HS2

PFMv9 Step Through Report

May 2020

Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

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1.1 Introduction

1.1.1 This document outlines the incremental effect of changes in HS2 Ltd.'s approach to developing the Economic Case for the HS2 scheme.

1.1.2 The report provides a summary of the key changes made to the analysis that supports the assessment of the Economic Case for HS2 since the last HS2 business case that was published in 2017, and the effect of these on the appraisal outputs.

1.1.3 This document is one of a series that provides explanation and analysis of the evidence which underpins the appraisal of HS2, including the PLANET Framework Model Development Report, Assumptions Report, and Forecasting Report.

1.1.4 As with any scheme, the Economic Case for HS2 will evolve over time and be influenced by many factors including:

- The design of the scheme;
- External factors such as economic or population forecasts, as well as future conventional rail service assumptions; and
- The guidance on forecasting and appraisal of transport schemes.

1.1.5 Since the 2017 Economic Case, HS2 Ltd has continued to develop and improve its modelling and economic appraisal tools, enhancing the evidence that informs forecast passenger demand. The specification of the scheme has been further developed, including refinements to the route for the Full HS2 Network. There have also been developments in transport modelling and appraisal best practice that have been incorporated into the Department for Transport's 'Transport Analysis Guidance' (TAG).

1.1.6 These changes have been incorporated into the analysis supporting the Economic Case. This document provides an assessment of the impact that specific changes have had on the point-estimate Benefit-Cost Ratio (BCR) of the HS2 scheme. The document also outlines the impact on the BCR of the latest cost estimates for the scheme.

1.2 Summary of Changes

1.2.1 The benefits and revenues forecasts in the current Economic Case, as set out in the Full Business Case (FBC) for Phase One, has been assessed using a newly-developed version of the PLANET Framework Model (PFM) known as PFM v9, which has been updated with various revisions to modelling and economic appraisal methods since the release of the previous model version, PFM v7.1, as used in the 2017 Economic Case.

1.2.2 This document outlines key changes in the assessment of benefits and revenues forecast for the Full HS2 Network scheme as a series of steps, from the 2017 Economic Case to the current Economic Case in the Phase One FBC, published in April 2020.

1.2.3 The key changes that have been made to the PFM modelling suite since the previous model release are as follows:

- Step 1: 2018 TAG Databook update including revised demand forecasts
- Step 2: Whole network train service specification (TSS) update
- Step 3: Revised schedule including appraisal year change
- Step 4: 2019 TAG Databook update including revised demand forecasts
- Step 5: HS2 TSS Revision (including a reliability methodology update)

1.2.4 Steps 1 to 5 each impact the benefits and revenues estimated for the scheme. The nature of this impact is described in separate sections in this report.

1.2.5 The report also covers key updates to other inputs to the BCR assessment of the scheme, as follows:

- Step 6: Updated Wider Economic Impacts (WEIs)
- Step 7: Updated operating cost estimate
- Step 8: Updated capital cost estimate

1.2.6 The detail of changes undertaken in Steps 6 to 8 is also described in separate sections in this report.

1.2.7 It should be noted that some of the changes made in Steps 1 to 5 would potentially drive some change in the items described under Steps 6 to 8. For example, an alteration to the HS2 Train Service Specification (TSS) would in turn drive some change in Operating Costs. However, for the purpose of this report, the impact assessment is set out in separate steps. Thus, in the example given, the change in benefits and revenues due to a change in the HS2 TSS would be captured in Step 5,

whilst the impact on Operating Cost of this change would be captured within changes outlined under Step 7.

1.3 Overall Impact of Changes

1.3.1 The overall impact of the updates that have been implemented in the Economic Case assessment of the Full HS2 Network between 2017 and 2020 is presented in Table 1.

