Robust Analysis

HS2-HS1 Connection Demand Analysis

Report for Greengauge 21

May 2013

mvaconsultancy

Document Control

Project Title:	HS2-HS1 Connection Demand Analysis
MVA Project Number:	102327
Document Type:	Report
Directory & File Name:	H:\Railair\102327 Greengauge 21 HS2-HS1 Connection\Report\20130508 Greengauge 21 HS2-HS1Connection Demand Analysis Report FINAL V5.Docx

Document Approval

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Distribution

Issue	Date	Distribution	Comments
1	02/05/2013	Neil Raha	First draft for internal review
2	03/05/2013	Greengauge 21	Draft report for client comments
3	09/05/2013	Neil Raha	Draft final for internal review
4	14/05/2013	Greengauge 21	Final report to client

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1 Introduction

1.1 Background

1.1.1 The Government is currently proposing to construct a link to connect HS1 to HS2 as part of Phase 1 of the HS2 project. With a HS2-HS1 link in place from 2026, there would be scope to operate regular services from Ashford, Ebbsfleet and Stratford on the HS1 section to destinations in the Midlands, North West and Yorkshire on the HS2 section such as Birmingham, Manchester and Leeds as well as international services to Paris and Brussels.

1.1.2 Greengauge 21 wishes to understand the broad level of demand and the range of services that could be provided on this new link for:

- domestic inter-regional markets; and
- international markets.

1.2 This Commission

1.2.1 Greengauge 21 commissioned MVA Consultancy to identify the scale of travel demand in a number of specified domestic and international markets with an assessment of:

- the total travel market in millions of passengers per annum (mppa) in a base year (2011) with a modal breakdown (car/rail/air); and
- the same for 2026 (the introduction of Phase 1 HS2 services) and 2033 (the introduction of Phase 2 HS2 services).

1.2.2 Based on these demand forecasts, the relative scale of these markets in comparison to the services planned to operate from central London and the likely market share that a high-speed service could attract are assessed.

1.3 Report Structure

1.3.1 The structure of this report is as follows:

- Chapter 2 discusses the model used to generate the demand forecasts;
- Chapter 3 discusses the updates applied to the model for this commission;
- Chapter 4 describes the original model zoning structure and the process applied to map the model zones to the markets of interest required for this commission;
- Chapter 5 documents the journey time, frequency and interchange assumptions applied in the model under the scenarios tested in the model;
- Chapter 6 presents the demand forecasts for the domestic inter-regional travel markets;
- Chapter 7 presents the demand forecasts for the international markets;
- Chapter 8 provides a summary of the results presented in the two previous chapters including an estimation of daily demand in each market considered. A comparison is also made against demand from Greater and Central London.

1 Introduction

2 Demand Model

2.1 Introduction

2.1.1 This chapter discusses the model that has been used in this study to generate the demand forecasts.

2.2 Demand Model

2.2.1 The forecasts for this commission have been generated using the demand model developed in a joint study by MVA Consultancy and Systra for a previous commission for Greengauge 21 in 2009. The model was developed to forecast UK high-speed rail demand, the outputs from which were subsequently used to prepare a Business Case for a high-speed network.

2.2.2 The model is a primarily mode choice model which takes the generalised cost for each mode and applies a LOGIT choice formula that predicts what the mode share, based on the generalised costs of each mode, of each mode on that route would be in the future.

2.2.3 Full details of the demand model structure and functionality were provided in the original report published in September 2009 including:

- base demand matrix structure;
- derivation of the base year demand and generalised costs for each mode and the data sources used;
- future year growth factors used;
- mode choice functionality (LOGIT); and
- model calibration.

2.2.4 The report is available to download from the Greengauge 21 website:

http://www.greengauge21.net/wp-content/uploads/Workstream-3-assessment-Methodology.pdf

2.3 Model Updates

2.3.1 For the purposes of this commission, several updates to the model have been carried out:

- the base year demand matrices (car, rail and air) have been updated from 2007 to 2011 (see Chapter 3); and
- growth factors have been updated where applicable (see Chapter 3).

2.3.2 However, it is important to note that:

- air and rail fares, and car costs remain unchanged;
- car, rail and air generalised journey times (GJTs) remain unchanged (with one exception as detailed in Chapter 3);
- the model has not been re-calibrated;

- the crowding functionality remains unchanged; and
- the fares assumptions remain unchanged, and in particular it is still assumed that no premium fare will apply to high-speed rail services compared to Classic services.

2.4 Model Forecast Years

2.4.1 The demand model contains four forecast years: 2021, 2025, 2040 and 2055. For the purposes of this commission, forecasts for the two desired forecast years (2026 and 2033) were obtained by interpolating the model results between 2025 and 2040.

2.5 Model Scenarios

2.5.1 The updated model was used to test the impact of three scenarios:

- **No HS2** – this assumes high-speed rail services are not introduced in 2026 and that Classic rail journey times and frequencies remain unchanged;
- **HS2 only scenario** – this assumes Phase 1 HS2 services begin in 2026 and Phase 2 in 2033, but that there is no direct link between HS2 and HS1; and
- **HS2-HS1 scenario** – as per the HS2 scenario but with a direct link between HS2 and HS1 enabling direct high-speed services from Kent (via Ashford and Ebbsfleet) and East London (via Stratford) to destinations in the West Midlands and Northern England.

3 Demand Model Updates

3.1 Introduction

3.1.1 This chapter discusses the updates applied to the model for this commission including:

- updating the base year demand for each mode (car, rail and air) from 2007 to 2011; and
- updating the model growth factors and parameters where applicable to grow the base demand to the future years.

3.2 Car Base Year Updates

3.2.1 The 2007 car demand matrix was derived from the Department for Transport (DfT) National Transport Model (NTM). To update the demand for 2011, analysis of the DfT's most recent National Road Traffic Forecasts (NRTF) was undertaken which suggested that national car travel had reduced slightly between 2007 and 2011. The DfT's publication of Road Traffic Statistics provided a direct comparison of actual car travel (in billion vehicle kilometres) by region between 2007 and 2011 and this was used to produce a matrix of scaling factors in order to create the 2011 car demand matrices. The same factors were applied to both the business and leisure demand matrices to maintain the distributional detail of the purpose splits as derived previously from the NTM.

3.2.2 Car costs and GJTs as derived from the NTM for the 2007 base year were left unchanged for the 2011 base year. The journey times include an allowance for congestion at the base year level, and since the overall level of travel had dropped marginally between 2007 and 2011 it was assumed that the level of congestion had not materially changed.

3.3 Rail Base Year Updates

3.3.1 Each of the model origin-destination flow pairs in the rail demand matrix were classified according to the rail market serving that flow:

- Long-distance (excluding Virgin West Coast Main Line services);
- Regional;
- London and South East;
- Virgin West Coast Main Line (WCML); and
- International (Eurostar).

3.3.2 A distinction was made for Virgin WCML flows to account for the additional demand generated by the step-change in service following the introduction of their Very-High Frequency (VHF) initiative in December 2008 in which the frequency was increased from 2 tph to 3 tph on the principal WCML routes, as well as faster journey times.

3.3.3 The four-year increase in passenger demand for each domestic market was sourced from ATOC and from Eurostar for international services (Table 3.1). These growth rates were then applied to the 2007 base rail demand matrix to generate the 2011 matrix.

Table 3.1 Passenger demand growth by market, 2007/08 to 2011/12

Market	Long-Distance	Regional	LSE	Virgin WCML	Eurostar
Passenger demand (m)					
2007/08	82.1	285.8	828.4	21.8	8.3
2011/12	95.1	340.9	993.9	30.2	9.7
Growth (%)	**15.8%**	**19.3%**	**20.0%**	**38.7%**	**17.4%**

Source: ATOC, Eurostar

3.3.4 Rail GJTs were left unchanged from the original model i.e. 2007 values for all flows except for those served by Virgin WCML services. For these flows, the impact on GJT was derived by assuming the additional demand growth observed on WCML services above that observed on other long-distance services was solely due to the impact of VHF on the GJT. Using this demand growth and a long-distance GJT elasticity of -0.9 (as per PDFH v5), an implied GJT reduction of -18% was derived which was then applied to all WCML flows.

3.4 Air Base Year Updates

3.4.1 The base year matrix for air demand was obtained by sourcing demand data for 2011 from the Civil Aviation Authority (CAA) with provides demand between airport pairs. For certain flows, demand is zero owing to the withdrawal of certain domestic services e.g. Leeds /Bradford – London Heathrow (a service that was in fact re-instated in 2012).

3.4.2 As per rail, air GJTs were left unchanged from 2007 with the exception of those services which have since been withdrawn; in these cases the GJT was set to a large value (9,999) to exclude air from the subsequent mode choice calculation.

3.5 Growth Factor and Parameter Updates

3.5.1 The base car, rail and air demand are grown forward using a variety of growth factors and parameters to generate demand in the forecast years. Where updates were available, these factors have been revised as per Table 3.2.

Table 3.2 Growth factor and parameter updates

	Update
Population growth	Base year and forecast year population updated using TEMPRO v6.2 to derive population growth factors
GDP per capita growth	GDP growth rates updated using latest WebTAG values (Unit 3.5.6, October 2012)
Employment growth	Base year and forecast year employment updated using TEMPRO v6.2 to derive employment growth factors
Car demand growth	Updated using 2011 NRTF based on NTM results
Car operating costs growth	Updated using latest WebTAG values (Unit 3.5.6, October 2012)
Values of time	2002 values updated to 2010 values from WebTAG (Unit 3.5.6, October 2012)
Growth in values of time	Updated using latest WebTAG values (Unit 3.5.6, October 2012)

4 Model Zone Disaggregation

4.1 Introduction

4.1.1 This chapter describes the original model zoning structure and the process applied to map the model zones to the markets of interest required for this commission.

