Rail freight forecasts: Scenarios for 2033/34 & 2043/44.

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MDS Transmodal

CONTENTS

EXECUTIVE SUMMARY

This report by MDS Transmodal (MDST) was commissioned by Network Rail and presents forecasts of rail freight in Great Britain for 2033/34 and 2043/44. It also presents forecasts for 2023/24, extracted from the equivalent report for 2023/24, which was finalised in May 2018. This report, for 2033/34 and 2043/44, combined with the May 2018 report for 2023/24, represent an update of the forecasts in Network Rail's 2013 Freight Market Study.

Over the period since 2004/05, total rail freight lifted has fallen from 115m tonnes to 86m tonnes in 2016/17. However, this is primarily a consequence of the Government's decision to phase out electricity generation by coal in order to meet international obligations on CO_2 emissions. A limited volume of biomass traffic has replaced some of the coal despatched by rail to the power stations. Coal accounts for under 1% of road freight but in 2004/05 coal to power stations (ESI coal) accounted for 35% of all rail freight lifted.

Traffic *excluding ESI coal and biomass* fell from 74.7m tonnes in 2004/05 to 67.7m tonnes in 2012/13, largely reflecting a decline in UK heavy industry and in the steel industry in particular. However, since then traffic *excluding ESI coal and biomass* has grown to 73.0m tonnes (+8%). Reflecting the decline in indigenous heavy industry, over the 12 years from 2004/05 to 2016/17 that are covered in the report (for which consistent rail freight volumes were available), HGV vehicle kms fell by 9% while rail freight *excluding ESI coal and biomass* fell by only 2%. This suggests that rail (excluding the energy supply industry) has grown its market share versus road.

These flows are summarised in the table below.

Table 1: GB rail freight and road freight, 2004/05 to 2016/17

	2004/05	2008/09	2012/13	2016/17
ESI Coal + biomass rail tonnes (million)	41	45	47	13
Other rail tonnes (million)	75	71	68	73
Total rail tonnes (million)	115	117	115	86
Index: Other rail tonnes (million)	100	95	91	98
HGV kms (Billions)	29.3	28.6	25.0	26.8
Index all HGV kms	100	98	85	91

Sources: Rail: MDS Transmodal processing of Network Rail data. HGV kms: Transport Statistics Great Britain (TSGB) for the calendar years 2004, 2008, 2012 and 2016 respectively.

For each sector there are six main capacity-unconstrained scenarios for 2033/34 and 2043/44 – with assumptions that vary by sector. The scenarios are comprised of an equivalent of the 4 scenarios (A-D) that were used for 2023/24:

Table 2: The four scenarios reflecting low and high market growth and favourability towards rail

	Low market growth	High market growth
Factors which favour rail relative to road	Scenario A	Scenario B
Factors which disfavour rail relative to road	Scenario C	Scenario D

along with:

- Scenario E: "Base" or "Central" scenario – reflecting a "Do Minimum" mind-set with central case assumptions.
- Scenario F: "Internalisation of externalities" – whereby users of both road and rail pay their full external costs. This is built on scenario E.

A sensitivity test G (2043/4 only) is also modelled: The introduction of a new European gauge freight route between Scotland and the Channel Tunnel Rail Link (CTRL) in East London.

Both the FMS and these latest projections are forecasts of *demand* – i.e. they are *unconstrained* by capacity limits. They assume the levels of service provided by the network in terms of end-to-end transit times remain constant, relative to the base year (2016/17). Similarly the gauge clearance capability of the network is assumed to remain constant relative to the base year, except in relation to certain new warehousing sites and under sensitivity test G.

The results of the 2033/34 and 2043/44 scenarios are shown below (tonnes and total tonne kms). The equivalent 2023/24 forecasts from the May 2018 report are also shown first in italics (these are the unconstrained scenarios A2 to D2):

Table 3: Rail freight TONNES forecast for <u>2023/24</u> scenarios by sector. Thousand tonnes per year

