specifications which can be incorporated into such a build. The High Speed 2 line will feature high speed train sets for forecast demand on a standard European loading gauge.

2.12. Unlike the West Coast Main Line, the larger structure gauge of the new line would allow taller trains with the possibility of double-decker train sets, such as the SNCF TGV Duplex, being utilised, should significant demand arise in the future. This presents a significant advantage over the minimum structure gauge of the conventional track, where upgrading to improve capacity has a higher cost.

Economic evaluation

2.13. The Benefit-cost ratio (BCR) of High Speed 2 running between London and Birmingham has been estimated as 1.6 and, if wider economic benefits are included, 2.0. With the full Y network (to Leeds and Manchester) these increase to 2.2 and 2.6 respectively. Of these 42% would accrue to London the South East and 63% are attributable to business[3].

2.14. The scale and complexity of the project are such that a higher BCR may not be possible. The Department for Transport appears to accept this and suggests that other non-monetised benefits underpin the case for high speed rail. Proper analysis of these benefits is therefore essential to ensure that the maximum benefits can be realised.

2.15. There are serious questions about the true value of time savings to business rail users, with modern portable ICT devices allowing productive use of time spent on train journeys. As the value of business time savings appears to play a major role in assessing the BCR of high speed rail travel, more evidence of its genuine value is needed.

2.16. The cost benefit ratio is also attended by cost, timing and performance risks associated with very large and complex projects over extended timescales. The standard ‘optimism bias’ has been included in the appraisal - yet this project would be one of the biggest, and most challenging civilian transport projects ever undertaken in Britain.

2.17. Unlike more conventional transport investment programmes, significant benefits would not start to flow until High Speed 2 was complete. Therefore the potential to change and adapt the project, should circumstances require it, is limited.

2.18. High Speed 2 would provide major opportunities for engineering in the UK. There would be work for engineering consultants and contractors and associated professionals including architects, surveyors, lawyers and project managers. However, there would also be considerable demands for materials and equipment, and the scale and maturity of the high speed rail industry in Europe and Asia would mean that these would be sourced globally. Two recent examples are the procurement of Tunnel Boring Machines for Crossrail[4]and new trains for Thameslink[5] which are being sourced from German based companies. The high speed rail industries are mature in Japan, France and Germany and are developing rapidly in China. There are already 15,000 kilometres of high speed rail around the world with 42,000 kilometres expected by 2024[6].

3 Economic Case for High Speed 2: The Y Network and London – West Midlands, DfT, February 2011

4 Crossrail Press Release, May 2011, http://www.crossrail.co.uk/news/press-releases/manufacture-crossrails-tunnel-boring-machines-to-get-underway-shortly

5 Thameslink Rolling Stock, Written Statement – DfT, June 2011 http://www.dft.gov.uk/news/statements/villiers-20110616

6 High Speed Rail: Fast track to sustainable mobility, International Union of Railways, November 2010

3. The High Speed Two proposals and alternatives

3.1. The proposals for a High Speed Rail Y shaped network do enhance capacity, speed and reliability, but any new line would accomplish this. More evidence needs to be presented to allow assessment of the 'value for money' argument.

3.2. The Department for Transport should encourage and support Network Rail to continue the development of other infrastructure projects independently and not have these delayed pending a decision on High Speed 2. This is particularly in respect of electrification of the Midland Main Line (MML) where there are minimal implications for High Speed 2, and none in High Speed 2 Phase 1 that might render this project abortive.

Rail Package 2 (RP2)

3.3. RP2 was put forward as part of the High Speed 2 Strategic Alternatives Study conducted on behalf of the government[7]; this was seen as the best strategic alternative to a new High Speed Rail line. However, RP2 was not a useful comparator.

3.4. RP2 called for several enhancements to the West Coast Main Line between London and the West Midlands to increase long distance capacity, including increasing service frequencies along with infrastructure improvements. RP2 also called for three new platforms at Euston and at Manchester Piccadilly stations along with four tracking along sections of the route.

3.5. Claims for capacity offered by these rail packages are implicitly based on the assumption of a peak level of service operating throughout the day. This is operationally untenable, and simply provides excess capacity when not required, hence the claimed low load factors.