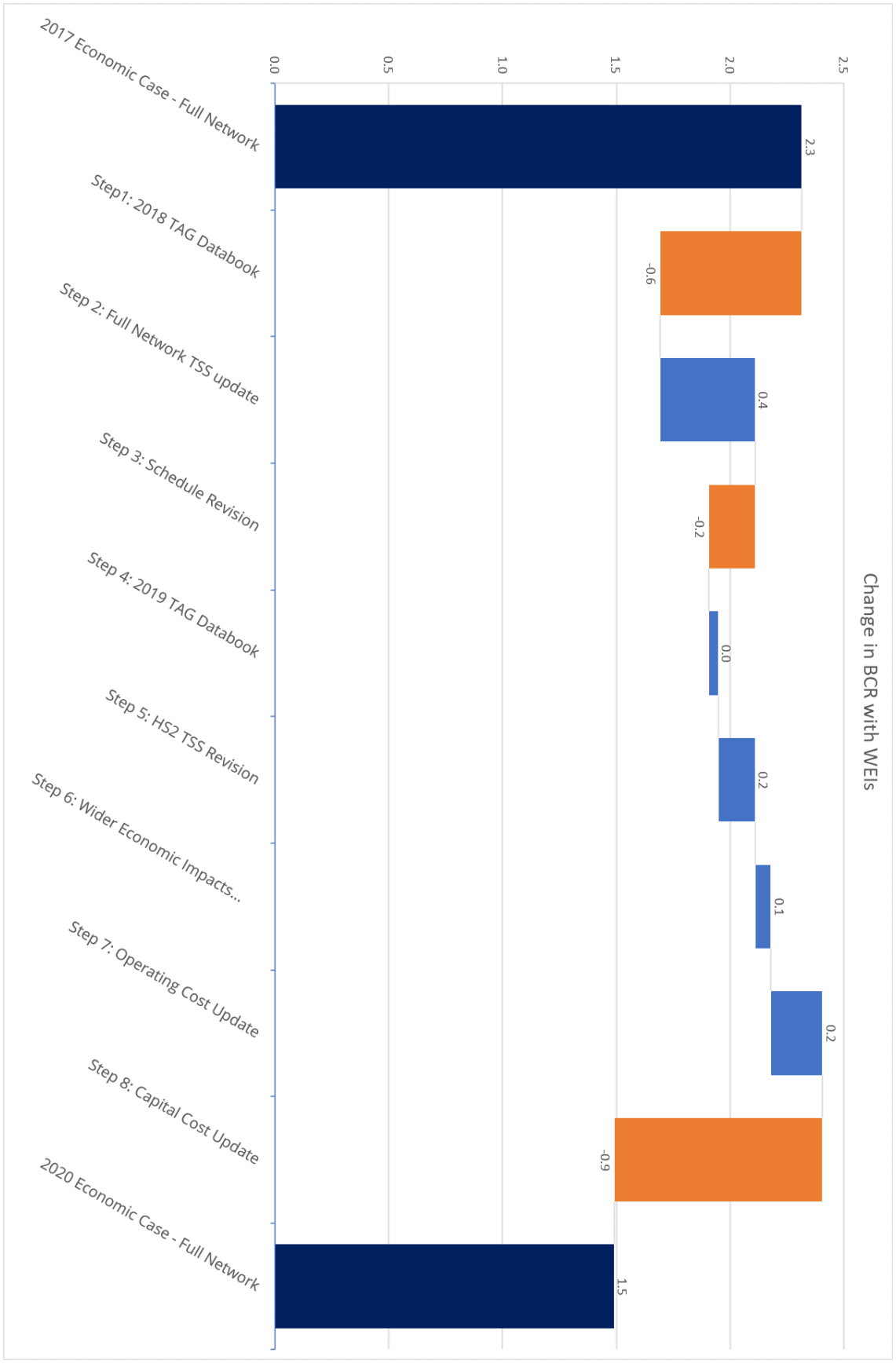
Table 1: Quantified costs and benefits for the 2017 and 2020 Economic Cases of the Full HS2 Network

Item	Full HS2 Network, Present Value, £bn 1Q2015 prices		
	2017 Economic Case	2020 Economic Case	Change
1a Transport User Benefits – Business	61.2	59.9	-2.0%
1b Transport User Benefits - Other	17.1	17.6	2.4%
2 Other quantifiable benefits	0.4	0.8	118.2%
3 Loss to Government of Indirect Taxes	-4.1	-4.1	1.9%
4 Net Transport Benefits (PVB)	74.6	74.2	-0.6%
5 Wider economic impacts (WEIs)	17.6	20.5	16.3%
6 Net benefits including WEIs = (4) + (5)	92.2	94.7	2.6%
7 Capital Cost	51.8	78.2	51%
8 Renewals	4.0	5.4	35%
9 Operating Costs	27.6	25.2	-8.6%
10 Total Costs = (7) + (8) + (9)	83.4	108.9	30.5%
11 Revenues	43.6	45.4	4.1%
12 Net costs to Government = (10) – (11)	39.8	63.5	59.3%
13 BCR without WEIs (ratio) = (4) / (12)	1.9	1.2	-37.6%
14 BCR with WEIs (ratio) = (6) / (12)	2.3	1.5	-35.6%

1.3.2 The change in the Full HS2 Network BCR (including WEIs) from 2017 to 2020 is displayed in Figure 1. The chart shows the change in the BCR for each of the steps outlined in section 1.2. The nature of the changes to the BCR may be summarised as follows:

- Step 1 reduces the BCR, primarily due to reduced demand and 'Value of Time' forecasts for future years, largely driven by downgraded forecasts for economic drivers (e.g. GDP).
- Step 2 increases the BCR, largely due to TSS updates made to both the HS2 and conventional rail network.
- Step 3 reduces the BCR, due to changes in the scheme schedule.
- Step 4 results in a marginal increase in the BCR, due in part to changes included in the May 2019 Transport Analysis Guidance (TAG) Databook.
- Step 5 increases the BCR due to further revision of the HS2 TSS assumptions, plus inclusion of an updated reliability and environmental modelling methodology.
- Step 6 increases the BCR due to updates made to the model and inputs used to assess the Wider Economic Impacts (WEIs) of the scheme.
- Step 7 increases the BCR due to updates made to the operating cost estimate since 2017.
- Step 8 reduces the BCR due to updates made to the capital cost estimate since 2017.