Sector	*Actual 2016/17*	*2023/24 A2*	*2023/24 B2*	*2023/24 C2*	*2023/24 D2*
Ports Intermodal	*16,213*	*24,252*	*27,133*	*15,320*	*17,077*
Domestic Intermodal	*2,481*	*8,009*	*8,606*	*3,281*	*3,493*
Channel Tunnel Intermodal	*374*	*529*	*578*	*420*	*458*
ESI Coal	*6,284*	*-*	*-*	*-*	*-*
Biomass	*6,470*	*8,464*	*13,045*	*8,464*	*13,045*
Waste	*1,226*	*1,165*	*1,287*	*1,165*	*1,287*
Construction materials	*24,286*	*33,133*	*43,383*	*22,887*	*29,967*
of which spoil	*735*	*997*	*1,306*	*733*	*960*
Petroleum	*4,710*	*4,822*	*5,330*	*4,470*	*4,940*
Chemicals	*899*	*934*	*1,032*	*863*	*954*
Industrial Minerals	*1,335*	*1,580*	*1,747*	*1,162*	*1,284*
Metals	*7,441*	*8,226*	*9,092*	*6,965*	*7,698*
Automotive	*450*	*468*	*583*	*437*	*548*
Ores	*4,259*	*4,046*	*4,472*	*4,046*	*4,472*
Coal Other	*1,955*	*1,857*	*4,052*	*1,857*	*4,052*
Other	*334*	*368*	*407*	*319*	*353*
Empty returns for containers carrying bulks	*413*	*397*	*439*	*393*	*434*
NR Engineering	*6,657*	*6,324*	*6,990*	*6,324*	*6,990*
Total	***85,786***	***104,574***	***128,175***	***78,371***	***97,052***
Total tonne KILOMETRES (million)	***18,962***	***23,923***	***28,472***	***17,502***	***21,152***

Scenario B2 shows the largest growth in tonnes (+49% overall) – particularly for the construction, and intermodal sectors. Scenario C2 shows a slight decline (9%). This is mostly accounted for by the decline in ESI (power station) coal.

Table 4: Rail freight TONNES forecast for 2033/34 scenarios by sector. Thousand tonnes per year

Sector	Actual 2016/17	2033/34 A	2033/34 B	2033/34 C	2033/34 D	2033/34 E	2033/34 F
Ports Intermodal	16,213	38,505	42,549	25,920	28,759	31,756	47,832
Domestic Intermodal	2,481	10,096	12,440	3,311	4,576	6,046	18,465
Channel Tunnel Intermodal	374	690	773	534	598	621	930
ESI Coal	6,284	-	-	-	-	-	-
Biomass	6,470	5,013	10,026	5,013	10,026	7,520	7,520
Waste	1,226	1,165	1,287	1,165	1,287	1,226	1,226
Construction materials	24,286	36,348	45,410	23,028	28,769	35,869	51,277
of which spoil	735	1,075	1,344	507	633	1,060	1,428
Petroleum	4,710	4,891	5,406	4,611	5,097	5,025	5,391
Chemicals	899	949	1,048	866	958	968	1,082
Industrial Minerals	1,335	1,618	1,789	1,177	1,301	1,518	1,858
Metals	7,441	8,455	9,345	7,281	8,047	8,433	9,319
Automotive	450	487	538	461	509	493	549
Ores	4,259	4,046	4,472	4,046	4,472	4,259	4,259
Coal Other	1,955	1,857	4,052	1,857	4,052	1,955	1,955
Other	334	404	446	343	380	383	385
Empty returns for containers carrying bulks	413	400	443	395	437	418	418
NR Engineering	6,657	6,324	6,990	6,324	6,990	6,657	6,657
Total	**85,786**	**121,248**	**147,013**	**86,333**	**106,258**	**113,145**	**159,122**
Total tonne KILOMETRES (million)	**18,962**	**30,898**	**36,958**	**21,428**	**25,957**	**27,717**	**41,443**

The central case (scenario E) shows an increase of 32% in tonnes (46% in tonne km), with intermodal tonnes doubling.

Table 5: Rail freight TONNES forecast for 2043/44 scenarios by sector. Thousand tonnes per year

