



HIGH SPEED TWO PHASE ONE INFORMATION PAPER

E10: CARBON

This paper outlines the carbon footprint and greenhouse gas assessment for HS2 Phase One.

It will be of particular interest to those potentially affected by the Government's proposals for high speed rail.

This paper was prepared in relation to the promotion of the Bill for Phase One of the scheme which is now enacted. Although the contents were maintained and updated as considered appropriate during the passage of the Bill (including shortly prior to the enactment of the Bill in February 2017) the contents are now historic and are no longer maintained.

If you have any queries about this paper or about how it might apply to you, please contact the HS2 Helpdesk in the first instance.

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1. Introduction

- 1.1. High Speed Two (HS2) is the Government's proposal for a new, high speed north-south railway. The proposal is being taken forward in two phases: Phase One will connect London with Birmingham and the West Midlands and Phase Two will extend the route to Manchester, Leeds and beyond.
- 1.2. HS2 Ltd is the non-departmental public body responsible for developing and promoting these proposals. The company works to a Development Agreement made with the Secretary of State for Transport.
- 1.3. In November 2013, HS2 Ltd deposited a hybrid Bill¹ with Parliament to seek powers for the construction and operation of Phase One of HS2 (sometimes referred to as 'the Proposed Scheme'). The Bill is the culmination of nearly six years of work, including an Environmental Impact Assessment (EIA), the results of which were reported in an Environmental Statement (ES) submitted alongside the Bill. The Secretary of State has also published draft Environmental Minimum Requirements (EMRs), which set out the environmental and sustainability commitments that will be observed in the construction of the Proposed Scheme.
- 1.4. The Bill is being promoted through Parliament by the Secretary of State for Transport (the 'Promoter'). The Secretary of State will also appoint a body responsible for delivering the Proposed Scheme under the powers granted by the Bill.
- 1.5. This body is known as the 'nominated undertaker'. There may well be more than one nominated undertaker – for example, HS2 Ltd could become the nominated undertaker for the main railway works, while Network Rail could become the nominated undertaker for works to an existing station such as Euston. But whoever they are, all nominated undertakers will be bound by the obligations contained in the Bill and the policies established in the EMRs.
- 1.6. These information papers have been produced to explain the commitments made in the Bill and the EMRs and how they will be applied to the design and construction of the Proposed Scheme. They also provide information about the Proposed Scheme itself, the powers contained in the Bill and how particular decisions about the project have been reached.

2. HS2 and Climate Change

- 2.1. This paper outlines the carbon footprint and greenhouse gas assessment for HS2 Phase One.

¹The High Speed Rail (London – West Midlands) Bill, hereafter 'the Bill'.

- 2.2. The approach, the context and results of the greenhouse gas assessment of the Proposed Scheme are presented in the Environmental Statement, which consists of the environmental statement that was deposited with the hybrid Bill in November 2013, the environmental statements for subsequent additional provisions and the supplementary environment statements. The assessment reports the greenhouse gas emissions in the form of the 'carbon footprint'² of the Proposed Scheme and a discussion of its potential significance.
- 2.3. A linked, but separate, Information Paper (Eg: Climate Change Adaptation and Resilience) has been produced which outlines:
 - how the combined impact of the Proposed Scheme and potential climate change, on the receiving environment and community, has been assessed; and
 - how the Proposed Scheme's resilience and capacity to cope with potential climate change impacts has been assessed.

3. Policy background

- 3.1. The Proposed Scheme has developed against a background of emerging concern about climate change. The Kyoto Protocol of 1997 took the lead in converting this concern into action at an international level, and was followed in the UK by the Climate Change Act 2008, which set statutory targets for carbon reduction.
- 3.2. The Carbon Plan (2011)³ sets out the Government's plans for achieving the greenhouse gas emissions reductions committed to in the Climate Change Act and the first four carbon budgets. Low carbon transport is an essential part of the Carbon Plan. The Plan states that rail travel will become substantially decarbonised through increasing electrification and the use of more efficient trains and lower carbon fuels. Furthermore, the Plan notes that further electrification of the rail network will support low carbon modal shift in the future. In addition the freight sector will have found lower carbon ways of working, such as modal shift to rail and water.

4. HS2 Ltd Policy

- 4.1. The HS2 Ltd Sustainability Policy⁴ states the aim to "minimise the carbon footprint of HS2 as far as practicable and deliver low carbon long distance journeys that are supported by low carbon energy".