Figure 1: Changes in Full HS2 Network BCR (with WEIs) between 2017 and 2020 Economic Cases



1.3.3 The remainder of this report will provide detail on the steps outlined in Figure 1.

2 Step 1: 2018 Databook Update and Revised Demand Forecasts

2.1 Introduction

2.1.1 This step includes the following updates to the PFM:

- 2018 Transport Analysis Guidance (TAG) Databook Update, including March 2018 Office for Budget Responsibility (OBR) forecasts
- Rail Demand Update
- Rebuild of the Highway Demand Matrices
- Air Demand Update

2.1.2 Table 2 below indicates the change in benefits and revenues in this step.

Table 2: Change in quantified costs & benefits following Step 1: Full HS2 Network

Item	Full HS2 Network, Present Value, £bn 1Q2015 prices		
	2017 Economic Case (PFM v7.1)	After Step 1 Update	Change
Transport User Benefits – Business	61.2	49.2	-19.6%
Transport User Benefits - Other	17.1	14.7	-14.2%
Other quantifiable benefits	0.4	0.3	-9.0%
Loss to Government of Indirect Taxes	-4.1	-3.7	-9.8%
Net Transport Benefits (PVB)	74.6	60.6	-18.8%
Revenues	43.6	39.1	-10.2%

2.2 Outline of Changes

2018 TAG Databook Update

2.2.1 The TAG Databook contains guidance on parameters that are used in PFM and the overall economic appraisal. The following have been updated in this step:

- Gross Domestic Product (GDP) growth forecasts;
- Population growth forecasts;
- Inflation and earnings growth data;
- Market Price Adjustment;
- Fuel Costs;
- Car Fleet Proportions (Petrol/Diesel/Electric);
- Marginal External Costs and Indirect Tax assumptions; and
- Carbon Value per Tonne.

2.2.2 These updates impact the forecast growth in the value of time (VoT), and vehicle operating costs. The largest impact arises from VoT changes, whereby the value of passengers' time is forecast to grow more slowly than was previously forecast, leading to a reduction in the value of the forecast benefits of the scheme.

2.2.3 The impact of this update is to reduce forecast benefits and revenues.

Rail Demand Update

2.2.4 The 'rail demand drivers' aligned with the May 2018 TAG Databook were adopted in this Step, as were changes to the forecasting methodology, in line with updated DfT TAG guidance. These rail demand drivers include latest forecasts for a number of factors which influence growth in the rail market, such as growth in GDP and population.

2.2.5 The changes result in a reduction in rail demand forecasts. The implication of lower rail demand is a reduction in the number of passengers that can benefit from HS2, as well as a reduction in the level of crowding in the 'Do Minimum' (without HS2) scenario.

2.2.6 The impact of this update is to reduce forecast benefits and revenues.

2.2.7 Further detail on the changes to the demand forecasts can be found in the latest PFM Demand Forecasting Report.

Rebuild of Highway Matrices

2.2.8 The base year highway demand matrices in the PLANET Long Distance (PLD) sub-model were rebuilt for PFM v9 using demand matrices from Highways England's Regional Transport Models (RTMs).

2.2.9 This update ensures that all the highway demand data comes from a single source (unlike previous versions of PFM) and provides an improved base demand matrix from which to forecast future year matrices.

2.2.10 The impact of this update on benefits and revenues is minimal.

Air Demand Update

2.2.11 The level of forecast air demand was updated using latest air demand forecasts from the DfT's Aviation Model. These new forecasts have reduced the levels of forecast air demand in both forecast years, as well as changing some of the patterns between regions.

2.2.12 The impact of this update on benefits and revenues is minimal.

3 Step 2: Whole Network Train Service Specification (TSS) Update and Do Minimum Demand Response

3.1 Introduction

3.1.1 This step includes the following updates to PFM:

- High-Speed and Conventional Rail TSS Updates
- Inclusion of a Do Minimum Variable Demand Response
- Adjusting the Second Forecast Year to 2039/40

3.1.2 The impact of these updates is shown in Table 3 below:

Table 3: Change in quantified costs & benefits following Step 2: Full HS2 Network

Item	Full HS2 Network, Present Value, £bn 1Q2015 prices		
	After Step 1 Update	**After Step 2 Update**	**Change**
Transport User Benefits – Business	49.2	54.4	10.5%
Transport User Benefits - Other	14.7	16.9	14.6%
Other quantifiable benefits	0.3	0.4	6.2%
Loss to Government of Indirect Taxes	-3.7	-4.1	11.8%
Net Transport Benefits (PVB)	60.6	67.5	11.4%
Revenues	39.1	43.9	12.1%

3.2 Outline of Changes

High-Speed and Conventional Rail TSS Updates

3.2.1 PFM v9 contains a full revision of the conventional rail TSS assumptions. These assumptions were supplied by the DfT, covering services for future scenarios both with and without HS2.

3.2.2 As well as updating assumptions on the general level of service provision and frequency, the vehicle capacities of all conventional rail services have been updated to reflect the latest assumptions in the DfT's National Modelling Framework (NMF).