Sector	Actual 2016/17	2043/44 A	2043/44 B	2043/44 C	2043/44 D	2043/44 E	2043/44 F
Ports Intermodal	16,213	51,844	56,596	35,099	39,321	42,879	61,493
Domestic Intermodal	2,481	16,724	23,633	5,203	9,026	10,933	27,613
Channel Tunnel Intermodal	374	811	925	641	732	746	1,091
ESI Coal	6,284	-	-	-	-	-	-
Biomass	6,470	5,013	10,026	5,013	10,026	7,520	7,520
Waste	1,226	1,165	1,287	1,165	1,287	1,226	1,226
Construction materials	24,286	47,903	72,412	37,782	57,113	53,338	63,182
of which spoil	735	1,294	1,956	1,042	1,575	1,496	1,714
Petroleum	4,710	5,064	5,597	4,833	5,341	5,209	5,459
Chemicals	899	1,009	1,116	928	1,025	1,025	1,109
Industrial Minerals	1,335	1,759	1,944	1,448	1,600	1,732	1,912
Metals	7,441	8,788	9,713	7,950	8,786	8,897	9,460
Automotive	450	497	549	479	529	509	555
Ores	4,259	4,046	4,472	4,046	4,472	4,259	4,259
Coal Other	1,955	1,857	4,052	1,857	4,052	1,955	1,955
Other	334	413	456	355	393	394	396
Empty returns for containers carrying bulks	413	401	443	396	438	419	419
NR Engineering	6,657	6,324	6,990	6,324	6,990	6,657	6,657
Total	**85,786**	**153,617**	**200,212**	**113,518**	**151,132**	**147,696**	**194,307**
Total tonne KILOMETRES (million)	**18,962**	**39,124**	**49,699**	**27,638**	**35,786**	**36,061**	**51,560**

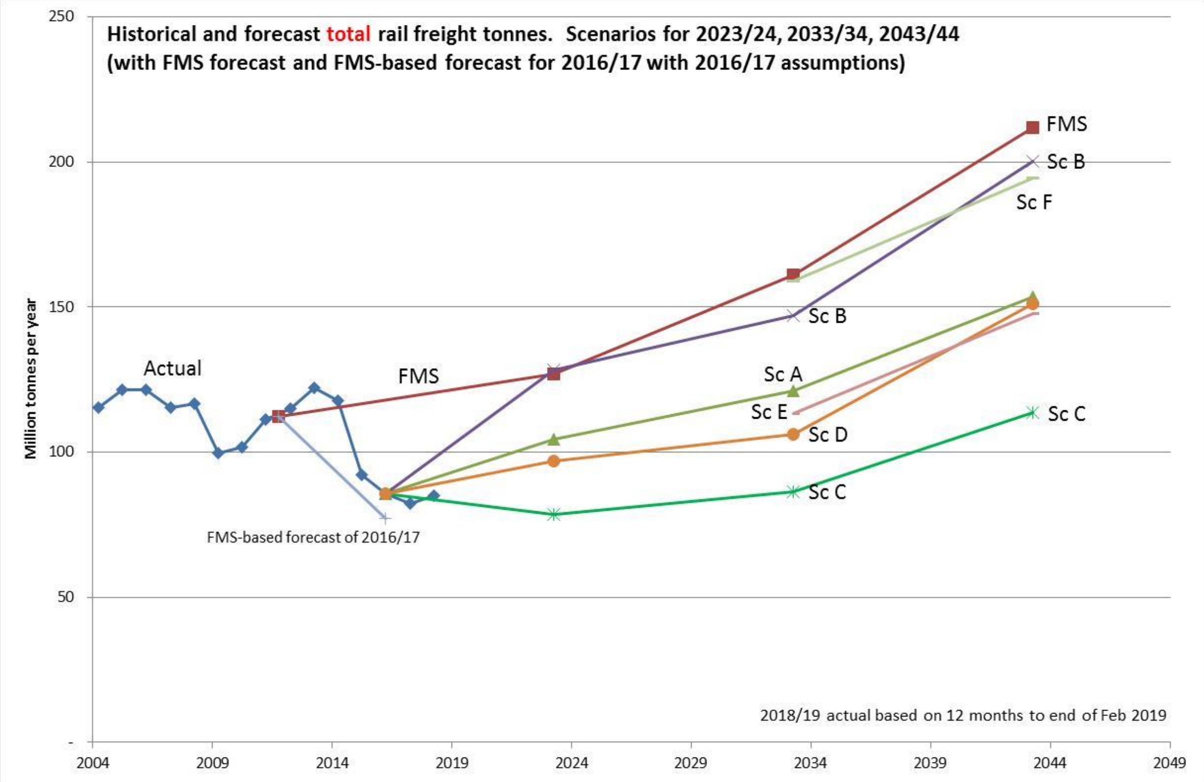
The central case (scenario E) shows an increase of 72% in tonnes (90% in tonne km), with intermodal tonnes increasing by 186% and construction materials increasing by 120%.