3.6. Additional capacity offered at peak times by these alternatives is a relatively small increment to the current provision, and unlikely to cater for demand growth. Moreover, achieving even the small service level enhancements offered by RP2, services at intermediate station such as Milton Keynes and Coventry would be reduced.

3.7. RP2 would see journey times to Manchester reduced by 6.5 minutes and journey times to Birmingham by 12 minutes, as a result of serving fewer intermediate stations. The BCR as assessed by the study was between 1.3 and 1.9 depending on whether or not the rolling stock is leased or purchased respectively.

3.8. As with any upgrade to an existing line, disruptions would occur to existing services while upgrades were conducted and according to the Department for Transport analysis this is one of the main reasons RP2 was ruled out.

3.9. As the best strategic alternative to High Speed 2, we believe that RP2 should have been used as the "do minimum" scenario on which High Speed 2 should have been assessed. Instead both High Speed 2 and RP2 were assessed independently using slightly different reference cases.[8]

7 High Speed 2 Strategic Alternatives Study – London to West Midlands Rail Alternatives, Atkins, February 2011

8 These were modelled on the Passenger Demand Forecasting Handbook 4.1 and the scenario PLANET Long Distance created, which forecast demand on the West Coast Main Line increasing by ~60% by 2043. The study noted that the current West Coast Main Line forecast is for an increase of over 100% on the line by 2043 (not ~60% forecast by the PLANET model). The disparity goes some way in showing the difficulty in forecasting passenger demand 30 years out. Indeed in the Economic Case report, this figure changes to 64% by 2043.Economic Case for HIGH SPEED 2 – The Y Network and London – West Midlands, Department for Transport, February 2011

Do minimum

3.10. The “do minimum” analysis has been badly defined, with different analyses used to evaluate High Speed 2 and RP2. Although both start out with the same approach, RP2 included more assumptions of what a “do minimum” option would look like and this resulted in a difference in crowding levels which are “somewhat lower than those forecast by High Speed 2 Ltd”.

3.11. The High Speed 2 reference case, as set out in the Department for Transport’s Economic Case looks at “do minimum” developments up to 2026, the year when the first phase of High Speed 2 will commence, while the RP2 reference case includes developments up until 2019, a seven year difference in assumptions. Additionally, as the aim is to construct the network in phases, the benefits are delayed until later stages of the network have been created. This phased approach should have been utilised to create reference cases for each phase of the line.

3.12. We believe that High Speed 2 should have been compared against another “do minimum” option such as RP2 to allow a proper assessment to be conducted. As stated above, other developments will need to take place to ensure additional capacity on the conventional network is available up to 2026.

3.13. Unlike international services on High Speed 1, High Speed 2 is not a point- to-point railway and as such the comparison against what amounts to a do nothing option after 2019 is flawed. High Speed 2 will run onto the conventional network and improvements to this should have been considered as part of the High Speed 2 reference case.

3.14. We believe that even taking into account the difficulty of forecasting, the right analysis has not been conducted to compare High Speed 2 to alternatives. Although RP2 would not be sufficient to meet capacity constraints, this flawed analysis undermines the case for high speed rail.

4. Service levels and costs of rail travel

4.1. To evaluate whether High Speed 2 is a value for money option, an analysis of planned service levels is important. This has been presented in the Department for Transport’s *Economic Case for HS2* report as Appendix 1, with service specifications for both Phase 1 and Phase 2 included (although the latter has not been altered to show Heathrow service specifications or connections to High Speed 1).

4.2. This analysis needs to focus not just on service levels for High Speed 2 but also those on the West Coast Main Line and the High Speed 1 connection. High Speed 2 trains will be running onto the classic network and as a result detailed service specifications need to be developed to determine how many trains paths will remain on the West Coast Main Line after Phase 2. This is important given the commitment to increase the number of stations served by West Coast Main Line services which will have an impact on the number of train paths available.

4.3. We are also not aware of any formal activity to define service patterns for the West Coast Main Line after High Speed 2, although individuals have tabled proposals. This should be addressed urgently as the residual West Coast Main Line service, redesigned to meet local needs, should be a positive aspect of High Speed 2 for counties such as Buckinghamshire and Northamptonshire through which the new line passes. In addition, proposals for Euston station need to be developed with knowledge of the train service that it is to handle. There are indications that defining this train service in more detail will expose opportunities to reduce the cost and disruption of the works at Euston by freeing up additional platforms at Euston for High Speed 2 services.