3.2.3 There have also been some changes to the high-speed service specification since PFM v7.1, including:

- Serving Stafford – Stoke – Macclesfield in Phases 2a and 2b, with a London service to Preston and Liverpool via a split-join at Crewe.
- A phased opening scenario in the first year of operation (2026/27 for this update) for the Full HS2 Network, with 3 trains per hour (tph) operating between Old Oak Common and Birmingham Curzon Street stations.

3.2.4 The impact of this update is to increase forecast benefits and revenues.

3.2.5 Further detail on the changes to the TSS assumptions can be found in the latest PFM Assumptions Report.

Do-Minimum Variable Demand Response

3.2.6 This step includes a change in modelling methodology to enable a demand response to supply side changes in the Do Minimum scenario. This considers changes in infrastructure and crowding conditions between a hypothetical 'Do Nothing' scenario (i.e. where no change is made to the current railway supply in future years) and the Do Minimum.

3.2.7 This change results in a reduction in forecast demand on the West Coast Mainline as demand is constrained due to increased crowding. Conversely, an increase in demand is forecast along the East Coast Mainline in response to planned infrastructure improvements.

3.2.8 Further detail on this methodology change is provided in the latest PFM Model Description Report.

3.2.9 The impact of this update is to slightly reduce forecast benefits and revenues.

Second Forecast Year to 2039/40

3.2.10 A further change covered in this step is a shift in the second forecast year to 2039/40 (compared to 2037/38 in the 2017 Economic Case). In line with TAG rail appraisal guidance, this reflects a change in the year of appraisal for the business case to 2019/20, and thus the fixed twenty-year forecasting horizon is adjusted to forecast out to 2039/40.

3.2.11 The impact of this update is to increase forecast benefits and revenues.

4 Step 3: Revised Schedule (including Appraisal Year Change)

4.1 Introduction

4.1.1 This step includes the following updates to PFM:

- Changing the Discount Year in the Economic Appraisal
- Revised Schedule for 'Delivery-Into-Service' Dates

4.1.2 Table 4 below illustrates the impact on benefits and revenues resulting from changes to both the appraisal year (restating Step 2 results with the 19/20 discount year) and the revision to the HS2 schedule.

Table 4: Change in quantified costs & benefits following Step 3: Full HS2 Network

Item	**Full HS2 Network, Present Value, £bn 1Q2015 prices**			
	After Step 2 Update - 17/18 Discount Year	**After Step 2 Update - 19/20 Discount Year**	**After Step 3 Update - 19/20 Discount Year**	**Change - 19/20 Discount Year**
Transport User Benefits – Business	54.4	57.9	56.0	-3.2%
Transport User Benefits - Other	16.9	17.9	17.4	-3.0%
Other quantifiable benefits	0.4	0.4	0.4	-2.5%
Loss to Government of Indirect Taxes	-4.1	-4.4	-4.1	-6.6%
Net Transport Benefits (PVB)	67.5	71.8	69.8	-2.9%
Revenues	43.9	46.7	43.6	-6.7%

4.2 Impact of Changes

Changing the Discount Year in the Economic Appraisal

4.2.1 The discount year is set to the year in which the scheme is being appraised, i.e. the financial year when the business case for the scheme is produced. In this step the discount year is set to 2019/20 in the 2020 Economic Case. This creates an uplift in the benefits and revenues, because the start of the appraisal period is closer in time to the year the benefits of the scheme are expected to be delivered.

4.2.2 On a present value basis, the benefits and revenues are therefore higher than in the previous model version. **However**, it should be noted that costs are also adjusted for the new appraisal year, and thus the impact of this adjustment on the BCR is neutral.

Revised Schedule

4.2.3 This step includes the impact of adjusting the delivery-into-service dates for the three Phases of HS2 to those assumed for the Phase One Full Business Case.

4.2.4 The delivery-into-service dates assumed in this step for the Full HS2 Network scenario are as follows:

- First services in operation (3 trains per hour from Old Oak Common to Birmingham) – 2029
- 10 trains per hour service from Euston (Phase 2a) – 2031
- 17 trains per hour service from Euston (Phase 2b) – 2035

4.2.5 The effect of these changes to the opening dates of the HS2 Phases is to reduce benefits and revenues, as these occur further from the appraisal year.

4.2.6 Furthermore, the overall appraisal period for the full scheme is reduced by 1 year, which leads to a further small reduction in benefits and revenues. (This occurs due to the Full HS2 Network appraisal period covering 60 years from the opening of Phase 2b, plus all previous years of scheme operation. Thus in the 2017 Economic Case the Full HS2 Network appraisal period was 67 years from 2026, whilst in the latest economic case this becomes 66 years from 2029.)

4.2.7 It should be noted that the revision to the scheme schedule also results in some changes in cost profiles. For the purposes of this analytical report, the necessary adjustments to cost including these cost profiling changes are captured within the overall cost changes outlined in Steps 7 and 8.