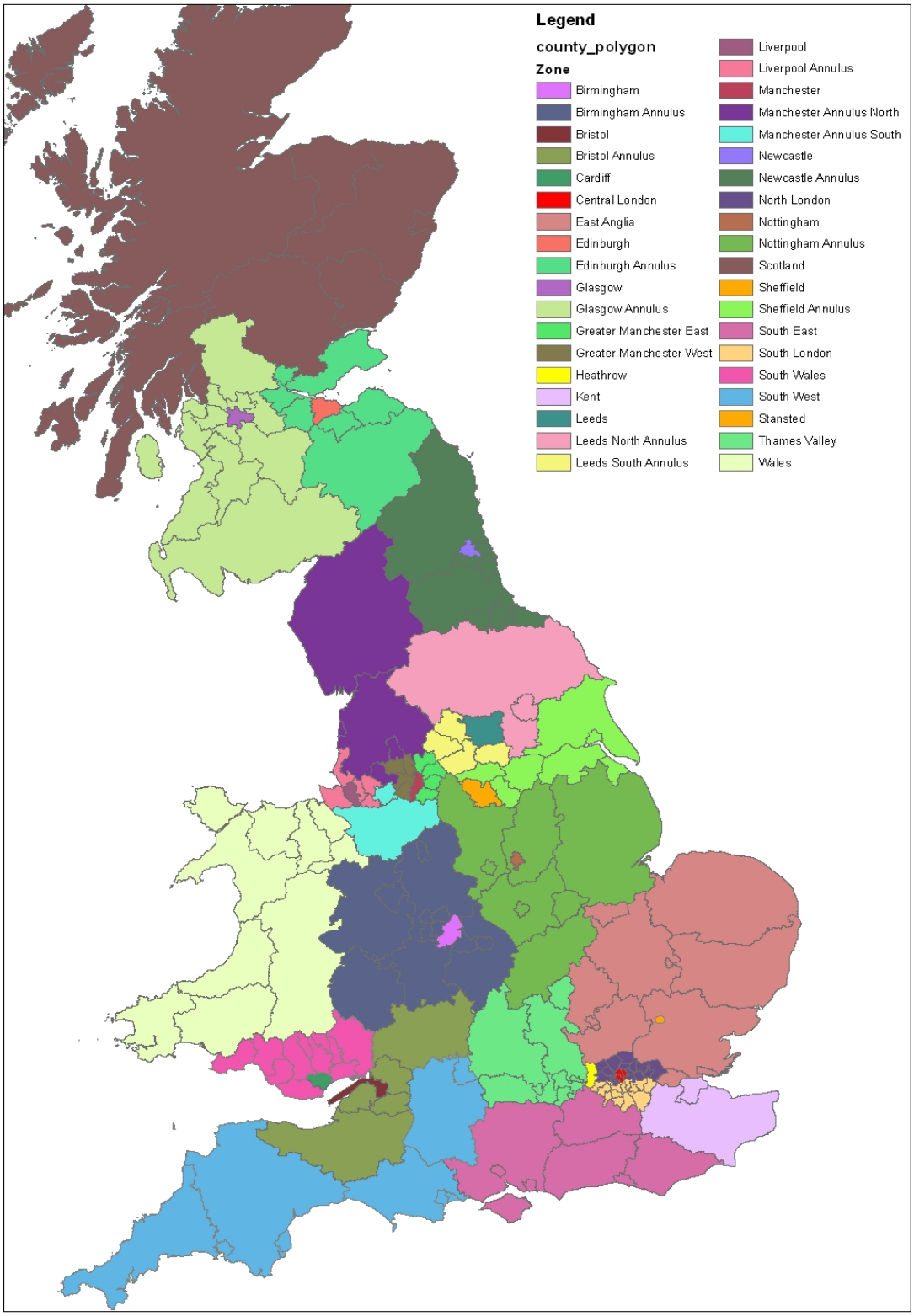
4.2 Model Zones

4.2.1 The model disaggregates travel demand according to 39 zones which cover England, Wales, Scotland and Europe. The zoning reflects the intercity nature of the market for high-speed rail and distinguishing between city centres and annuli allows differential access times to be reflected. The model zoning system focuses on UK cities served (directly or with an interchange) by HS rail; each of which has at least one annulus which covers the area immediately surrounding the city. The purpose of the annulus is to account for differences in travel behaviour and mode share between trips from the city centre and those from its hinterland. For example, trips beginning in the city centre may be more likely to use rail for a trip due to easier access to the city centre station. The Europe zone is used to model travel between the UK and European destinations which are likely to become more attractive once high-speed rail is introduced. Demand has been split into business and leisure travel. For the purposes of modelling, commuting trips have been grouped with business trips.

4.2.2 The model zones form a 39 by 39 matrix of movements between zones (1,521 origin destination pairs). Flows have been assumed to be one way therefore for example the Manchester to London flow demand has an equivalent London to Manchester demand (as symmetry is expected for annualised demand values).

4.2.3 A map and list of the model zones is shown in Figure 4.1.

Figure 4.1 Model zones



4.3 Zonal Disaggregation outside of Greater London

4.3.1 This commission is concerned with demand to and from specific areas, either at a county or regional level. Outside of Greater London, these areas generally mapped directly to one or more model zones. For example, the West Midlands region is represented by the Birmingham and Birmingham Annulus model zones.

4.3.2 For certain areas (Essex/Suffolk, Thames Valley and Milton Keynes), a direct mapping to a model zone or zones was not possible. In these cases, zones were mapped to county level by pro-rating zonal demand according to population which was sourced from 2011 Census data (Table 4.1).

Table 4.1 Model zone to county/region mappings

County/Region	Model Zone(s)	Proportion of Zonal Demand
Kent	Kent	100%
Essex/Suffolk	East Anglia	42%
West Midlands	Birmingham	100%
	Birmingham Annulus	100%
North West England	Greater Manchester East	100%
	Greater Manchester West	100%
	Manchester	100%
	Manchester Annulus North	100%
	Manchester Annulus South	100%
	Liverpool	100%
	Liverpool Annulus	100%
Milton Keynes	Thames Valley	11%
Thames Valley	Thames Valley	89%
West of England	Bristol	100%
	Bristol Annulus	100%
South Wales	Cardiff	100%
	South Wales	100%
East Midlands	Nottingham	100%
	Nottingham Annulus	100%
Yorkshire	Sheffield	100%
	Sheffield Annulus	100%
	Leeds	100%
	Leeds North Annulus	100%
	Leeds South Annulus	100%

4.4 Zonal Disaggregation within Greater London

4.4.1 Within Greater London a more detailed disaggregation was sought to provide an accurate representation of trip distributions for trips from and within London as specified in the commission. This disaggregation was derived with the use of data from the London Transportation Studies (LTS) model authorised for use in this study by kind permission of Transport for London (TfL).

4.4.2 The LTS model is a multi-modal model which provides an accurate representation of car, public transport and active mode trip movements to/from/within the Greater London Authority (GLA) area and other regions within the M25. LTS demand matrices were manipulated and analysed to produce a trip distribution which corresponded to the Greengauge 21 model data. The following assumptions were made:

- LTS demand matrices were annualised using standard LTS annualisation factors to scale period demand to be comparable to GG21 annual demand matrices;
- 2011, 2026 and 2031 LTS demand matrices were used where 2031 is a proxy to the required 2033 forecast year;
- LTS matrices for 'in work time' and 'out work time' were used to produce the trip distribution for business and leisure demand respectively; and
- the trip distribution for the 'no HS2' or 'no HS2-HS1' case was applied to all scenarios as the LTS model does not currently include high speed rail schemes.

4.4.3 The LTS demand matrices were mapped outside the GLA to the Greengauge/MVA model zones. Where Greengauge model zones did not match LTS boundaries exactly proportions were created using 2011 Census Output Area population data contained within the respective overlapping regions. This provided information on where trips originating in London, at a detailed disaggregate level, are going to within and outside of the GLA.

4.4.4 This data was finally aggregated to create the market interest areas within and outside London as specified in the commission. It should be noted that the LTS trip distribution within the GLA was adopted wholly, without retaining the trip distributions inherent from the four constituent Greengauge 21 model London zones. This process was used as LTS trip movements were thought to be more accurate than those in the Greengauge model at GLA level, and also it provided better disaggregation between Hillingdon borough (in the North West London market) and Heathrow.

5 HS2 and HS1 Model Inputs

5.1 Introduction

5.1.1 This chapter documents the journey time, frequency and interchange assumptions applied in the model under the three scenarios tested in the model:

- No HS2;
- HS2 services only; and
- HS2-HS1 services.

5.1.2 These are three of the components of the generalised cost formulation for the HS rail mode. The equation for generalised cost for high speed rail in the forecast year (with all components expressed in terms of generalised minutes) is given below:

HS generalised cost = HS gjt + (HS Fare * VoT)

where

HS gjt = Classic Rail gjt + *Change* in Journey Time + *Change* in Frequency + Weighted *Change* in Reliability + *Change* in Interchange Penalty

and

Classic Rail gjt = Journey Time + Weighted Access Time + Weighted Reliability + (Fare * VoT)

and *change* is defined as the difference between high speed and classic journey times, frequency, reliability and interchanges

5.1.3 Therefore a reduction in the journey time and/or number of interchanges with the implementation of HS rail, in particular the HS2-HS1 connection, drives the demand model by reducing the generalised cost for HS rail.

5.2 No HS2 Inputs

5.2.1 In the absence of any high-speed services, the base case inputs were based on current Classic rail journey times, frequencies and interchange assumptions. For key routes such as London to Birmingham, the current journey time, frequency and number of interchanges were sourced from published HS2 Ltd documents. For other routes outside of Greater London, the information was sourced from National Rail Enquiries (based on average off-peak values). For journeys within Greater London, for example, from Stratford to London Euston, the information was sourced from Transport for London's journey planner.

5.2.2 The Classic rail inputs are shown in Appendix A.

5.3 HS2 Only Inputs

5.3.1 HS2 inputs have been sourced from published HS2 Ltd documents. Two sets of inputs were required:

- Phase 1 from 2026 in which the high-speed line will run as far as Birmingham; Classic compatible high-speed services will then extend northwards to Manchester and Leeds; and
- Phase 2 from 2033 in which the high-speed line will extend to Leeds and Manchester resulting in faster journey times.

5.3.2 The HS2 inputs are shown in Appendix B.

5.4 HS2-HS1 Inputs

5.4.1 To derive the inputs with the HS2-HS1 link in place, the following assumptions were made:

- high-speed journey times from Stratford International to HS2 destinations are as those from London Euston **+10 minutes**
- high-speed journey times from Ashford International to HS2 destinations are as those from London Euston **+41 minutes** (based on the 10 minutes additional journey time to Stratford, plus an additional 31 minutes which is the current Stratford – Ashford journey time on Southeastern HS1 services);
- a high-speed frequency of 2 tph from Ashford/Ebbsfleet/Stratford.

5.5 Worked Example

5.5.1 To illustrate how journey time savings and differences in frequencies and interchanges have been derived, the Kent to Birmingham flow is shown as an example. The modelled station for the Kent zone is Ashford and for the Birmingham zone, Birmingham New Street (for Classic Services) and Birmingham Curzon Street (for HS2 services).