² A carbon footprint is the total greenhouse gas emissions associated with a particular scheme, policy or development. The greenhouse gas emissions are converted into tonnes of carbon dioxide equivalent (tCO_{2e}) which standardises the global warming potential of the six greenhouse gases regulated under the Kyoto protocol into one index based on the global warming potential of CO₂.

³ The Carbon Plan (2011), <https://www.gov.uk/government/publications/the-carbon-plan-reducing-greenhouse-gas-emissions>

⁴ Environmental Statement, Volume 1, figure 2.

5. Assessment of Greenhouse Gas Emissions

- 5.1. A bespoke carbon model⁵ has been developed for the greenhouse gas assessment of the Proposed Scheme. The assessment approach has been informed by national and international standards and guidance and is based on the following greenhouse gas sources from the Proposed Scheme:
- construction - embedded emissions in construction materials, associated construction activities;
 - operational - electricity from the national grid used to power the Proposed Scheme's trains, stations and tunnel fans;
 - modal shift of passengers during operation - the Proposed Scheme will attract users from road, the classic rail network and aviation;
 - surface access during operation - new journeys to access the Proposed Scheme's stations;
 - modal shift of freight during operation - released capacity on the classic network will allow additional freight to move from road to rail; and
 - carbon sequestration - from planting 2 million trees.
- 5.2. The assessment covers the construction period (2017 -2026) and 60 years (2026 - 2085) of operation. Although the design life of the Proposed Scheme is 120 years, the 60 year operational assessment period is consistent with the assessment period used in the Economic Case for HS2.
- 5.3. An assessment covering such a long timescale requires a number of assumptions to be made including:
- the rate of replacement of fossil fuel electricity generation with low carbon generation capacity;
 - the ability of the steel and cement industries to implement greater efficiencies;
 - the rate of uptake of electric cars; and
 - changes in aviation policy around fuels and airport capacity.
- 5.4. Consequently, the carbon footprint is presented as a range to take account of these uncertainties. This range is represented by two scenarios based largely on projections for the replacement of fossil fuel electricity generation with low carbon alternative electricity generation and electric vehicle uptake forecasts.

⁵The carbon model calculates the carbon footprint by combining the units of quantity of materials, distance and land area with the appropriate emission factors, and then subtracting the benefits of emission reductions due to modal shift from road and air onto the Proposed Scheme, carbon sequestration associated with tree planting and benefits from released capacity on the classic network allowing additional freight to move from road to rail.

6. Carbon Footprint

- 6.1. There is a large carbon saving associated with the operation of the Proposed Scheme. The Proposed Scheme's operational emissions are anticipated to result in between -2,970,000 tonnes of carbon dioxide equivalent (tCO₂e) and -3,160,000 tCO₂e over the 60 year operational assessment period, once modal shift⁶, carbon mitigation from tree planting and freight benefits from released capacity⁷ on the classic network are taken into account. There is also a wider benefit associated with the increase in the total carrying capacity of the rail transport system; since the Proposed Scheme would increase the total capacity of the rail transport system, it would provide a means to free up capacity on existing rail networks.
- 6.2. The significant passenger capacity of the Proposed Scheme, combined with its ability to draw power from an increasingly decarbonised National Grid, means that it would be one of the most effective low carbon transport solutions for travel between London and the West Midlands in 2030. In terms of emissions per passenger kilometre, the Proposed Scheme is 8 gCO₂e/pkm⁸ as compared to inter-urban cars (67 gCO₂e/pkm); intercity rail (22 gCO₂e/pkm⁹) and UK domestic flights (170 gCO₂e/pkm), based on projected carbon emissions in 2030.
- 6.3. Nevertheless, the greenhouse gas emissions associated with the construction of the Proposed Scheme are significant, as might be expected from a national level infrastructure scheme. The construction carbon footprint is estimated to range between 5,755,000 tCO₂e and 6,125,000 tCO₂e¹⁰. This is mostly a result of the construction of tunnels, earthworks, bridges, viaducts and underpasses many of which have been included in order to mitigate other significant environmental noise and visual effects.
- 6.4. When the operational and construction carbon footprints of the Proposed Scheme are combined to form a total carbon footprint over the 60 year assessment period (plus the 10 years of construction), the residual carbon ranges between 2,595,000 tCO₂e and 3,155,000 tCO₂e. This includes all emissions associated with construction, operation and maintenance of the Proposed Scheme, as well as modal shift, carbon mitigation from tree planting and freight benefits from released capacity on the classic network. If the same assumptions for the first 60 years of assessment are extended for another 60 years to align

⁶ The transfer of passenger journeys from the classic rail network, road and air to the Proposed Scheme.