4.4. Open access trains do not appear to have formed part of the government's thinking around the provision of train services. Open access trains could help to provide high speed services to destinations outside the network which are not planned as part of the franchise model.

Cost of rail fares

4.5. The Department for Transport has also looked at journey time savings as part of the economic case, to quantify what is classified as "value of time". This valuation is based on research into journey choices but has not been published alongside the consultation.

4.6. As discussed above, the time saving between London to Birmingham, as part of Phase 1, of 30 minutes may not be a significant benefit for many, especially at certain times of the day and rail fares could be the deciding factor on whether or not to use High Speed 2. We would hope that a significant study has been conducted to compare the differences in demand for rail services based on journey time savings and rail fares on the Southeastern Highspeed services, Gatwick Express and the Heathrow Express and their comparable alternative routes, to help inform the High Speed 2 fare levels. Southeastern Highspeed services which compete with Southeastern Main Line services (both under franchise) currently offer journey time savings of around 49 minutes from stations such as Canterbury West, Ramsgate and Ashford International, the difference in price is £5 which represents a minimal difference in rail fares for a significant journey time saving.

4.7. In 2008, the then Transport Secretary commissioned Passenger Focus to conduct a study into rail fares and ticket prices in the UK[9]. As part of this report, comparisons between France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland and the UK were conducted. The report looked at a variety of commuter journeys: short, medium and longer distance and also looked at long distance journeys (e.g. London to Manchester/Leeds/Glasgow).The results for these long distance journeys showed that for a walk-up fully flexible day return fare to the 'principal' city in each country, UK fares were 1.87 times higher than in the next most expensive country, Germany, and 3.31 times more expensive than the cheapest country, the Netherlands.

4.8. The Government has indicated its intention to conduct a consultation on rail fares in the UK. This may be the best opportunity to factor in how the price mechanism can encourage modal shift toward high speed rail, so that a holistic proposition could be developed for High Speed 2 and competing services.

5. International connections

5.1. A phased roll-out of the Y network seems essential to minimising construction costs, but the resulting overall timescale means that it would be some time before full benefits are experienced.

5.2. In addition, the connection for services to the continent does not appear to form part of the route selection process and has appeared as an afterthought, to the extent that no information is provided on available train paths in the Department for Transport's Economic Case.

High Speed 1 connection

5.3. A joined up High Speed network is a sensible solution, therefore it is unhelpful that this has not been significantly appraised.

9 Fares and Ticketing Study – Final report, Passengerfocus, February 2009 (for the purposes of this response - Appendix B)

The physical connection

5.4. The proposal for a single track link to High Speed 1, using part of the North London Line, appears very short-sighted. The consultation document itself seems to acknowledge the fact that mixing high speed international trains with London Overground services will create operational problems, and it is difficult to see how the conflicts involved can avoid having an impact on the robustness of High Speed 2 operations.

5.5. We accept that traffic projections can be difficult, but the proposed limit of three international trains an hour imposed by the proposed solution may turn into a major bottleneck in the long term. A single track connection may be acceptable, but a dedicated high speed route should be assessed, rather than what appears to be a halfway solution.

5.6. It should be noted that when the North London terminus for High Speed 1 was proposed, the North London line was suggested as the route to use to arrive into St. Pancras, but this was ruled out in favour of dedicated track.

5.7. London Overground has also made clear that significant capacity issues on the North London Line would only allow for one train path per hour per direction, a view they claim is supported by Network Rail. This needs to be considered alongside the disruptions which would need to occur on the existing line while connections are made.

The international connection

5.8. Given that the High Speed 1 connection would be able to provide an international service, border security equipment would potentially need to be deployed at every station on the High Speed 2 network. This is one reason why service provisions for the link to High Speed 1 needs to be urgently stated as this has a cost. In our view there would not be enough passengers to make a direct link viable without picking up passengers from St. Pancras.

5.9. One possible solution could be to use Ebbsfleet International as the primary interchange station allowing High Speed 2 services to run directly to Ebbsfleet and then have passengers transfer onto international or other services.

5.10. This use of Ebbsfleet, with its proximity to the M25, could also help with intermodal transfers from car to rail of passengers wanting to head to Birmingham and the rest of the Y network from the South East, as it would negate the need to travel into London. This would also reduce the additional loading on the underground network of passengers travelling across London to get to Euston.