HS2 only

5.5.2 Under the HS2-only scenario, the benefit compared to Classic will only be realised over the London to Birmingham portion of the journey as passengers from Ashford will still need to interchange in London as currently. Given the model is only concerned with *changes* in GJT, for this scenario only this portion of the journey is considered (Table 5.1).

Table 5.1 Kent – Birmingham Classic and HS2 inputs

	Journey Time (min)	Frequency (tph)	Interchanges
London Euston – Birmingham:			
Classic	84	3	0
HS2	49	3	0
Difference (HS2 – Classic)	**-35**	**0**	**0**

Source: HS2 Ltd

HS2-HS1

5.5.3 Under the HS2-HS1 link scenario, the benefit will be realised from the start of the journey due to the direct services from Ashford. The entire journey is therefore considered (Table 5.2).

Table 5.2 Kent – Birmingham Classic and HS2-HS1 inputs

	Journey Time (min)	Frequency (tph)	Interchanges
Ashford – Birmingham:			
Classic	170	2	2
HS2-HS1	90	2	0
Difference (HS2 – Classic)	**-80**	**0**	**-2**

Source: National Rail Enquires, Southeastern, MVA/Greengauge 21 assumptions

6 Domestic Inter-Regional Demand Results

6.1 Introduction

6.1.1 This chapter presents the demand model results for each of the following specified domestic inter-regional travel markets:

- **Kent – West Midlands / North West England** (Section 6.2);
- **Essex / Suffolk – West Midlands / North West England** (Section 6.3);
- **East London / Docklands – West Midlands / North West England** (Section 6.4);
- **Kent / Essex / Suffolk / East London / Docklands – Thames Valley / Heathrow / West of England / South Wales** (Section 6.5);
- **Kent / Essex / Suffolk / East London / Docklands – North West London / Milton Keynes** (Section 6.6);
- **Kent / Essex / Suffolk / East London / Docklands services – Heathrow** (Section 6.7) (this market is a subset of the results presented in section 6.5); and
- **Kent / Essex / Suffolk / East London / Docklands services – East Midlands / Yorkshire** (Section 6.8).

6.1.2 Remoter destinations such as Scotland, North East England, North Wales and South West England have not been selected for market appraisal however there may also be further benefits gained for trips to/from these areas due to better connectivity to HS rail services with the HS2-HS1 connection in place.

6.1.3 For each market, the following results are presented:

- base year (2011) demand and % market share by mode;
- forecast year (2026 and 2033) demand and % market share by mode for the three scenarios tested:
  - No HS2
  - HS2 only
  - HS2-HS1
- the demand change (absolute and %) by mode in the HS2-HS1 scenario compared to HS2 only; and
- for 2033, the breakdown of high-speed rail demand in terms of whether abstracted from another mode (car, Classic rail and air) or generated.

6.1.4 It should be noted that HS2 only serves the East Midlands and Yorkshire market from 2033 and therefore analysis of the market Kent/Essex/Suffolk/East London/Docklands – East Midlands/Yorkshire is only carried out for the 2033 forecast year.

6.1.5 All demand results shown represent the total bidirectional demand between the two geographical markets.

6.1.6 As a check the demand results from the model have been benchmarked against the publicly-available demand HS2 Ltd forecasts. Table 6.1 shows forecast rail demand (Classic and

high-speed) between London and the West Midlands, the North West, the East Midlands and Yorkshire & Humber in 2026. In general the two sets of forecasts are consistent.

Table 6.1 Comparison of rail demand forecasts in 2026

2026 Rail demand to/from London (Classic + HS)	West Midlands	North West	East Midlands	Yorkshire & Humber
Greengauge 21 study	17,078,000	12,862,000	14,070,000	8,328,000
HS2 Ltd	18,108,876	16,205,774	14,267,332	8,991,848

6.2 Kent – West Midlands/North West England

6.2.1 The scope of the Kent to/from West Midlands and North West England market is shown in the Figure 6.1.

Figure 6.1 Kent - West Midlands/North West England Market

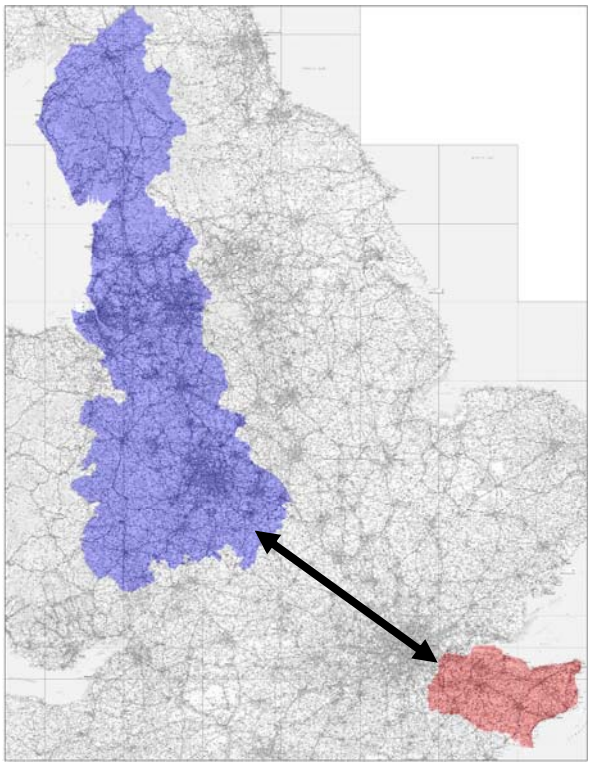


Table 6.2 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	1,135,000	231,000	32,000	-	**1,398,000**
Mode Share	81%	17%	2%	0%	**100%**

Table 6.3 2026 Forecast Demand

2026 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	1,527,000	290,000	21,000	-	**1,838,000**
	Mode Share	83%	16%	1%	0%	**100%**
HS2 Only	Demand	1,502,000	110,000	17,000	221,000	**1,850,000**
	Mode Share	81%	6%	1%	12%	**100%**
HS2-HS1	Demand	1,278,000	89,000	7,000	635,000	**2,009,000**
	Mode Share	64%	4%	0%	32%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-224,000**	**-21,000**	**-10,000**	**414,000**	**159,000**
	% change	-15%	-19%	-59%	187%	9%

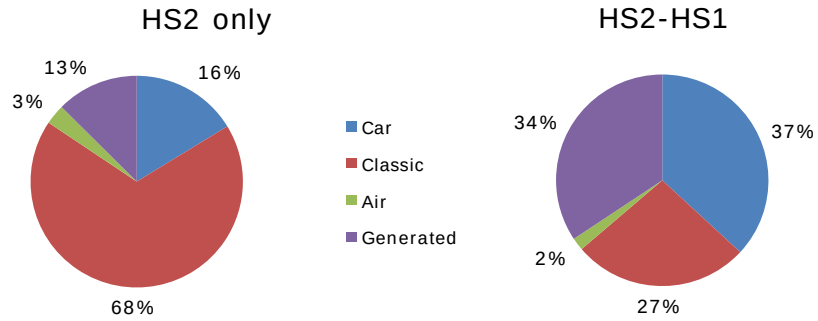
Table 6.4 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	1,711,000	325,000	24,000	-	**2,060,000**
	Mode Share	83%	16%	1%	0%	**100%**
HS2 Only	Demand	1,663,000	124,000	15,000	295,000	**2,097,000**
	Mode Share	79%	6%	1%	14%	**100%**
HS2-HS1	Demand	1,406,000	103,000	8,000	827,000	**2,344,000**
	Mode Share	60%	4%	0%	35%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-257,000**	**-21,000**	**-7,000**	**532,000**	**247,000**
	% change	-15%	-17%	-47%	180%	**12%**

Table 6.5 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	48,000	201,000	9,000	37,000	**295,000**
HS2-HS1	305,000	222,000	16,000	284,000	**827,000**

Figure 6.2 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



6.3 Essex / Suffolk – West Midlands / North West England

6.3.1 The scope of the Essex and Suffolk to/from West Midlands and North West England market is shown in the Figure 6.3.

Figure 6.3 Essex / Suffolk - West Midlands / North West England Market

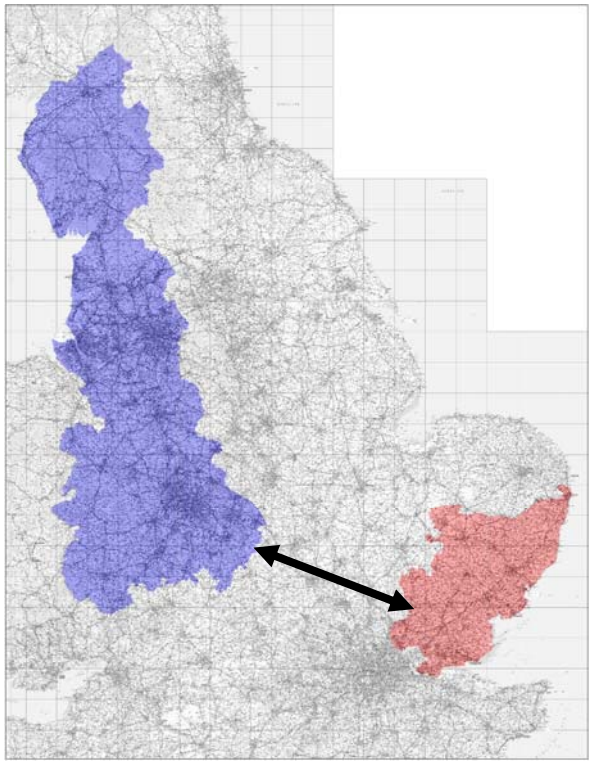


Table 6.6 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	4,216,000	643,000	14,000	-	**4,873,000**
Mode Share	87%	13%	0%	0%	**100%**

Table 6.7 2026 Forecast Demand

2026 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	5,549,000	783,000	59,000	-	**6,391,000**
	Mode Share	87%	12%	1%	0%	**100%**
HS2 Only	Demand	5,471,000	304,000	49,000	626,000	**6,450,000**
	Mode Share	85%	5%	1%	10%	**100%**
HS2-HS1	Demand	4,996,000	265,000	25,000	2,227,000	**7,513,000**
	Mode Share	66%	4%	0%	30%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-475,000**	**-39,000**	**-24,000**	**1,601,000**	**1,063,000**
	% change	-9%	-13%	-49%	256%	**16%**