⁷ Current work shows that capacity released by the Proposed Scheme should enable at least 10 freight paths per day from London to the West Midlands in each direction, giving at least 20 additional freight paths per day. More freight paths may become available during the course of timetable development, and would provide further benefits.

⁸ Grams of carbon dioxide equivalent per passenger kilometre.

⁹ It should be noted that the intercity rail forecast is for the entire classic network, including the predicted mix of both diesel and electric trains in 2030.

¹⁰ The construction carbon footprint in the main ES was estimated to range between 5,300,000 tCO₂e and 5,590,000 tCO₂e. Assuming no improvement from 2013 in the efficiency of the manufacture of materials such as steel and their use in construction, the construction carbon footprint could be up to 6,460,000 tCO₂e. See information paper E32: Guide to the Environmental Statement for a description of the changes to the Proposed Scheme since the main ES.

with the 120 year design life of the Proposed Scheme, the footprint ranges from 305,000 tCO₂e to 815,000 tCO₂e.

- 6.5. The operational and construction carbon footprints of the Proposed Scheme do not account for (i.e. subtract) the emissions associated with an alternative option to address the projected future transport infrastructure constraints between London and the West Midlands. As a comparison, the construction of a new motorway would have a smaller construction footprint (based on very simple high level design); however its operational footprint would be significantly higher ranging between 23 and 25 million tCO₂e over a 60 year appraisal period.
- 6.6. The benchmarking of the Proposed Scheme's annualised construction and operation emissions against the UK's projected carbon footprint in 2030 shows that it represents a small contribution to the UK's annual emissions (0.15%). Operational emissions in 2030 are estimated at 0.06% of projected total UK transport emissions in 2030.
- 6.7. The European Union Emissions Trading System (ETS), a cap and trade system with a decreasing cap over time, is a significant policy tool available for implementing the Carbon Plan. The emissions of the UK's electricity generation sector used to power the Proposed Scheme are regulated by the EU ETS, as are EU cement and steel industries which are likely to be used in the construction of the Proposed Scheme. The emissions associated with the total carbon footprint of the Proposed Scheme will therefore be largely regulated through the EU ETS. This means that, overall, most of the Proposed Scheme's carbon emissions will not contribute to an increase in Europe-wide carbon emissions.
- 6.8. Additionally, greenhouse gas emissions from journeys currently (and in the future) made by road and classic diesel rail that are currently not traded within the EU ETS cap, which will be taken on the Proposed Scheme through mode shift, will become tradable within the EU ETS cap.
- 6.9. Greenhouse gas emissions not regulated by the EU ETS, predominantly from construction, will be managed through other policy tools as part of the Climate Change Act target of at least an 80% reduction in emissions by 2050. Nevertheless HS2 Ltd is committed to minimising carbon emissions both in the traded and non-traded sectors by implementation of its Sustainability Policy.
- 6.10. HS2 Ltd cannot directly influence all of the elements that underpin the carbon footprint. Some of the elements of the carbon footprint are only influenced by Government, whilst others are related to the commercial decision of private companies, outside the direct control of both Hs2 Ltd and the Government.

7. HS2 Ltd's Carbon Minimisation Policy

- 7.1. In accordance with the climate change objective of the HS2 Sustainability Policy, a carbon management strategy will be developed and applied and will:

- calculate the carbon footprint of the Proposed Scheme and use this as a tool to assess the potential to reduce carbon across the design, construction and operation phase;
 - consider low carbon options in developing the detailed design of the Proposed Scheme;
 - reduce embedded carbon in construction materials and carbon emissions from construction works, where practicable;
 - reduce energy requirements of the scheme and maximise the energy efficiency of operations, if practicable;
 - use and/or generate low carbon energy, if practicable; and
 - sequester carbon, if practicable.
- 7.2. This approach forms a hierarchy of actions, with avoidance generally being the most preferable option. The carbon footprint will be calculated at appropriate intervals to determine progress in carbon reduction.

8. More information

- 8.1. More detail on the Bill and related documents can be found at: www.gov.uk/HS2