5 Step 4: 2019 Databook Update and Revised Demand Forecast

5.1 Introduction

5.1.1 This step includes the following updates to PFM:

- 2019 Transport Analysis Guidance (TAG) Databook Update, including March 2019 OBR forecasts
- Revised Demand Forecasts

5.1.2 The impact of these updates is shown in table 5 below.

Table 5: Change in quantified costs & benefits following Step 4: Full HS2 Network

Item	Full HS2 Network, Present Value, £bn 1Q2015 prices		
	After Step 3 Update	**After Step 4 Update**	**Change**
Transport User Benefits – Business	56.0	57.0	1.6%
Transport User Benefits - Other	17.4	17.3	-0.5%
Other quantifiable benefits	0.4	0.6	67.8%
Loss to Government of Indirect Taxes	-4.1	-4.0	-1.4%
Net Transport Benefits (PVB)	69.8	71.0	1.6%
Revenues	43.6	43.8	0.5%

5.2 Impact of Changes

2019 TAG Databook Update

5.2.1 The May 2019 TAG Databook contains guidance on parameters that are used in PFM and the overall economic appraisal. The following have been updated in this step:

- Gross Domestic Product (GDP) growth forecasts;
- Population growth forecasts;
- Inflation and earnings growth data;
- Market Price Adjustment;
- Fuel Costs;

- Car Fleet Proportions (Petrol/Diesel/Electric);
- Marginal External Costs and Indirect Tax assumptions; and
- Carbon Value per Tonne.

5.2.2 It should be noted that these updates have driven an increase in 'Other quantifiable benefits' due to changes in highway related inputs. However, this has a minimal impact on the overall scheme benefits.

Revised Demand Forecasts

5.2.3 The 'demand drivers' aligned with the May 2019 TAG Databook were used to update all future year rail demand in this step. As a consequence, in the second forecast year (2039/40) total rail demand increases by around 1.5%.

5.2.4 The change in rail demand results in a relatively small increase in passengers that can benefit from HS2. Therefore, there is also a correspondingly small increase in scheme benefits and revenues.

5.2.5 Highway demand was also updated for each forecast year using latest TEMPRO growth assumptions.

5.2.6 Further detail on the changes to the demand forecasts can be found in the latest PFM Forecasting Report.

6 Step 5: HS2 TSS Revision including Reliability and Phased Opening

6.1 Introduction

6.1.1 This step included the following updates to PFM:

- Reliability Methodology Update
- High-Speed TSS Revisions and Conventional Rail TSS Amendments
- Alternative opening service scenario

6.1.2 In addition, updates have been made to models used to estimate 'Other quantifiable benefits', most notably updates to the noise, carbon and diesel models and inputs used to assess environmental impacts.

6.1.3 The impact of these updates is shown in table 6 below.

Table 6: Change in quantified costs & benefits following Step 5: Full HS2 Network

Item	Full HS2 Network, Present Value, £bn 1Q2015 prices		
	After Step 4 Update	After Step 5 Update	Change
Transport User Benefits – Business	57.0	59.9	5.2%
Transport User Benefits - Other	17.3	17.6	1.3%
Other quantifiable benefits	0.6	0.8	29.7%
Loss to Government of Indirect Taxes	-4.0	-4.1	3.0%
Net Transport Benefits (PVB)	71.0	74.2	4.6%
Revenues	43.8	45.4	3.5%

6.2 Impact of Changes

Reliability Update

6.2.1 In this step, a revised methodology for modelling reliability on conventional and high-speed services was adopted. The previous methodology involved reducing HS2 journey times to reflect greater reliability (measured against average performance on conventional rail services).

6.2.1 The revised methodology adds an element of delay time to the journey time for each conventional rail service. This delay time is calculated specifically for the relevant train service group as a delay per kilometre multiplied by the distance travelled. The delay per kilometre is specific to each Train Operating Company and is based on historic data over the last 10 years.

6.2.2 Delay is added onto conventional rail services' journey times in both the Do Minimum and Do Something scenarios. A lower level of delay is added to high-speed rail services.

6.2.3 The new reliability methodology results in a small increase in benefits and revenues.

6.2.4 Further detail on this methodology can be found in the latest PFM Model Description Report and PFM Assumptions Report.

High-Speed Rail TSS Revision and Conventional Rail Amendments

6.2.5 The HS2 TSS has been further revised to reflect the Department for Transport's latest scheme assumptions, as follows:

- Preston services are extended to run to/from Lancaster in all Phases.
- A Carlisle call for all Scotland services is included in all Phases of the scheme (in Phase 2b the split-join on HS2 London to Scotland services occurs here rather than Carstairs)
- Birmingham Curzon Street – Leeds services are operated on the captive HS2 network only, removing the Sheffield call and longer journey times that were assumed in the 2017 Economic Case.

6.2.6 As part of this update, several conventional rail TSS assumptions were also updated.

6.2.7 These updates result overall in a small increase in benefits and revenues, mainly due to the new Lancaster and Carlisle calls on HS2 services. There is a reduction in benefits for Sheffield – Leeds movements but this is somewhat offset by Leeds-Birmingham journey time improvements.