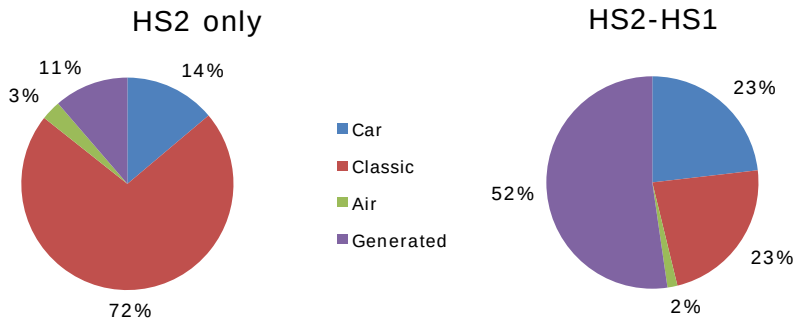
Table 6.8 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	6,116,000	958,000	72,000	-	**7,146,000**
	Mode Share	86%	13%	1%	0%	**100%**
HS2 Only	Demand	6,001,000	363,000	47,000	829,000	**7,240,000**
	Mode Share	83%	5%	1%	11%	**100%**
HS2-HS1	Demand	5,476,000	322,000	30,000	2,762,000	**8,590,000**
	Mode Share	64%	4%	0%	32%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-525,000**	**-41,000**	**-17,000**	**1,933,000**	**1,350,000**
	% change	-9%	-11%	-36%	233%	**19%**

Table 6.9 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	115,000	595,000	25,000	94,000	**829,000**
HS2-HS1	640,000	636,000	42,000	1,444,000	**2,762,000**

Figure 6.4 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



6.4 East London/Docklands – West Midlands/North West England

6.4.1 The scope of the East London/Docklands to/from West Midlands and North West England market is shown in the Figure 6.5.

Figure 6.5 East London / Docklands - West Midlands / North West England Market

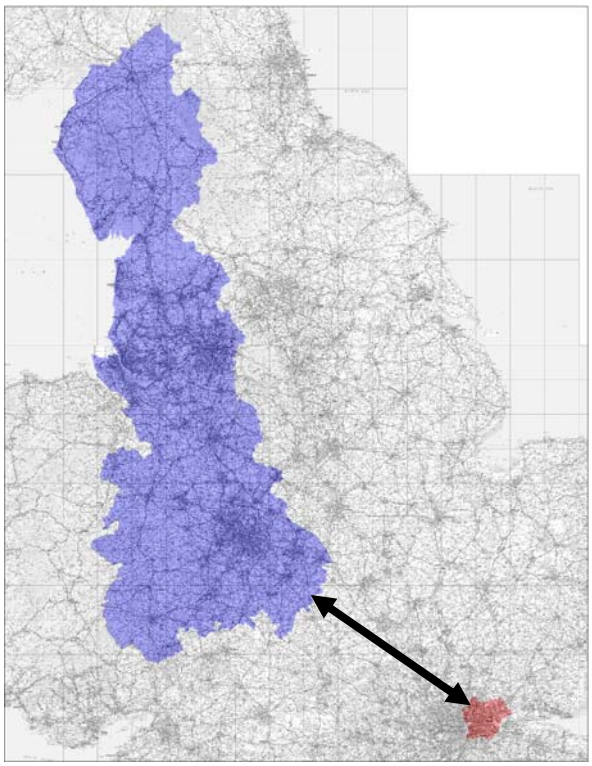


Table 6.10 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	905,000	2,767,000	145,000	-	**3,817,000**
Mode Share	24%	72%	4%	0%	**100%**

Table 6.11 2026 Forecast Demand

2026 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	1,387,000	4,133,000	180,000	-	**5,700,000**
	Mode Share	24%	73%	3%	0%	**100%**
HS2 Only	Demand	1,339,000	1,840,000	159,000	2,535,000	**5,873,000**
	Mode Share	23%	31%	3%	43%	**100%**
HS2-HS1	Demand	1,022,000	1,708,000	136,000	3,964,000	**6,830,000**
	Mode Share	15%	25%	2%	58%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-317,000**	**-132,000**	**-23,000**	**1,429,000**	**957,000**
	% change	-24%	-7%	-14%	56%	**16%**

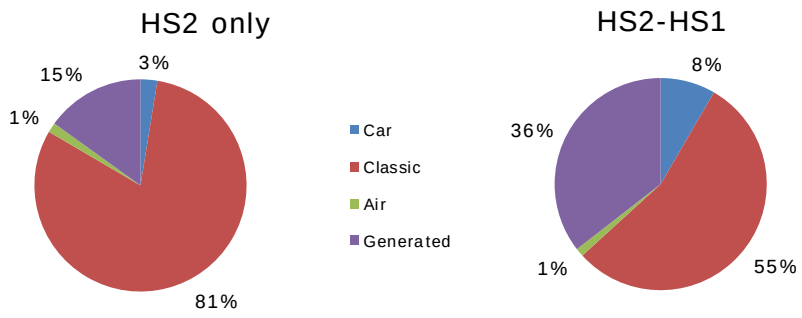
Table 6.12 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	1,598,000	5,102,000	203,000	-	**6,903,000**
	Mode Share	23%	74%	3%	0%	**100%**
HS2 Only	Demand	1,510,000	2,311,000	151,000	3,451,000	**7,423,000**
	Mode Share	20%	31%	2%	46%	**100%**
HS2-HS1	Demand	1,148,000	2,162,000	135,000	5,362,000	**8,807,000**
	Mode Share	13%	25%	2%	61%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-362,000**	**-149,000**	**-16,000**	**1,911,000**	**1,384,000**
	% change	-24%	-6%	-11%	55%	**19%**

Table 6.13 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	88,000	2,791,000	52,000	520,000	**3,451,000**
HS2-HS1	450,000	2,940,000	68,000	1,904,000	**5,362,000**

Figure 6.6 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



6.5 Kent/Essex/Suffolk/East London/Docklands – Thames Valley/Heathrow/West of England/South Wales

6.5.1 The scope of the East London/Docklands to/from West Midlands and North West England market is shown in the Figure 6.7. This market includes an interchange at Old Oak Common to connect with services towards the West of England, with the exception of Heathrow. The Kent/Essex/Suffolk/East London/Docklands to/from Heathrow market assumes a direct service, and this market is analysed separately in Section 6.7.

Figure 6.7 Kent / Essex / Suffolk / East London / Docklands – Thames Valley / Heathrow / West of England / South Wales Market

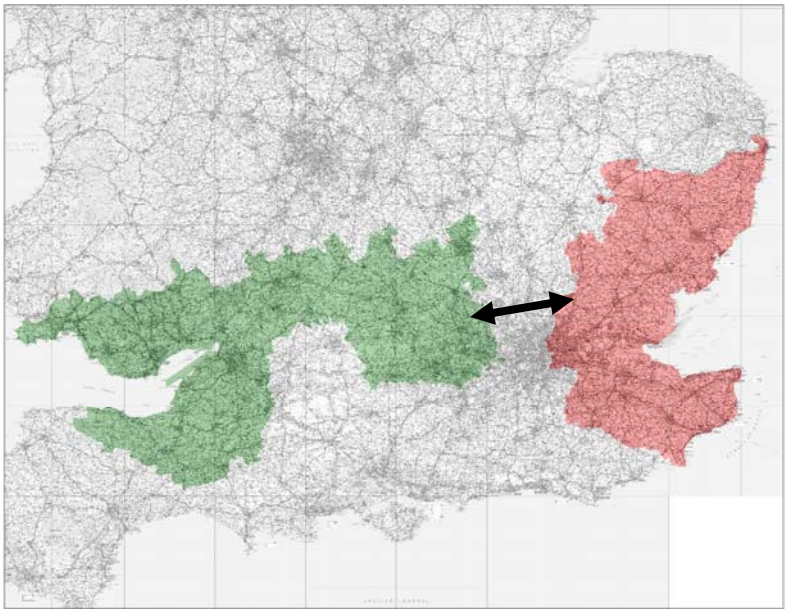


Table 6.14 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	61,135,000	27,643,000	-	-	**88,778,000**
Mode Share	69%	31%	0%	0%	**100%**

Table 6.15 2026 Forecast Demand

2026 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	79,836,000	45,924,000	-	-	**125,760,000**
	Mode Share	63%	37%	0%	0%	**100%**
HS2 Only	Demand	79,182,000	43,910,000	-	3,109,000	**126,201,000**
	Mode Share	63%	35%	0%	2%	**100%**
HS2-HS1	Demand	77,915,000	37,764,000	-	12,200,000	**127,879,000**
	Mode Share	61%	30%	0%	10%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-1,267,000**	**-6,146,000**		**9,091,000**	**1,678,000**
	% change	-2%	-14%		292%	**1%**

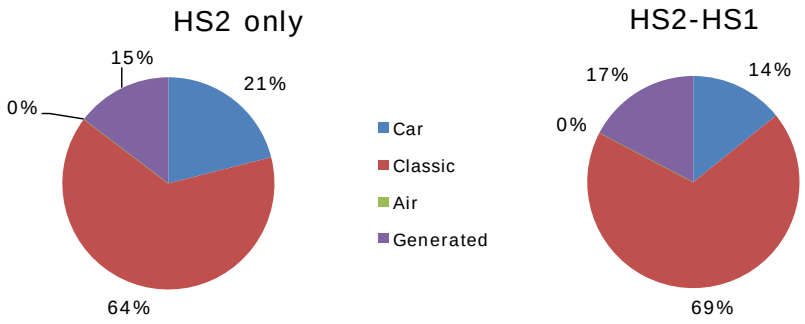
Table 6.16 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	87,262,000	58,214,000	-	-	**145,476,000**
	Mode Share	60%	40%	0%	0%	**100%**
HS2 Only	Demand	86,597,000	56,182,000	-	3,160,000	**145,939,000**
	Mode Share	59%	38%	0%	2%	**100%**
HS2-HS1	Demand	85,218,000	48,378,000	-	14,368,000	**147,964,000**
	Mode Share	58%	33%	0%	10%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-1,379,000**	**-7,804,000**		**11,208,000**	**2,025,000**
	% change	-2%	-14%		355%	**1%**

Table 6.17 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	665,000	2,032,000	-	463,000	**3,160,000**
HS2-HS1	2,044,000	9,836,000	-	2,488,000	**14,368,000**

Figure 6.8 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



6.6 Kent / Essex / Suffolk / East London / Docklands – North West London / Milton Keynes

6.6.1 The scope of the Kent/Essex/Suffolk/East London/Docklands to/from North West London and Milton Keynes market is shown in the Figure 6.9. It should be noted that demand generation for this market relies on a suitable connection at Old Oak Common to serve this corridor. This could potentially be achieved by a proposed Crossrail connection to the West Coast Mainline (as currently proposed by Greengauge 21, Network Rail and TfL).