The table and graph below shows how the new 2023/24, 2033/34 and 2043/44 scenarios compare with the FMS forecasts, along with the historical traffics from 2004/05. It also shows what the FMS forecasts would have been for 2016/17 if out-turn assumptions for 2016/17 had been input into the FMS models.

Table 6: Comparison of new forecasts with the FMS

Scenario	Million Tonnes
2016/17 actual	85.8
2023/24 A2: Factors favouring rail, low market growth	*104.6*
2023/24 B2: Factors favouring rail, high market growth	*128.2*
2023/24 C2: Factors disfavouring rail, low market growth	*78.4*
2023/24 D2: Factors disfavouring rail, high market growth	*97.1*
2023/24 Average of A2, B2, C2 & D2	*102.0*
2023/24 A3: A2 with capacity constraint	*101.5*
2023/24 B3: B2 with capacity constraint	*119.7*
2033/34 A: Factors favouring rail, low market growth	121.2
2033/34 B: Factors favouring rail, high market growth	147.0
2033/34 C: Factors disfavouring rail, low market growth	86.3
2033/34 D: Factors disfavouring rail, high market growth	106.3
2033/34 E: Central	113.1
2033/34 F: Internalisation of external costs	159.1
2043/44 A: Factors favouring rail, low market growth	153.6
2043/44 B: Factors favouring rail, high market growth	200.2
2043/44 C: Factors disfavouring rail, low market growth	113.5
2043/44 D: Factors disfavouring rail, high market growth	151.1
2043/44 E: Central	147.7
2043/44 F: Internalisation of external costs	194.3
2012 actual (from FMS) (12 months to the end of September 2012)	112.4
2016/17 forecast from FMS base with 2016/17 assumptions	77.1
Original FMS central case forecast for 2023/24	127.0
Original FMS central case forecast for 2033/34	161.1
Original FMS central case forecast for 2043/44	211.7

Figure 1



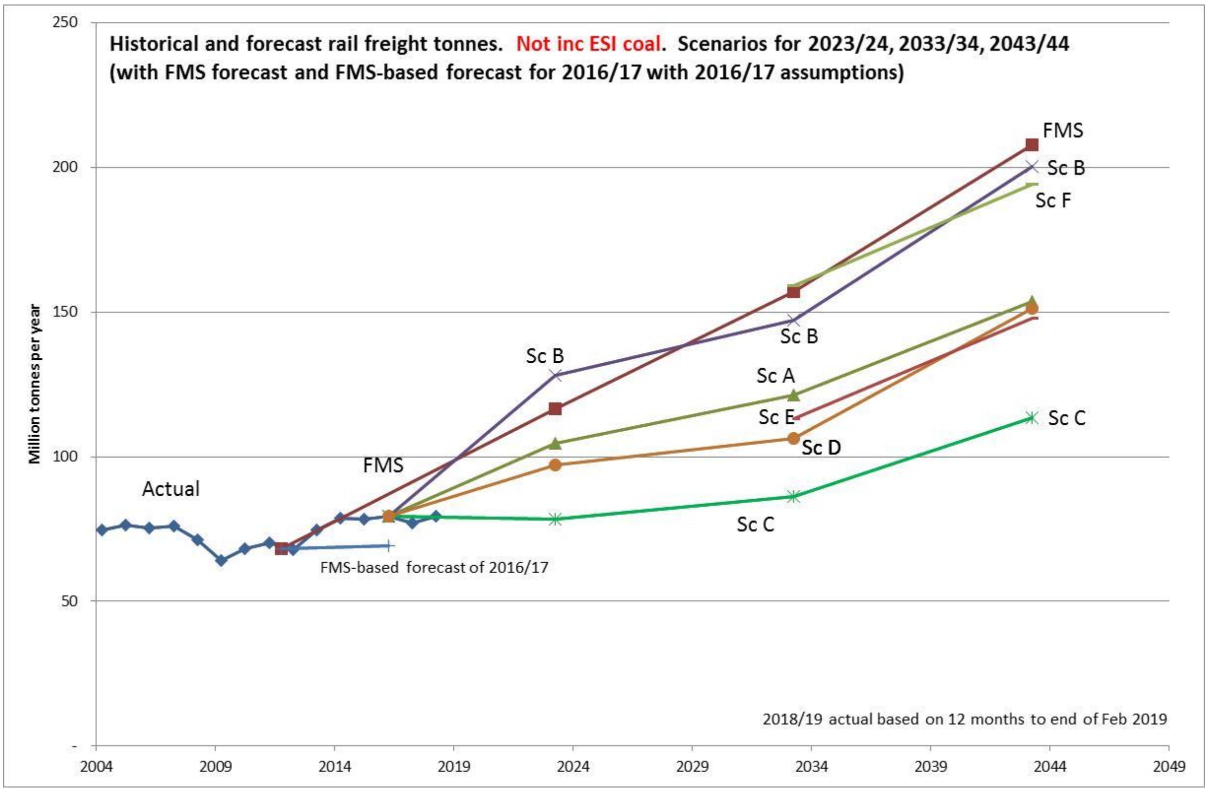
Note the "FMS-based forecast of 2016/17" line shows what a forecast of 2016/17 would have been (77 m tonnes) using