6.2.8 Further detail on the changes to the TSS assumptions can be found in the latest PFM Assumptions Report.

Alternative opening scenario

6.2.9 This step also introduces a new opening scenario, whereby 6 HS2 trains per hour (tph) are assumed to run to and from Old Oak Common as the London terminus station until Euston opens for HS2 services. Specifically, the 2020 Economic Case assumes the following service pattern for 2 years from 2029 until 2031:

- 3tph Old Oak Common – Birmingham Curzon Street
- 1tph Old Oak Common – Manchester Piccadilly via Wilmslow
- 1tph Old Oak Common – Liverpool via Crewe
- 1tph Old Oak Common – Glasgow via Warrington, Wigan, Preston and Carlisle

6.2.10 Expanding the opening scenario from 3tph (as modelled from Step 3) to 6tph increases the benefits and revenues delivered in the initial years of operation. However, as this phase is only assumed to be in operation for two years the overall impact on the scheme appraisal is minimal. In addition, the cost estimates used in the 2020 Economic Case are adjusted with a provisional estimate to accommodate the additional 3tph to and from Old Oak Common.

Updates to models used in 'Other Quantifiable Benefits'

6.2.11 The estimated environmental impacts have changed due to methodological improvements in estimating the impact of noise, diesel and carbon, including:

- More detailed inspection of the Phase 2a and Phase 2b route, which estimated lower noise disturbance from HS2 services than previously modelled, thus reducing the estimated disbenefit.
- An increase in the estimated car kilometres removed by modal shift induced by HS2 is offset by reduced average road speeds and a higher assumed uptake of electric cars. The net impact of these changes is a £80 million reduction in HS2's environmental benefits.
- Greater detail on conventional rolling stock types and the relevant fuel consumption factors has been built into the diesel model, allowing for a more accurate estimation of carbon impacts, resulting in a £150 million increase in HS2's environmental benefits.

6.2.12 Total environmental benefits are estimated at £190 million in the 2020 Economic Case, compared to a £2 million disbenefit in the 2017 Economic Case (Q1 2015 prices, present value).

7 Step 6: Wider Economic Impacts Update

7.1 Introduction

7.1.1 HS2 Ltd. uses outputs from PFM in the 'Wider Impacts in Transport Appraisal' (WITA) software to estimate the wider economic impacts not captured in the appraisal of net transport user benefits. This considers additional employment and productivity benefits in line with DfT TAG guidance. The WITA software is owned by the DfT.

7.1.2 The Wider Economic Impacts (WEIs) of HS2 have increased from £17.6 billion in the 2017 Economic Case to £20.5 billion in the 2020 Economic Case (Q1 2015 prices, present value, as shown in Table 1 of this report). This follows developments to the WITA software, and updates to the latest local economic forecasts. The updated model has been tested in line with the DfT's Quality Assurance of Analytical Modelling Framework.

7.2 Impact of Changes to WITA Model Inputs

7.2.1 WEIs have been updated to align with PFM v9 outputs. The move from PFM v7.1 to PFM v9 in isolation (i.e. without changing scheme opening dates) increases the wider economic benefits of the scheme by £180 million. Adjusting the opening dates in isolation (from 2026, 2027, 2033 to 2029, 2031 and 2035, and estimated using PFM v9) then reduces wider economic benefits by £390 million.

7.3 Impact of Changes to WITA Model Software

7.3.1 HS2 Ltd. has migrated to WITA 2.0 BETA version, in line with DfT guidance. WITA v2.0 has been rewritten in a modern and more transparent programming language. The move from WITA v1.2 to WITA v2.0 has a negligible effect on the value of wider economic benefits.

7.4 Impact of Changes to Local Economic Forecasts

7.4.1 The datasets used in WITA contain up-to-date local, sectoral level data on employment, GDP per worker and earnings. These are aligned with Office for Budget Responsibility economic forecasts (March 2019) and DfT's National Trip End Model (NTEM) v7.2 employment forecast.

7.4.2 Updates to the economic forecasts, outlined in the 2019 TAG update, increased the wider economic benefits of the scheme by £0.4 billion. The move from dataset v2.5 to v3.1 also had a strong impact on agglomeration effects and labour supply impacts – increasing the wider economic benefits of the scheme by approximately £2.8 billion.

7.4.3 The latest dataset also contains the latest Local Authority District boundary definitions. The impact of moving to these new definitions on wider economic benefits is negligible.

8 Step 7: Updated Operating Cost Estimate

8.1 Introduction

8.1.1 Since publication of the 2017 Economic Case, significant updates and improvements have been made to HS2 Ltd.'s Operating Cost modelling.

8.1.2 Following an update to the HS2 Development Agreement in December 2018, Clause 13.3 requires HS2 Ltd to build a Baseline Operational Cost Model (BOCM) to be used for business case analysis, and more generally to act as a baseline to assess and control changes to the scheme.

8.1.3 The conclusion of this development has resulted in a revised operating cost estimate for all Phases of the HS2 scheme, as shown in Table 1.

8.1.4 The remainder of this section provides a general overview of changes in the operating cost modelling and estimates.