Figure 6.9 Kent/Essex/Suffolk/East London/Docklands – North West London/ Milton Keynes Market

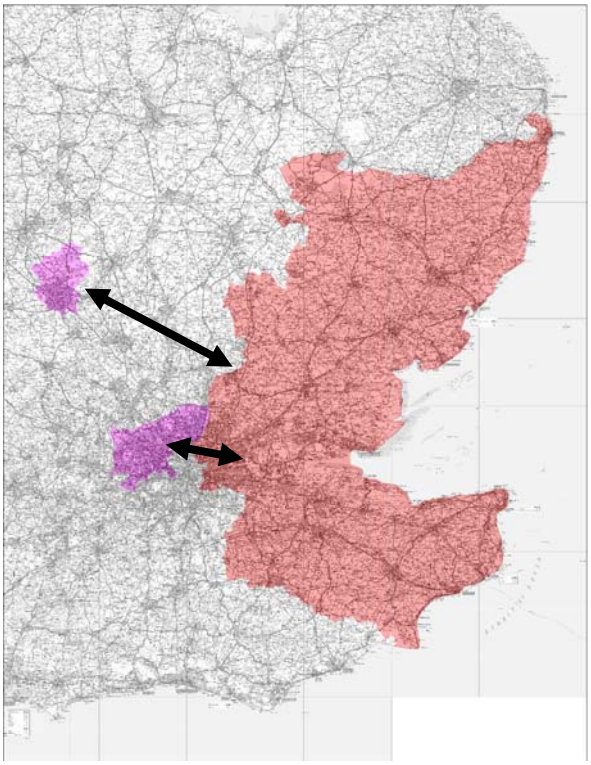


Table 6.18 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	79,788,000	32,647,000	-	-	**112,435,000**
Mode Share	71%	29%	0%	0%	**100%**

Table 6.19 2026 Forecast Demand

2026 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	104,210,000	49,040,000	-	-	**153,250,000**
	Mode Share	68%	32%	0%	0%	**100%**
HS2 Only	Demand	103,637,000	47,076,000	-	3,038,000	**153,751,000**
	Mode Share	67%	31%	0%	2%	**100%**
HS2-HS1	Demand	102,797,000	46,420,000	-	5,109,000	**154,326,000**
	Mode Share	67%	30%	0%	3%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-840,000**	**-656,000**		**2,071,000**	**575,000**
	% change	-1%	-1%		68%	**0%**

Table 6.20 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	114,367,000	61,943,000	-	-	**176,310,000**
	Mode Share	65%	35%	0%	0%	**100%**
HS2 Only	Demand	113,787,000	59,966,000	-	3,082,000	**176,835,000**
	Mode Share	64%	34%	0%	2%	**100%**
HS2-HS1	Demand	112,905,000	59,133,000	-	5,430,000	**177,468,000**
	Mode Share	64%	33%	0%	3%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-882,000**	**-833,000**		**2,348,000**	**633,000**
	% change	-1%	-1%		76%	**0%**

Table 6.21 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	580,000	1,977,000	-	525,000	**3,082,000**
HS2-HS1	1,462,000	2,810,000	-	1,158,000	**5,430,000**

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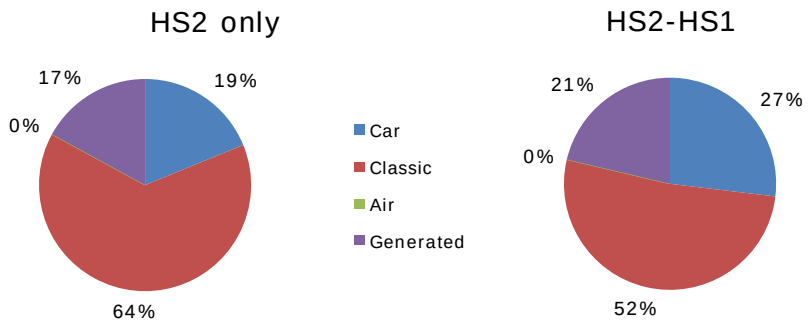
Figure 6.10 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



6.7 Kent/Essex/Suffolk/East London/Docklands services – Heathrow

6.7.1 The scope of the Kent/Essex/Suffolk/East London/Docklands to/from Heathrow market is shown in the Figure 6.11. This assumes direct services from Ashford and Stratford to Heathrow for the HS2-HS1 scenario and from London Euston to Heathrow with an interchange at Old Oak Common in the HS2 only scenario.

Figure 6.11 Kent / Essex / Suffolk / East London / Docklands – Heathrow Market

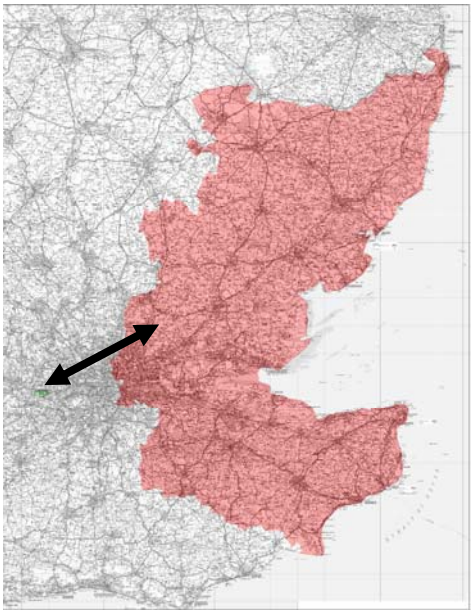


Table 6.22 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	14,982,000	17,658,000	-	-	**32,640,000**
Mode Share	46%	54%	0%	-	**100%**

Table 6.23 2026 Forecast Demand

2026 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	19,718,000	30,929,000	-	-	**50,647,000**
	Mode Share	39%	61%	0%	0%	**100%**
HS2 Only	Demand	19,065,000	28,908,000	-	3,120,000	**51,093,000**
	Mode Share	37%	57%	0%	6%	**100%**
HS2-HS1	Demand	18,194,000	28,898,000	-	4,388,000	**51,480,000**
	Mode Share	35%	56%	0%	9%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-871,000**	**-10,000**		**1,268,000**	**387,000**
	% change	-5%	0%		41%	**1%**

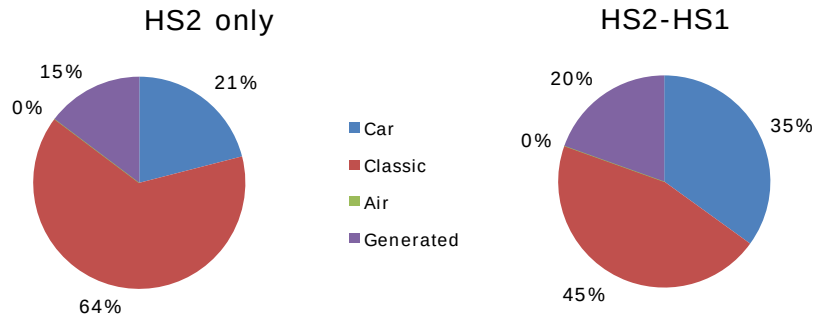
Table 6.24 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	21,597,000	39,331,000	-	-	**60,928,000**
	Mode Share	35%	65%	0%	0%	**100%**
HS2 Only	Demand	20,931,000	37,292,000	-	3,172,000	**61,395,000**
	Mode Share	34%	61%	0%	5%	**100%**
HS2-HS1	Demand	20,022,000	37,282,000	-	4,504,000	**61,808,000**
	Mode Share	32%	60%	0%	7%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-909,000**	**-10,000**		**1,332,000**	**413,000**
	% change	-4%	0%		42%	**1%**

Table 6.25 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	666,000	2,039,000	-	467,000	**3,172,000**
HS2-HS1	1,575,000	2,049,000	-	880,000	**4,504,000**

Figure 6.12 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



6.8 Kent/Essex/Suffolk/East London/Docklands services – East Midlands/Yorkshire

6.8.1 The scope of the Kent/Essex/Suffolk/East London/Docklands to/from East Midlands and Yorkshire market is shown in the Figure 6.13. The analysis has only been carried out for the 2033 forecast year, as HS2 only starts to serve the East Midlands and Yorkshire market from this point.

Figure 6.13 Kent/Essex/Suffolk/East London/Docklands – East Midlands/ Yorkshire Market

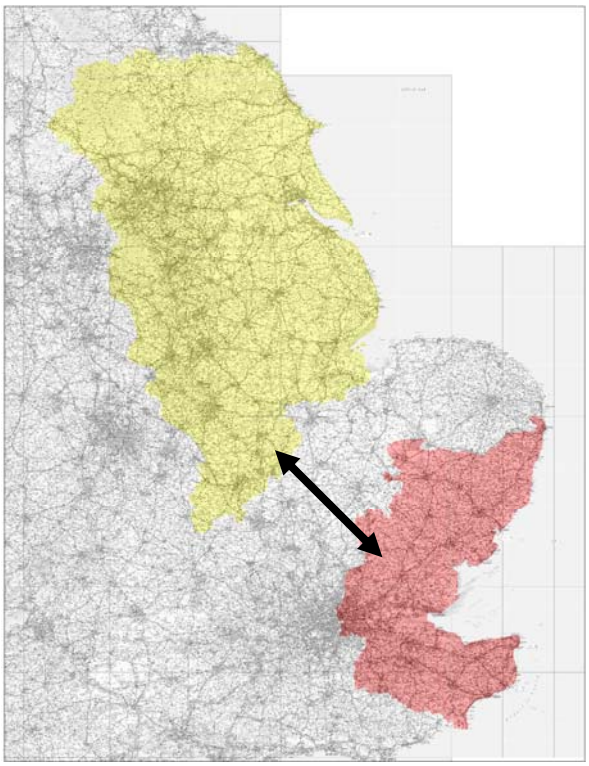


Table 6.26 Base Year Demand

2011 Base Year	Car	Classic Rail	Air	HS Rail	Total
Demand	33,416,000	3,492,000	14,000	-	**36,922,000**
Mode Share	91%	9%	0%	-	**100%**