- the FMS base year (12 months to the end of September 2012)
- input assumptions that reflect the true outcome in 2016/17 (such as lower fuel prices)
- the forecasting methods used in the FMS

See the May 2018 report on 2023/24 forecasts for further details.

ESI (power station) coal has historically been a volatile commodity – and is no longer forecast to be carried by rail in these forecast scenarios. The graph below shows an equivalent graph but with ESI coal excluded. Note that the graph *does* include biomass, which reflects conversion of power stations from coal to biomass.

Figure 2



The FMS forecasts of 2013 were at the top end of the range of our new forecasts. Our new forecasts show:

- Lower growth in intermodal traffics due to the less favourable revised input assumptions for rail costs versus road costs (particularly lower fuel costs), and a lower extent to which we assume rail-served distribution parks will be developed.
- Lower biomass growth (the FMS had 14m tonnes)
- Higher construction materials growth due to a larger assumed growth in the overall market than previously forecast in the FMS

The forecast assumptions for the 2033/34 and 2043/44 scenarios were agreed with stakeholders using the available information at the time (October 2018). There may be subsequent changes to some of these exogenous assumptions prior to publication of the final report which have not been taken into account in the modelling and quantified results. The forecasts therefore do not reflect changes in official projections, forecasts and policies since October 2018.

Planned infrastructure upgrades have not been taken into account that could potentially reduce operational costs along certain routes. The forecasts (and routeings) therefore reflect the network of early 2017 and do not reflect any upgrades implemented since then or any planned upgrades.

The forecasts do not reflect changes in rail freight volumes between 2016/17 (the base year for the forecasts) and 2018/19; i.e. the base year has not been updated. The indications are that there has been little change in total volumes in 2018/19 relative to 2016/17, albeit Lynemouth biomass power station has come on line – receiving several trains per day as expected in our forecast assumptions.

1. INTRODUCTION

In 2013 MDS Transmodal produced unconstrained rail freight demand forecasts for Network Rail for 2023/24, 2033/34 and 2043/44 for input into their 2013 Freight Market Study (FMS). These had a model base year of 12 months to the end of September 2012.

These forecasts were originally reported in an April 2013 report to Network Rail and were consulted upon. Through that process some input assumptions were revised but the forecasting methodology remained as described in that report.

There have been several exogenous developments since 2013 that were not anticipated in those projections which have had the effect of adversely affecting the competitive position of rail freight in the UK. These include:

- Government energy policy changes resulting in a faster reduction in the role of coal fired power stations and a lower take-up of biomass than expected because of cuts in the level of financial support available
- Lower fuel price growth and wage growth than expected. Fuel prices have declined in real terms. The projections had been based on the then projections being made by the DfT.
- Lower rate of build-out of rail served warehousing sites than expected, consequent on the 'lost years' of the financial crisis which delayed projects that continue to be 'live'.

Another factor which may have adversely affected the competitive position of rail freight is the existence of capacity constraints on the rail network. The FMS forecasts were not capacity constrained and therefore did not take account of these constraints.

There have also been developments that have resulted in higher-than-projected volumes, particularly in the market for transporting construction materials.

Overall these developments have meant that the FMS growth projections (for GB rail freight in total) are not being realised.

Network Rail therefore commissioned MDS Transmodal to produce revised rail freight forecasts for the year 2023/24, with a base year of 2016/17. The resultant forecasts were consulted upon and final forecasts with an associated report ("Rail freight forecasts: Scenarios for 2023/24. Final Report", May 2018. Ref: 217023r11) were produced in May 2018.