8.2 BOCM Overview and key operating cost updates

8.2.1 This section provides an overview of the BOCM modelling suite, as used to produce the operating cost estimates for the 2020 Economic Case.

8.2.2 Key definitions:

- Operating Cost Estimate (OCE) – the forecast operating expenditure of HS2 (including the change in operating cost of the Conventional Rail Network (CRN)) that arises as a result of operating the HS2 railway. As a rule, these costs will typically start from the commencement of revenue service, but there are some that will commence earlier.
- Baseline Operational Cost Model (BOCM) – the underlying model, input calculations, assumptions and logic that generate the OCE and will be used to generate options and updated estimates.

8.2.3 The previous operating cost estimate was based on a number of top-down benchmarks and assumptions which were appropriate at Strategic Outline Business Case / Outline Business Case stage, given the relative maturity of the scheme. For the Full Business Case, the operational scope and availability of data has progressed as the scheme has developed. This has in turn allowed for the development of a

more detailed, and in many cases bottom-up, set of models that have been used to estimate operating costs.

8.2.4 The BOCM modelling suite comprises six Individual Building Block (IBB) input models, which are linked to an overarching model. The individual IBB models are defined as:

- **Infrastructure Manager (IM) model**: Operating and maintenance costs associated with operation, maintenance and renewals (albeit renewals are included in Step 8 under capital costs in this report) of the HS2 railway infrastructure including stations
- **Rolling Stock (RS) model** – operation and maintenance of the rolling stock procured to run HS2 services
- **Train Operations (TO) model**: Train operator costs (excluding resources costed elsewhere – for example within the stations, whether TOC or IM resources)
- **Conventional Rail Network (CRN) model**: Savings made on the CRN as a result of the introduction of HS2 services and amending the wider network TSS accordingly
- **Non-Ticket Revenue (NTR) model**: Revenue collected by either the TOC or the IM not directly a result of ticket sales, e.g. car parking, retail, advertising, wayleaves, catering, commissions etc.
- **Undertaking & Assurances (U&As) and third-party assets model (abbreviated henceforth just by UA model)**: Operational costs associated with fulfilling U&As and other liabilities as a result of delivering the project, but not directly related to operation of the railway, such as the ongoing monitoring of environmental assets and ongoing maintenance of environmental mitigations

Operating Cost Update

8.2.5 The key changes since the 2017 Economic Case, as part of producing and using the BOCM (version OCE v2.1), are summarised in the table below.

Table 7: Key changes in operating costs following Step 7: Full HS2 Network

Building Block & Net Change	Main Increases	Main Decrease
Infrastructure Manager – marginal increase	• Non-traction power costs – previously underestimated • Stations Operations and Maintenance – change to Full Time Equivalent (FTE) based staff modelling	• Renewals – change to slab track in Phases 1 and 2a • Infrastructure Maintenance – change to FTE based modelling and change to slab track in Phases 1 and 2a
Rolling Stock – large decrease	• Renewals – inclusion of mid-life refurbishments and inclusion of second renewal at end of appraisal period	• Maintenance – significant change due to bottom-up modelling of maintenance • Maintenance – significant change due to change from RPI to CPI measures of inflation (to align with the HS2 Rolling Stock contract)
Train operations – increase	• On-board staffing – change to FTE based modelling approach (previously used per km proxy) using staff diagramming, and updated salaries • Unit kilometres and staffing increases due to HS2 TSS changes and more detailed depot designs • CRN access / usage charges – change to align with Network Rail CP6 charging	• CRN access / usage charges – reduced due to removal of capacity charges
Conventional rail network – marginal decrease	• CRN Rolling stock maintenance – increased costs (reduced abstraction) – updates to rolling stock types and mileages • CRN access / usage charges – increased cost (reduced abstraction) – removal of capacity charges	• CRN access / usage charges – decreased cost (increased abstraction) – change to align with Network Rail CP6 charging
Non-ticketed revenue – decrease (in costs)	• On-board catering (net cost) – methodology revised and benchmarked against comparable TOC accounts	• Station revenues (excludes over site development at Euston) – new revenue opportunities identified (cost reduction), e.g. station retail, car parking.

Building Block & Net Change	Main Increases	Main Decrease
		• Commissions – reduction due to inclusion of CRN abstracted commissions
U&As and 3rd party – increase	• Previously excluded – new items identified and included	
General	• Optimism Bias (OB) – methodology revised to assign OB rates to maturity indicators of each cost item. Overall net increase to OB	• Opening dates – marginal decreases due to deferral of assumed opening dates

9 Step 8: Updated Capital Cost Estimate

9.1 Introduction

9.1.1 Capital costs have been updated for all Phases of the HS2 scheme to reflect more mature cost estimates. The different Phases of the scheme are at a different stage of design maturity and the process of estimating the costs reflects this.

9.1.2 Since the 2017 Economic Case, the total estimated cost of construction has increased, leading to a downward pressure on the Benefit-Cost Ratio (BCR).

9.2 Changes in Full HS2 Network Costs

9.2.1 The costs for each Phase have moved away from a Funding Envelope position that was used in the 2017 Economic Case to estimates based on a more mature understanding of capital costs.