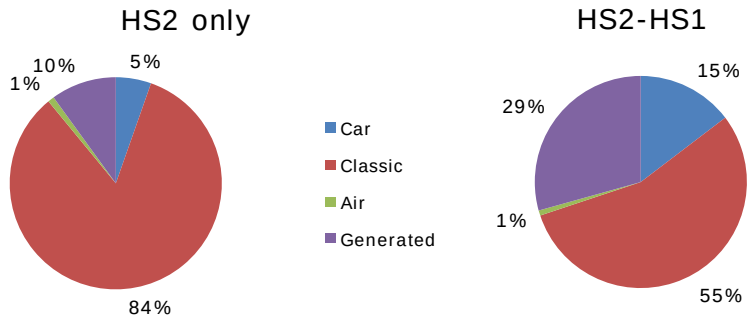
Table 6.27 2033 Forecast Demand

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
No HS2	Demand	48,186,000	7,820,000	91,000	-	**56,097,000**
	Mode Share	86%	14%	0%	0%	**100%**
HS2 Only	Demand	48,042,000	5,587,000	65,000	2,669,000	**56,363,000**
	Mode Share	85%	10%	0%	5%	**100%**
HS2-HS1	Demand	47,514,000	5,285,000	55,000	4,589,000	**57,443,000**
	Mode Share	83%	9%	0%	8%	**100%**
HS2-HS1 cf. HS2 only	Demand change	**-528,000**	**-302,000**		**1,920,000**	**1,080,000**
	% change	-1%	-5%		72%	**2%**

Table 6.28 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)

2033 Forecast Year	Car	Classic Rail	Air	Generated	Total
HS2 Only	144,000	2,233,000	26,000	266,000	**2,669,000**
HS2-HS1	672,000	2,535,000	36,000	1,346,000	**4,589,000**

Figure 6.14 Sources of High-Speed Demand in 2033 (HS2 only and HS2-HS1)



7 International Demand Results

7.1 Introduction

7.1.1 This chapter presents an estimation of the total demand to and from international destinations on the near-Continent that could potentially be served by high-speed rail with the HS2-HS1 link.

7.1.2 Demand results are presented for the following zones:

- **Europe – West Midlands / North West England** (Section 7.6);
- **Europe – Stratford** (Section 7.7); and
- **Europe – Heathrow** (Section 7.8).

7.2 Europe Zone

7.2.1 The following destinations are included within the Europe zone: **Paris, Brussels, Lille, Amsterdam, Rotterdam, Antwerp, Aachen, Liege, Frankfurt and Cologne**.

7.3 2011 Base Year Europe Demand

7.3.1 The 2011 base year demand to/from Europe consists of:

- Rail demand (Eurostar) to/from Paris, Lille and Brussels with London interchange where applicable; and
- Air demand to/from all destinations listed in 7.2.

7.3.2 Other travel modes such as car and coach are ignored, as well as any rail demand to destinations other than Paris, Lille and Brussels.

Rail demand

7.3.3 The 2007 base rail demand for the Europe model zone in the demand model showed demand between destinations across the UK and Europe which was then mapped to the model zones. The rail matrix was updated to 2011 by applying the four-year growth in Eurostar demand (17.4%, as per Table 3.1).

7.3.4 Further analysis of market research data indicated that 70% of UK to Europe rail demand was on services between London and Paris, with the remaining 30% on services between London and Brussels. It was further assumed that two-thirds of demand on Brussels services was for Brussels and one-third for Lille. Europe rail demand from each model zone was therefore assigned to Paris, Brussels and Lille according to these proportions.

Air demand

7.3.5 As per section 3.2 the base year matrix for air demand was obtained by sourcing demand data for 2011 from the Civil Aviation Authority (CAA) with provides demand between airport pairs. In the original model the Europe zone consisted of just airports in Paris (Charles De Gaulle, Orly, Beauvais, Le Bourget), Brussels (Brussels and Charleroi) and Lille. This flow

now includes demand for Amsterdam, Rotterdam, Antwerp, Aachen, Liege, Frankfurt and Cologne airports. As per domestic demand, only terminating passengers were counted.

7.3.6 Total demand between UK mainland airports and the above Europe airports was calculated from the 2011 CAA data and then mapped onto GG21 model zones using CAA annual surveys the demand at each airport regarding passengers' origins.

7.4 2026 and 2033 Europe Demand

7.4.1 The 2011 base air and rail Europe demand matrices were grown by the same factors as per domestic demand (see section 3.5) to generate demand matrices in the two forecast years, 2026 and 2033.

7.5 Estimating Rail Market Share

7.5.1 To estimate the high-speed rail mode share in 2026 and 2033, the total rail journey time from each market considered to each European destination was calculated (including a 30 minute interchange at Ebbsfleet where applicable).

7.5.2 The rail market share was then estimated from Figure 7.1 which can be used to determine the proportion of demand that a new high-speed rail service will abstract from air. This proportion was then applied to the total market i.e. air and rail in order to provide an estimate of the annual rail market.

7.5.3 For Lille, the rail mode share was assumed to be 100%, given there are currently no flights between the UK and Lille.

7.5.4 This approach assumes that the frequency of rail services is broadly equivalent to that of air.

7.5.5 A limitation of this approach is that is does not account for any generated demand as a result of an improvement to the rail service; this is discussed later in section 7.9.

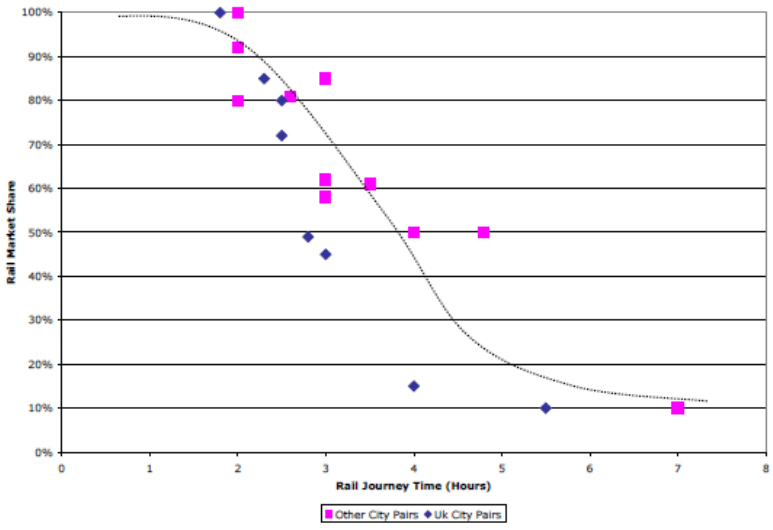


Figure 7.1 Rail/air mode shares by rail journey time
Source: MVA/SNCF

7.6 Europe – West Midlands/North West England

7.6.1 The West Midlands/North West England region has been defined as per the domestic demand analysis (see Table 4.1 for the model zones included). Table 7.1 presents the 2011 base year demand and mode share for trips between Europe and the West Midlands and North West England. HS rail represents trips using Eurostar on HS1 between London and Europe with an interchange to domestic services between London and the West Midlands/North West.

Table 7.1 2011 Base Year Demand and Mode Share

2011 Base Year	Air	HS Rail	Total
Paris	703,000	168,000	**871,000**
Lille	-	24,000	**24,000**
Belgium*	298,000	48,000	**346,000**
Holland+	1,167,000	-	**1,167,000**
Cologne	42,000	-	**42,000**
Frankfurt	458,000	-	**458,000**
Total Demand	**2,668,000**	**240,000**	**2,908,000**
% Mode Share	**92%**	**8%**	**100%**

*Belgium consists of Brussels, Antwerp and Liege; +Holland consists of Amsterdam and Rotterdam
Source: Eurostar, CAA

Table 7.2 2026 and 2033 Total Demand (Air & Rail combined)

Forecast Year	2026	2033
Paris	1,335,000	1,679,000
Lille	37,000	47,000
Belgium	530,000	667,000
Holland	1,787,000	2,245,000
Cologne	65,000	82,000
Frankfurt	702,000	883,000
Total Demand	**4,456,000**	**5,603,000**

7.6.2 The impact of HS2-HS1 in 2026 and 2033 was modelled both with an interchange at Ebbsfleet (where an interchange of 30 min was assumed) and without i.e. direct through services (see Table 7.3 to Table 7.6).

7.6.3 The impact of through services is to increase the overall rail mode share for this market from 34% to 40% in 2033.

With Ebbsfleet interchange

Table 7.3 2026 Rail journey time, estimated rail market share and demand (with Ebbsfleet interchange)

	Journey time	% Rail share	Estimated rail demand 2026
Paris	3 hr 50 min	50%	**668,000**
Lille	3 hr 05 min	100%	**37,000**
Belgium	3 hr 25 min	62.5%	**331,000**
Holland	6 hr 05 min	12.5%	**223,000**
Cologne	7 hr 30 min	10%	**7,000**
Frankfurt	8 hr 30 min	5%	**35,000**
		Total	**1,301,000**
		Rail Mode Share	**29%**

Table 7.4 2033 Rail journey time, estimated rail market share and demand (with Ebbsfleet interchange)

	Journey time	% Rail share	Estimated rail demand 2033
Paris	3 hr 35 min	60%	**1,007,000**
Lille	2 hr 50 min	100%	**47,000**
Belgium	3 hr 10 min	67.5%	**450,000**
Holland	5 hr 50 min	15%	**337,000**
Cologne	7 hr 15 min	10%	**8,000**
Frankfurt	8 hr 15 min	5%	**44,000**
		Total	**1,893,000**
		Rail Mode Share	**34%**

With through services

Table 7.5 2026 Rail journey time, estimated rail market share and demand (with through services)

	Journey time	% Rail share	Estimated rail demand 2026
Paris	3 hr 20 min	62.5%	**834,000**
Lille	2 hr 35 min	100%	**37,000**
Belgium	2 hr 55 min	75%	**398,000**
Holland	5 hr 35 min	17.5%	**313,000**
Cologne	7 hr 00 min	12.5%	**8,000**
Frankfurt	8 hr 00 min	7.5%	**53,000**
		Total	**1,643,000**
		Rail Mode Share	**37%**

Table 7.6 2033 Rail journey time, estimated rail market share and demand (with through services)

	Journey time	% Rail share	Estimated rail demand 2033
Paris	3 hr 05 min	70%	**1,175,000**
Lille	2 hr 20 min	100%	**47,000**
Belgium	2 hr 40 min	82.5%	**550,000**
Holland	5 hr 20 min	18.5%	**415,000**
Cologne	6 hr 45 min	13.5%	**11,000**
Frankfurt	7 hr 45 min	10%	**66,000**
		Total	**2,264,000**
		Rail Mode Share	**40%**

7.7 Europe – Stratford

7.7.1 Analysis of the Europe to Stratford market assumes that the Stratford station catchment has been defined as:

- East London and Docklands; and
- Essex and Suffolk.