5.11. Ebbsfleet could then perform the central hub role akin to Lille-Europe with destinations on the continent, connections to St. Pancras/Kings Cross for East Coast and Midland Main Line services, Euston for West Coast Main Line, Heathrow and Birmingham Interchange for flights and Birmingham and the north for through services. The area is also part of the Thames Gateway regeneration in Ebbsfleet Valley.

Heathrow and Birmingham Airports

5.12. The case for a direct link to Heathrow Airport has not been proven. The ‘spur’ solution implies a regular service of trains from the West Midlands and the North to Heathrow only (however this is not included in the service levels presented see 4.1). Such a link might be under utilised and wasteful of line capacity if offering a frequent service or prove unattractive to passengers if the service were infrequent. In addition, junctions on High Speed lines compromise the available headways and as a result line capacity. A possible solution could be a frequent, high quality shuttle to and from Old Oak Common, which would connect with all High Speed 2 services, similar to the Birmingham Airport link. Such a link might prove more beneficial both commercially and operationally.

5.13. Alternatively, if the Heathrow link were to go ahead, the Department for Transport could look at encouraging airlines to conduct code share agreements with High Speed 2 as conducted in France between SNCF and a number of airlines utilising through ticketing techniques, to achieve modal shift to rail from internal connecting flights within the UK and Europe.

5.14. Unless the Department for Transport plans to significantly intervene in the role and operation of Heathrow, a lot of the resulting destinations served by Heathrow will depend on the operation of the market and the supply provided by High Speed 2. Heathrow's role as a strategic national interest is currently being considered as part of the Department for Transport's *Developing a sustainable framework for UK aviation* consultation and we expect these questions to make reference to High Speed 2 proposals and the connection to Heathrow planned in Phase 2.

5.15. The link with Birmingham Airport seems sensible to provide a joined up transport system and could perhaps lead to a regional airport to compete with the South East and this should be applauded. However it is not clear why all the train paths put forward for the London to West Midlands route show a stop at Birmingham Interchange which is less than 10 minutes from Birmingham Curzon Street, which goes against one of the principles put forward for long distance city to city journeys.

6. The impact of principles and specifications used by High Speed 2 Ltd

6.1. The following questions have a direct impact on the BCR rating of the High Speed 2 proposal. A number of the principles and specifications presented have a direct impact on the route options which are subsequently available.

Speed

6.2. The specification of the requirement for 'internationally recognised levels of speed' has an impact on the route alignment, the aerodynamic design of the train, the power transmissions and the requirements for crash safety and safe operation. High Speed 2 is being designed for a line speed of 400km/h (250mph) with an expected running speed of 360km/h (225mph) at completion in 2026. While we accept the need to future-proof the network, no analysis has been presented as to why High Speed 2 requires a line speed of 400km/h, when the proximity of UK cities and the factors included below are factored in.

6.3. The International Union of Railways suggests "Maximum speeds should be determined on commercial factors (travel time between cities), estimated cost (extreme high speed may not be economically feasible), and technical issues."[10]

6.4. The initial 'reach' of High Speed 2 would be about 300kms (London ↔ Leeds & London ↔ Manchester) which (see table 2) is at the bottom end of the range of services operated in France, Germany and Spain. If connected to Glasgow and Edinburgh this would push High Speed 2 toward the top of this table with a reach of around 650kms for London to Glasgow and London to Edinburgh.

10 Necessities for future high speed rolling stock, UIC High Speed, January 2010

Sector	Distance
Paris – Marseille	770 kms
Madrid – Barcelona	600 kms
Madrid – Corruna	590 kms
Berlin - Munich	580 kms
Berlin – Cologne	560 kms
Paris – Bordeaux	550 kms
Madrid – Seville	510 kms
Berlin – Frankfurt	510 kms
Paris – Lyon	450 kms
Paris – Strasbourg	440 kms
Berlin – Hamburg	280 kms

Table 2: Key Intercity Distances in France, Germany and Spain
Source: Michelin European Route Planner

6.5. High Speed 1 has a line speed of 300km/h (186mph)[11] and TGV lines allow 320km/h (200mph), while most Japanese Shinkansen lines run at 300km/h (186mph)[12] and in China the highest design speed is 380km/h (236mph) but on completion this route, the Beijing to Shanghai, was slowed to 300km/h (186mph)[13].