9.2.2 Whilst costs have generally increased, this is most pertinent for civil engineering works, tunnels and rail systems. Scope that is funded from outside of the HS2 funding envelope is removed from the cost inputs in the Economic Case. An adjustment to capital cost estimates to accommodate the running of 6 trains per hour to and from Old Oak Common in the opening years of Phase one services is made for the purpose of the Economic Case.

9.2.3 Contingency and optimism bias assumptions have been updated to align with the latest baseline estimates. There is no material impact for phase one construction contingency, however both phase 2a and phase 2b construction see a reduction in contingency translating to an NPV capital cost saving. Rolling stock contingency has been aligned with construction contingency, which is now weighted by each cost pillar, resulting in an overall increase in NPV rolling stock costs

9.2.4 The appraisal period has been adjusted since the 2017 Economic Case to reflect updated opening dates: from 2026 to 2029 for Phase One 2027 to 2031 for Phase 2a and 2033 to 2035 for Phase 2b. This is also reflected in the updated cost profiles for each Phase.

9.2.5 The cost changes for each Phase of the scheme between the 2017 and 2020 Economic Cases are outlined below. These changes refer only to the change in the point estimate and do not include contingency or represent present value figures.

- The Phase One point-estimate has moved from a Funding Envelope estimate to a target price estimate that is consistent with the Baseline 7 cost estimate for Phase One. This adds £11.1bn to the point estimate for this Phase.
- Phase 2a has moved from a Funding Envelope estimate to an estimate that is consistent with the emerging Baseline 2 for this Phase. This represents the best current estimate of Phase 2a costs as at the time of publication. This adds £2.0bn to the point estimate for this Phase.
- Phase 2b has moved from a Funding Envelope estimate to an estimate consistent with Control Point 2.1, which represents an early picture of the upcoming Baseline 2 estimate for Phase 2b. This adds £10.6bn to the point estimate for this Phase.
- Rolling stock cost profiles have been adjusted to reflect updated opening dates and a recalibration of required rolling stock units, which lead to an increase to capital costs. These increased rolling stock costs are accounted for in the increased point estimates for Phase One and 2b, as described above.

9.3 Changes in Appraisal Methodology

9.3.1 The Capital Expenditure (Capex) model has undergone several methodological changes to further develop the accuracy of the model and to adjust the modelling scenario to align with the assumptions that underpin the 2020 Economic Case.

9.3.2 The Economic Case base year has been moved from 2017/18 to 2019/20, reducing the impact of discounting which produces an upward impact on costs (note this is offset by the same discounting adjustment being made to benefits and revenues, with a neutral impact on the BCR). Changing the base year also increases the level of sunk costs, which are excluded from the costs included in the Economic Case in line with DfT TAG guidance, producing a downward impact on costs. The overall impact of these methodology changes is to reduce the capital cost estimates and to increase the BCR.

9.3.3 Land and Property costs have been adjusted since the 2017 Economic Case. The 2017 economic case Do Minimum scenario assumed all Land and Property costs would be wholly recoverable if the HS2 scheme should not proceed. In the 2020 Economic Case it is assumed that 75% of Land and Property is recoverable. This is based on new evidence not available at the time of the 2017 Economic Case related to the discharge of property acquired through discretionary or compulsory purchase. This assumption been agreed with the DfT. This has increased the sunk costs and reduced the construction cost estimate.

9.3.4 Construction cost inflation assumptions have been adjusted since the 2017 Economic Case. In the 2017 Economic Case, HS2 inflation estimates were based on forecasts in three areas (Materials, Construction Wages and Plant Costs). It was also

assumed that HS2 inflation estimates would align with the ONS GDP Deflator after five years. In the 2020 Economic Case, it was agreed with the DfT to produce inflation estimates across the whole of HS2's spending profile. These estimates were produced through external consultation with the 'Independent Inflation Experts' (IIE) and 'NERA Economic Consultancy'. It was also assumed the construction inflation forecasts would converge over a four-year period to the historic construction inflation rate (1.38% above the GDP Deflator). These assumptions have increased the net present value (NPV) of capital costs relative to previous business case assumptions by £2.3bn

9.4 Infrastructure Renewals

9.4.1 Infrastructure renewals measure the cost of refurbishing and replacing HS2 infrastructure over the full appraisal period. Renewals costs are presented separately from the costs of construction and are estimated at £5.4 billion (1Q2015 prices, Net Present Value (NPV)) when combined with rolling stock renewals.

9.4.2 Renewals are impacted by the adjusted appraisal period, which overall reduces the cost estimates due to a shorter appraisal period for infrastructure renewals and higher discounting from the later opening dates. Phase One renewal costs have also been reduced to reflect the decision to move from ballast to slab track.

9.4.3 Infrastructure renewals have also been inflated by the difference between Retail Price Index (RPI) and the GDP Deflator in all years up to 2039. This adds to the NPV renewals cost. RPI is chosen over a more detailed construction inflation estimate due to the uncertainty of future inputs required for infrastructure renewal.

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