7.7.2 Table 7.7 shows the demand and mode share for base year trips between Stratford and Europe, where HS rail represents trips using Eurostar on HS1 between London St Pancras and Europe and include an interchange in central London to/from Stratford catchment.

Table 7.7 2011 Base Year Demand and Mode Share

2011 Base Year	Air	HS Rail	Total
Paris	191,000	1,292,000	**1,483,000**
Lille	-	186,000	**186,000**
Belgium	57,000	372,000	**429,000**
Holland	501,000	-	**501,000**
Cologne	76,000	-	**76,000**
Frankfurt	156,000	-	**156,000**
Total Demand	**981,000**	**1,850,000**	**2,831,000**
% Mode Share	**35%**	**65%**	**100%**

Source: Eurostar, CAA

Table 7.8 2026 and 2033 Total Demand (Air & Rail combined)

Forecast Year	2026	2033
Paris	2,564,000	3,303,000
Lille	322,000	413,000
Belgium	744,000	959,000
Holland	850,000	1,104,000
Cologne	127,000	164,000
Frankfurt	276,000	362,000
Total Demand	**4,883,000**	**6,305,000**

7.7.3 The impact of HS2-HS1 in 2026 and 2033 was modelled assuming direct through-services to/from Stratford (see Table 7.9 and Table 7.10).

Table 7.9 2026 Rail journey time, estimated rail market share and demand

	Journey time	% Rail share	Estimated rail demand 2026
Paris	2 hr 15 min	90%	2,308,000
Lille	1 hr 30 min	100%	322,000
Belgium	1 hr 50 min	95%	465,000
Holland	4 hr 30 min	30%	255,000
Cologne	5 hr 55 min	15%	19,000
Frankfurt	6 hr 55 min	12.5%	35,000
		Total	**3,404,000**
		Rail Mode Share	**70%**

Table 7.10 2033 Rail journey time, estimated rail market share and demand

	Journey time	% Rail share	Estimated rail demand 2033
Paris	2 hr 15 min	90%	2,973,000
Lille	1 hr 30 min	100%	413,000
Belgium	1 hr 50 min	95%	647,000
Holland	4 hr 30 min	30%	331,000
Cologne	5 hr 55 min	15%	25,000
Frankfurt	6 hr 55 min	12.5%	45,000
		Total	**4,434,000**
		Rail Mode Share	**70%**

7.8 Europe – Heathrow

7.8.1 The Heathrow demand was based on the CAA data. Only terminating passengers were included (47% of total) as it was assumed inter-lining passengers would not switch to high-speed rail.

Table 7.11 2011 Base Year Demand

2011 Base Year	Demand to/from Heathrow
Paris	676,000
Lille	-
Belgium	243,000
Holland	663,000
Cologne	69,000
Frankfurt	692,000
Total Demand	**2,343,000**

Source: CAA

Table 7.12 2026 and 2033 Total Demand

Forecast Year	2026	2033
Paris	921,000	1,084,000
Lille	-	-
Belgium	331,000	390,000
Holland	903,000	1,063,000
Cologne	94,000	111,000
Frankfurt	943,000	1,110,000
Total Demand	**3,192,000**	**3,758,000**

7.8.1 The impact of HS2-HS1 in 2026 and 2033 was modelled assuming direct through-services to/from Heathrow (see Table 7.13 and Table 7.14).

Table 7.13 2026 Rail journey time, estimated rail market share and demand

	Journey time	% Rail share	Estimated rail demand 2026
Paris	2 hr 35 min	85%	**783,000**
Lille	1 hr 50 min	95%	**-**
Belgium	2 hr 10 min	90%	**298,000**
Holland	4 hr 50 min	22.5%	**203,000**
Cologne	6 hr 15 min	15%	**14,000**
Frankfurt	7 hr 15 min	10%	**94,000**
		Total	**1,392,000**
		Rail Mode Share	**44%**

Table 7.14 2033 Rail journey time, estimated rail market share and demand

	Journey time	% Rail share	Estimated rail demand 2033
Paris	2 hr 35 min	85%	**921,000**
Lille	1 hr 50 min	95%	**-**
Belgium	2 hr 10 min	90%	**351,000**
Holland	4 hr 50 min	22.5%	**239,000**
Cologne	6 hr 15 min	15%	**17,000**
Frankfurt	7 hr 15 min	10%	**111,000**
		Total	**1,639,000**
		Rail Mode Share	**44%**

7.9 Generated demand

7.9.1 As an indication of the levels of generated demand that could be expected in these international markets resulting from the improved rail service, an elasticity to GJT is applied.

7.9.2 For demand to the nearest European destinations i.e. Paris and Brussels where the GJT improvement as a proportion of the current GJT is highest, a demand generation in the region of 15% to 20% could be expected. For example, for Birmingham to Paris, the current GJT is 515 min (consisting of station to station journey time, service penalty and interchange penalty). With an HS2-HS1 through service, a GJT saving of 100 min is assumed (based on a quicker journey time to London, and the removal of the London interchange). With an elasticity to GJT of -0.9 (as per PDFH v5), a demand uplift of approximately 20% is estimated.

7.9.3 For destinations further away such as Holland and Germany, the GJT improvement as a proportion of the current GJT is lower and we would therefore expect only a minimal demand uplift (up to 5%).

8 Results Summary and Discussion

8.1 Introduction

8.1.1 This chapter provides a summary of the results presented in the two previous chapters including an estimation of daily demand in each market considered. A comparison is also made against demand from Greater London and Central London.

8.2 Domestic high-speed demand

8.2.1 The domestic demand results presented in Chapter 6 are summarised in Table 8.1. In addition to the annual demand in 2033 with the HS2-HS1 link in place, the daily unidirectional demand is shown (by taking 50% of the bidirectional demand and dividing by 365); as a guide a typical HS train has a capacity of 1,100 passengers.

8.2.2 Demand is forecast to be highest where East London and Docklands are served (from Stratford), on both inter-urban long distance services to the West Midlands and the North West, but also on regional services to North West London, Milton Keynes and Heathrow.

Table 8.1 Summary of domestic high-speed demand by market

Market	2033 Annual demand	2033 Daily one-way demand
Kent - West Midlands / North West England	827,000	1,100
Essex / Suffolk - West Midlands / North West England	2,762,000	3,800
East London / Docklands - West Midlands / North West England	5,362,000	7,300
Kent / Essex & Suffolk / East London & Docklands - East Midlands / Yorkshire & Humber	4,589,000	6,300
Total HS1-HS2 mainline demand (to/from Midlands/North)	**13,540,000**	**18,500**
Kent / Essex & Suffolk / East London / Docklands - Thames Valley (excluding Milton Keynes) / West of England / South Wales	8,265,000	11,300
Kent / Essex & Suffolk / East London & Docklands - North West London / Milton Keynes	5,430,000	7,400
Kent / Essex & Suffolk / East London & Docklands – Heathrow (no interchange at Old Oak Common)	4,504,000	6,200
Total additional HS1-HS2 Rail Demand	**18,199,000**	**24,900**
Total all markets	***31,739,000***	***43,500***

8.2.3 As a comparison, the size of the high-speed markets in the base and forecast years between London (both Greater and Central) and the West Midlands and North West, and between London (both Greater and Central) and the East Midlands and Yorkshire & Humber are presented in Table 8.2 to Table 8.6 respectively. Table 8.2 and Table 8.3 show in particular the high mode share for Classic rail in the base year scenario for Central and Greater London flows. A summary of the HS rail demand for these markets is presented in Table 8.6.

Table 8.2 Greater/Central London to West Midlands and North West market in 2011

2011 Base Year		Car	Classic Rail	Air	HS Rail	Total
Greater London	Demand	6,974,000	19,251,000	1,151,000	-	**27,376,000**
	Mode Share	25%	70%	4%	-	**100%**
Central London	Demand	473,000	12,986,000	275,000	-	**13,734,000**
	Mode Share	3%	95%	2%	-	**100%**

Table 8.3 Greater/Central London to East Midlands and Yorkshire in 2011

2011 Base Year		Car	Classic Rail	Air	HS Rail	Total
Greater London	Demand	6,238,000	15,560,000	141,000	-	**21,939,000**
	Mode Share	28%	71%	1%	-	**100%**
Central London	Demand	281,000	9,367,000	33,000	-	**9,681,000**
	Mode Share	3%	97%	0%	-	**100%**

Table 8.4 Greater/Central London to West Midlands and North West market in 2033

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
Greater London	Demand	8,902,000	14,436,000	1,048,000	36,686,000	**61,072,000**
	Mode Share	15%	24%	2%	60%	**100%**
Central London	Demand	921,000	9,945,000	188,000	20,009,000	**31,063,000**
	Mode Share	3%	32%	1%	64%	**100%**

Table 8.5 Greater/Central London to East Midlands and Yorkshire in 2033

2033 Forecast Year		Car	Classic Rail	Air	HS Rail	Total
Greater London	Demand	9,438,000	19,856,000	217,000	12,996,000	**42,507,000**
	Mode Share	22%	47%	1%	31%	**100%**
Central London	Demand	500,000	13,979,000	51,000	5,683,000	**20,213,000**
	Mode Share	2%	69%	0%	28%	**100%**

Table 8.6 Summary of Greater/Central London HS rail demand in 2033

Market	2033 Annual demand	2033 Daily one-way demand
West Midlands / North West		
Greater London	36,686,000	50,300
Central London	20,009,000	27,400
East Midlands / Yorkshire & Humber		
Greater London	12,996,000	17,800
Central London	5,683,000	7,800

8.2.4 Table 8.7 and Table 8.8 show the relative size of the high-speed rail demand for the markets assessed compared to the Greater London and Central London demand respectively.