Impact on route options

6.6. Higher line speeds require the radii of curves to be larger, affecting the route options available; a 200km/h track requires a minimum radius of 2500m and 300km/h one of 5500m[14] while a 400km/h requires a 7200m radius.[15]

Impact on costs

6.7. A decision to build a line at 400km/h also has an impact on both capital and operating costs. The technical specification provides no evidence of whether or not the cost of designing for higher speeds, including the impact on the quality requirements for permanent way structures, has been factored in.

6.8. Higher speeds require stronger permanent way structures and more frequent maintenance, leading to the possible procurement of non-standard equipment both in track building and possibly rolling stock.

6.9. One of the downsides of not building the entire Y network at once is the cost of rolling stock. According to the Economic Case, the classic-compatible fleet of trains that will be able to run on both the High Speed network and the conventional network each cost up to £23m more to build than a pure High Speed fleet.

Impact on energy consumption

6.10. Line speed is an issue for several reasons: energy consumption doubles when the speed is increased from 200km/h to 300km/h, carbon emissions per journey would therefore increase (see section 7 for more detail on carbon reduction,

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11 Facts and figures on the CTRL, DfT http://webarchive.nationalarchives.gov.uk/+/http://www.dft.gov.uk/pgr/rail/pi/ctrl/factsandfiguresonthectrl-/

12 High Speed Lines in the World, International Union of Railways, July 2010 http://www.uic.org/IMG/pdf/20110701_a1_high_speed_lines_in_the_world.pdf

13 China tests its high-speed rail link from Beijing to Shanghai, June 2011, Guardian: http://www.guardian.co.uk/world/2011/jun/27/china-high-speed-rail-beijing

14 High Speed Rail: Fast track to sustainable mobility, International Union of Railways, November 2010

15 Professor Andrew McNaughton FREng at the IET's Rail TPN Annual Lecture on High Speed Rail – 22nd October 2009

construction mitigation and sustainability) along with the cost of electricity. For that reason, without seeing the analysis conducted, it is not clear why the government is planning for a 400km/h design speed, except that it may allow trains of this speed to operate on the line in the future.

6.11. If the 400km/h design speed is retained, we hope that consideration will be given to operating the line at speeds below 360km/h to reduce energy costs and carbon emissions. Analysis conducted by the Institution of Mechanical Engineers suggest a maximum operating speed of only 320km/h (averaging 200-240km/h) until improvements in a decarbonised electricity supply mix, aerodynamics and power transmission are developed[16].

7. Carbon reduction and sustainability

7.1. The high-speed line could lead to an increase, not a reduction in CO_2 emissions if assessed in isolation. If a reduction in CO_2 emissions is a driver for transport policy, a more comprehensive analysis (including, for example, the contribution of longer distance commuting, enabled by reduction of intercity traffic on the main routes) is needed.

7.2. The twin-track approach of modal shift from road to rail and reducing the emissions from road transport by advanced engineering encouraged by the EU targets for reductions in car emissions, will reduce emissions from transport. However, it is unlikely to be adequate to meet the 80 percent reduction in emissions, enshrined in the 2008 Climate Change Act and supported by the Coalition Government.

7.3. Most (65%) of the travel on High Speed 2 is expected to come from people whom would use the railways anyway; followed by new trips (22%). Only a minority of those using High Speed 2 would switch from car (7%) and air (6%)[17]. So relief to these other forms of transport would be small with the exception of air travel between Scotland and London, and the scale of this would depend on how the airlines responded.

Energy consumption of present-day trains

7.4. A study carried out for the Rail Safety and Standards Board, acting on behalf of the Department for Transport, analysed the measured energy use of a number of present-day intercity trains.[18] Data from that paper are shown in Figure 1.

16 High Speed Rail 2 – Transport Policy Statement: 20/01, Institution of Mechanical Engineers, September 2010
17 Economic Case for High Speed 2: The Y Network and London – West Midlands, table 3.
18 Kemp R J, Traction Energy Metrics, RSSB Research Report T618, June 2007

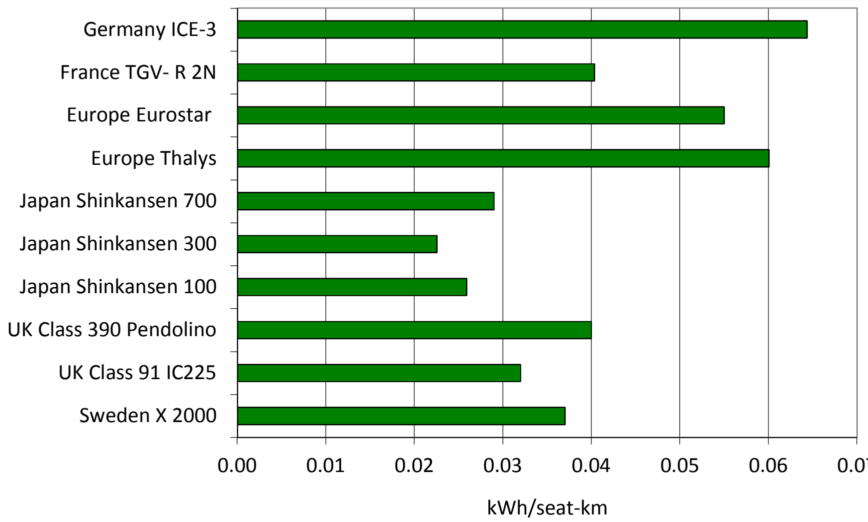

Figure 1: Energy consumption of intercity trains

7.5. It can be seen that energy use varies between 0.023 and 0.065 kWh/seat-km. This wide variation is related to the operating speed and number of stops, the drag factors and also the number of passengers that are seated per metre of train. British trains are at the lower end of the spectrum because of the narrow allowable body width, due to Victorian infrastructure limits, and dead space at the ends of trains, due to safety requirements.

7.6. If one takes Eurostar as typical of a 300km/h train built to British requirements, the energy use is 0.055 kWh/seat-km. Using the estimated figure for the 2030s carbon intensity of electricity of 200g/kWh, this is equivalent to CO_2 emissions of 11 g/seat-km.

Modal comparisons

7.7. To compare the emissions of different modes of transport in 20 years time requires a number of assumptions: the technical specification of the vehicles, their source of energy, the proportion of seats occupied, the maximum speed and the driving style.

7.8. For inter-city trains, where passengers expect to have a seat, the load factor is defined as the number of passengers divided by the number of seats. Some TOCs, principally those operating long-distance trains, achieved load factors around 40%, but most average 30% or less. It has to be remembered that these are averages over the day and over the route. Some long-distance services, such as Euston to Glasgow, have several intermediate stops; a train may be "standing room only" leaving Euston but at Warrington, Wigan, Preston, Lancaster and Carlisle more people leave than join so, by the time it crosses the Scottish border, fewer than a quarter of the seats may be occupied.

7.9. For the RSSB study, it was assumed that long-distance train operators achieve 40% load factors and that all other operators achieve 30%. The two air routes are assumed to have a load factor of 70%, which is typical of European short haul traffic. (NB: The A321 was used in the original RSSB study as the data was available; the predominant planes on the Scotland-London routes are A319 and A320, which will have slightly different fuel consumption patterns.)

7.10. The load factor of the new high-speed train, referred to as "Eurostar derivative" was taken as 40% – the same as other long-distance domestic trains and much less than the 60% achieved by Eurostar in 2007[19]. There are two reasons for this:

- Firstly, Eurostar mainly carries passengers' end-to-end so does not experience the drop-off in numbers over a journey, as was described earlier for the Euston – Glasgow route. The new line, on the other hand, is more like a conventional service with intermediate stations.
- Secondly, Eurostar competes with airlines that have fixed booking systems and where passengers can expect time-consuming security procedures; they are thus likely to accept a booking system where they may not get a reservation for their 2½ hr trip on their preferred train. The new train will be operating on routes like London-Birmingham with a journey time of 50 minutes. On short trips like this, passengers will expect a "turn-up and walk-on" service when they want to travel, rather than an inflexible pre-booked seat.

7.11. From the point of view of emissions per passenger-km, the new trains could be expected to have a performance comparable to the Eurostar fleet; while the "intercity" trains against which they are compared would have similar characteristics to the present Pendolino trains on the West Coast Main Line (this does not include the carbon costs of construction, see 7.18 below). This is rather different to the figures implied by Figure 1.2 in the consultation document, copied as Figure 2 below. In this graph, Eurostar is shown as having emissions roughly similar to those calculated above, while intercity rail is shown as more than twice the above figures.