Table 8.7 Comparison of scale of demand against Greater London demand

	% Greater London demand
West Midlands / North West	
Kent	2%
Essex/Suffolk	8%
East London/Docklands	15%
Total	***24%***
East Midlands / Yorkshire & Humber	
Kent / Essex & Suffolk / East London & Docklands	35%

Table 8.8 Comparison of scale of demand against Central London demand

	% Central London demand
West Midlands / North West	
Kent	4%
Essex/Suffolk	14%
East London/Docklands	27%
Total	***45%***
East Midlands / Yorkshire & Humber	
Kent / Essex & Suffolk / East London & Docklands	81%

8.2.5 Table 8.9 shows the change in the rail mode share between 2011 (Classic only) and 2033 (Classic and HS services). An increase in the total rail mode share of up to 26 percentage points is observed, with the greatest increases in those markets with the greatest journey time saving and the largest reduction in the number of central London interchanges such as Kent and Essex.

Table 8.9 Change in rail market share

Market	2011 rail mode share (Classic)	2033 rail mode share (Classic + high-speed)	Change
Kent - West Midlands / North West England	17%	40%	23%
Essex / Suffolk - West Midlands / North West England	13%	36%	23%
East London / Docklands - West Midlands / North West England	72%	85%	13%
Kent / Essex & Suffolk / East London / Docklands - Thames Valley / Heathrow / West of England / South Wales	31%	42%	11%
Kent / Essex & Suffolk / East London & Docklands - North West London / Milton Keynes	29%	36%	7%
Kent / Essex & Suffolk / East London & Docklands - Heathrow	54%	68%	14%
Kent / Essex & Suffolk / East London & Docklands - East Midlands / Yorkshire & Humber	9%	17%	8%

8.2.6 A summary of the market sizes for all modes is given Table 8.10 below, along with the HS market share for the scenario with the HS2-HS1 connection in place. This shows that the larger markets generally have a lower market share for high speed rail particularly in comparison to classic rail. The largest four markets show a lower market share for HS rail due to competition from either classic rail and/or highway modes. In addition the top three markets in terms of size include the shortest distance trips, and therefore experience lower penetration by HS services as Classic rail services remain competitive due to smaller journey time savings.

Table 8.10 All mode market size

Market	2033 demand (all modes)	2033 HS rail mode share	2033 total rail mode share
Kent / Essex & Suffolk / East London & Docklands - North West London / Milton Keynes	177,468,000	3%	36%
Kent / Essex & Suffolk / East London / Docklands - Thames Valley / Heathrow / West of England / South Wales	147,964,000	10%	42%
Kent / Essex & Suffolk / East London & Docklands - Heathrow	61,808,000	7%	68%
Kent / Essex & Suffolk / East London & Docklands - East Midlands / Yorkshire & Humber	57,443,000	8%	17%
East London / Docklands - West Midlands / North West England	8,807,000	61%	85%
Essex / Suffolk - West Midlands / North West England	8,590,000	32%	36%
Kent - West Midlands / North West England	2,344,000	35%	40%

8.3 Sensitivity Tests

8.3.1 Two sensitivity tests were carried out to test the responsiveness of the forecast high-speed demand to:

- the proposed HS2-HS1 service frequency (1 tph and 3 tph against 2 tph); and
- car demand growth.

8.3.2 Table 8.11 shows the impact on high-speed demand as a result of varying the HS2-HS1 service frequency from 2 tph to 1 tph and 3 tph. Reducing the frequency to 1 tph reduces annual demand by 8% across all markets; increasing the frequency to 3 tph increases demand by 4% overall.

Table 8.11 HS2-HS1 service frequency sensitivity test

Market	2033 demand (2 tph)	2033 demand (1 tph)	% change in demand cf. 2 tph	2033 demand (3 tph)	% change in demand cf. 2 tph
Kent - West Midlands / North West England	827,000	760,000	-8%	870,000	5%
Essex / Suffolk - West Midlands / North West England	2,762,000	2,415,000	-13%	3,001,000	9%
East London / Docklands - West Midlands / North West England	5,362,000	5,068,000	-5%	5,559,000	4%
Kent / Essex & Suffolk / East London / Docklands - Thames Valley / Heathrow / West of England / South Wales	14,368,000	12,939,000	-10%	14,875,000	4%
Kent / Essex & Suffolk / East London & Docklands - North West London / Milton Keynes	5,430,000	5,056,000	-7%	5,653,000	4%
Kent / Essex & Suffolk / East London & Docklands - Heathrow	4,504,000	4,216,000	-6%	4,648,000	3%
Kent / Essex & Suffolk / East London & Docklands - East Midlands / Yorkshire & Humber	4,589,000	4,307,000	-6%	4,773,000	4%

8.3.3 Table 8.12 shows the impact on high-speed demand as a result of varying the car growth assumptions. The low car growth sensitivity test reduces the level of car growth within the model by 50%, and the high car growth sensitivity tests increases the level of car growth by 50%. The 50% increase in car growth forecasts affects the overall demand across all markets by +5% and the 50% decrease in car growth forecasts changes the market demand by -6% overall.

Table 8.12 Car Growth Forecasts sensitivity test

Market	2033 demand (2 tph)	2033 demand (Low Car Growth)	% change in demand	2033 demand (High Car Growth)	% change in demand
Kent - West Midlands / North West England	827,000	776,000	-6%	878,000	6%
Essex / Suffolk - West Midlands / North West England	2,762,000	2,647,000	-4%	2,876,000	4%
East London / Docklands - West Midlands / North West England	5,362,000	5,285,000	-1%	5,439,000	1%
Kent / Essex & Suffolk / East London / Docklands - Thames Valley / Heathrow / West of England / South Wales	14,368,000	13,266,000	-8%	14,936,000	4%
Kent / Essex & Suffolk / East London & Docklands - North West London / Milton Keynes	5,430,000	4,966,000	-9%	5,895,000	9%
Kent / Essex & Suffolk / East London & Docklands - Heathrow	4,504,000	4,061,000	-10%	4,918,000	9%
Kent / Essex & Suffolk / East London & Docklands - East Midlands / Yorkshire & Humber	4,589,000	4,457,000	-3%	4,721,000	3%

8.4 International demand

8.4.1 The international demand results presented in Chapter 7 are summarised in Table 8.13 in terms of the annual demand in 2033 and the daily unidirectional demand. It should be noted that the Europe to West Midlands/North West England market includes an interchange at Ebsfleet and 30 minute journey time penalty, whereas the shorter distance trips to Stratford and Heathrow are assumed to be direct services.

Table 8.13 Summary of international demand

Market	2033 Annual demand	2033 Daily one-way demand
Europe – West Midlands/North West England	1,893,000	2,600
Europe – Stratford	4,434,000	6,100
Europe – Heathrow	1,639,000	2,200

9 Appendix A: Classic Rail Inputs

Table 9.1 2011 Classic Rail Inputs from Central London

Route	Journey Time (min)	Frequency (tph)	Interchanges
London Euston – Birmingham New Street	84	3	0
London Euston – Birmingham International	70	3	0
London Euston – Manchester Piccadilly	128	3	0
London Euston – Crewe	90	3	0
London Euston – Liverpool Lime St	128	3	0.67
London St Pancras – Nottingham	104	2	0
London St Pancras – Sheffield	125	2	0
London St Pancras – Sheffield Meadowhall	134	2	1
London Kings Cross – Leeds	132	2	0
London Paddington – Reading	27	9	0
London Paddington – Bristol Temple Meads	107	4	0.5
London Paddington – Bristol Parkway	84	2	0
London Paddington – Cardiff	124	2	0
London Euston – Heathrow	36	4	1

Source: HS2 Ltd, National Rail Enquiries

Table 9.2 2011 Classic Rail Inputs from Kent

Route	Journey Time (min)	Frequency (tph)	Interchanges
Ashford Int'l – Birmingham New Street	170	2	2
Ashford Int'l – Birmingham International	155	2	2
Ashford Int'l – Manchester Piccadilly	210	2	2
Ashford Int'l – Crewe	181	2	2
Ashford Int'l – Liverpool Lime St	225	2	2
Ashford Int'l – Nottingham	166	1	1
Ashford Int'l – Sheffield	210	2	1
Ashford Int'l – Sheffield Meadowhall	219	2	2
Ashford Int'l – Leeds	216	2	2
Ashford Int'l – Reading	115	2	2
Ashford Int'l – Bristol Temple Meads	210	2	2
Ashford Int'l – Bristol Parkway	176	2	2
Ashford Int'l – Cardiff	216	2	2
Ashford Int'l – Heathrow	102	2	2

Source: National Rail Enquiries

Table 9.3 2011 Classic Rail Inputs from Essex, Suffolk, East London and Docklands

Route	Journey Time (min)	Frequency (tph)	Interchanges
Stratford – Birmingham New Street	132	3	2
Stratford – Birmingham International	118	3	2
Stratford – Manchester Piccadilly	179	3	2
Stratford – Crewe	150	2	2
Stratford – Liverpool Lime St	194	2	2
Stratford – Nottingham	140	2	1
Stratford – Sheffield	161	2	1
Stratford – Sheffield Meadowhall	170	2	2
Stratford – Leeds	185	2	2
Stratford – Reading	79	9	1
Stratford – Bristol Temple Meads	160	4	1.5
Stratford – Bristol Parkway	136	2	1
Stratford – Cardiff	176	2	1
Stratford – Heathrow	60	4	2

Source: National Rail Enquiries, TfL journey planner

10 Appendix B: HS2 Inputs

Table 10.1 HS2 Inputs (from 2026)

Route	Journey Time (min)	Frequency (tph)	Interchanges
London Euston - Birmingham Curzon Street	49	3	0
London Euston - Birmingham Interchange	38	3	0
London Euston - Manchester Piccadilly	101	3	0
London Euston - Crewe	63	2	0
London Euston - Liverpool	110	2	0
London Euston – Nottingham	110	3	0
London Euston - Sheffield	129	3	0
London Euston - Sheffield Meadowhall	134	3	1
London Euston - Leeds	140	3	0

For destinations other than Birmingham, journey times are based on high-speed running as far as Birmingham and Classic journey times further north.

Source: HS2 Ltd

Table 10.2 HS2 Inputs (from 2033)

Route	Journey Time (min)	Frequency (tph)	Interchanges
London Euston - Birmingham Curzon Street	49	3	0
London Euston - Birmingham Interchange	38	3	0
London Euston - Manchester Piccadilly	68	3	0
London Euston - Crewe	58	2	0
London Euston - Liverpool	96	2	0
London Euston - Nottingham	68	3	1
London Euston - Sheffield	79	3	1
London Euston - Sheffield Meadowhall	69	3	0
London Euston - Leeds New Lane	82	3	0

Source: HS2 Ltd

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