7.12. One can surmise that this is because the Eurostar is assumed to be fed with French "nuclear" electricity while intercity rail is assumed to be fed by the current UK electricity energy mix, a distinction which is inappropriate if the purpose of the document is to represent alternatives for the UK in the 2030s.

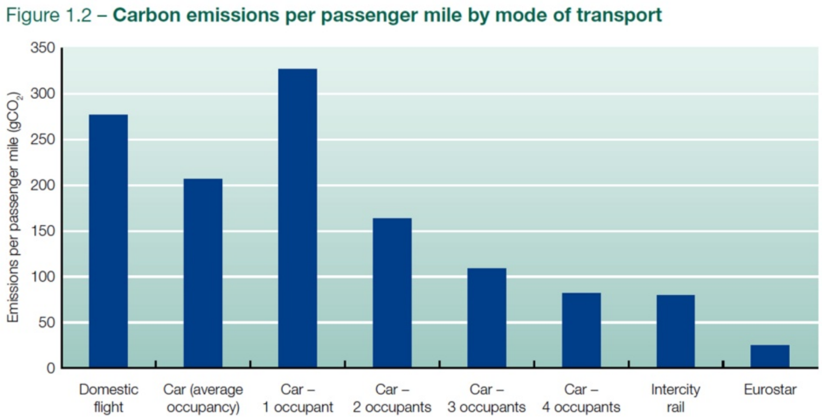

Figure 2: Modal comparison from consultation document

Mitigating the impact of construction

7.13. Historically, railways have always tried to be reasonably 'neutral' in terms of large scale earth moving. Alignments were designed to use earth removed from cuttings in adjacent embankments such that large amounts of spoil removal or infill material import were not needed. Clearly the impact of geography and

19 Supplementary memorandum from Eurostar (RWP 11A), Transport Select Committee, February 2008, http://www.publications.parliament.uk/pa/cm200708/cmselect/cmtran/219/219we15.htm

operational performance meant that could not always be completely achieved but it was a design objective.

7.14. Increasingly, we have seen concern to alleviate noise and visual impact along high-speed lines pushing the route into otherwise unnecessary tunnels and cuttings. This occurred on High Speed 1 and again for High Speed 2 large amounts of tunnel and cutting is being proposed.

7.15. On the exit from London this is clearly unavoidable; however, in other areas, this is trading benefits in terms of ‘soft’ environmental issues such as noise and visual impact for the hard environmental and financial cost of excavating and disposing of large amounts of additional spoil on a 22 metre wide alignment. Each additional 1m of depression means that another 22,000 cu metres of spoil per kilometre needs to be disposed of.

7.16. The cost and CO_2 burden (a hard environmental cost) of having to excavate, transport and dump the millions (probably tens of millions) of tons of excess spoil generated is substantial and unrecoverable.

7.17. Further, 11% of the route in tunnel means reduced journey times and additional energy usage through the life of the line, both adding cost and reducing benefit. As well as running cost, this will add a CO_2 burden the magnitude of which can only be ascertained once the generating mix is known.

7.18. The risk resulting from a vehicle intrusion from a road over rail bridge (a ‘Selby’ type accident) is significant in the overall risk assessment. Every road over rail bridge will thus need extensive intrusion protection measures and it is assumed that a lower alignment means more roads over rail bridges. Tunnels do at least avoid that risk.

7.19. A holistic assessment therefore needs to be made to confirm that the net environmental impact of the noise and visual impact mitigation measures proposed is justifiable.

8. Concluding remarks

8.1. There are a number of engineering and economic issues that need further scrutiny before reaching a decision on the High Speed 2 proposal. The discussion above highlights the issues that the IET and the Royal Academy of Engineering believe are of particular importance.

8.2. If High Speed 2 is to deliver the environmental benefits intended, there must be robust evidence that it truly diverts passengers from car and air transport and that the high speeds intended do not lead to increased emissions. If it is to deliver the desired economic benefits, there must be evidence that it presents the level of value to business travellers claimed, and that it is the best option for boosting the economy of Northern cities. In essence, High Speed 2 could be a landmark engineering project, but issues such as these must be resolved for it to be a success.