Network Rail then commissioned MDS Transmodal to produce revised rail freight forecasts for years 2033/34 and 2043/44 (also with a base year of 2016/17 to be consistent). This report describes the assumptions, method and the forecast results for 2033/34 and 2043/44. It also includes the May 2018 results for 2023/24 in italics, but the May 2018 report should be considered the main source of information for the 2023/24 results.

The modelling methodology varies by sector, but the methods used are in most cases the same as those used in the 2013 forecasts and the 2018 forecasts.

Like the recent 2023/24 forecasts there are several scenarios. These scenarios are intended to give a range spanning factors favouring rail to factors disfavouring rail, and low market growth to high market growth:

- 2033/34 & 2043/44 scenario A: Factors which favour rail relative to road, with low market growth
- 2033/34 & 2043/44 scenario B: Factors which favour rail relative to road, with high market growth
- 2033/34 & 2043/44 scenario C: Factors which disfavour rail relative to road, with low market growth
- 2033/34 & 2043/44 scenario D: Factors which disfavour rail relative to road, with high market growth
- 2033/34 & 2043/44 scenario E: Central assumptions neither favouring nor disfavouring rail relative to road, with central market growth
- 2033/34 & 2043/44 scenario F: As scenario E, but with internalisation of external costs[1]

An additional sensitivity test (scenario G in 2043/44) also considers the traffic that would be attracted to a European gauge freight route between the Channel Tunnel and Central Scotland – see section 8.

As with the FMS and the main scenarios for 2023/24, these 2033/34 and 2043/44 scenarios are NOT capacity constrained. In reality, unless more capacity is secured for rail freight at capacity-constrained locations on the network, it is unlikely that high quality paths along preferred routes will be available, and the unconstrained growth forecast in some scenarios may as a consequence, not be achievable.

The forecasts assume the levels of service provided by the network in terms of end-to-end transit times remain constant, relative to the base year (2016/17). Similarly the gauge clearance capability of the network is assumed to remain constant relative to the base year, except in relation to certain new warehousing sites and under sensitivity test G. The gauge clearance assumptions in relation to new warehousing sites are discussed under Section 3.2.

The project has involved consultation with key stakeholders (the Freight Operating Companies (FOCs) Network Rail and DfT) at each stage. Individual interviews with Direct Rail Services (DRS), DB Cargo,

[1] We would expect scenario F to have more traffic than scenario E given that road's externalities are considered greater than rail's (as per the DfT's Mode Shift Benefit calculations (MSBs)) such that user costs would increase more for road than rail

Freightliner, GB Railfreight, and Colas were conducted to seek their views on assumptions and market conditions in each sector.

This report is structured as follows:

- Section 2 describes the assumptions for each scenario
- Section 3 describes the methods and models employed
- Section 4 summarises the results
- Section 5 comments on the results in section 4
- Section 6 describes the assignment of trains and paths to the rail network
- Section 7 gives the rail market shares in each sector
- Section 8 describes the sensitivity test (scenario G) incorporating a European gauge freight route
- Section 9 concludes the report.

2. ASSUMPTIONS

For each sector there are six main capacity-unconstrained scenarios for 2033/34 and 2043/44 – with assumptions that vary by sector. The scenarios are comprised of an equivalent of the 4 scenarios (A-D) that we used for 2023/24:

Table 7: Four scenarios reflecting low and high market growth and favourability towards rail

	Low market growth	High market growth
Factors which favour rail relative to road	Scenario A	Scenario B
Factors which disfavour rail relative to road	Scenario C	Scenario D

along with:

- Scenario E: "Base" or "Central" scenario – reflecting a "Do Minimum" mind-set with central case assumptions.
- Scenario F: "Internalisation of externalities" – whereby users of both road and rail pay their full external costs. This is built on scenario E.
- Sensitivity test G (2043/4 only): The introduction of a new European gauge freight route between Scotland and the Channel Tunnel Rail Link (CTRL) in East London. See section 8

The model outputs for the above scenarios are *unconstrained* by capacity.

2.1 General assumptions (all commodities)

The tables below show the assumptions that were used for 2023/24 in italics (based on data available in June 2017), along with the assumptions used (with their sources) for scenarios A, B, C, D and E for 2033/34 and 2043/44 based on data available in October 2018.

Note that all % changes are in real terms (i.e. the change in costs, if economy-wide inflation were to be zero) for the 7 years from the base year (2016/17) to 2023/24, the 17 years from 2016/17 to 2033/34 and the 27 years from 2016/17 to 2043/44.

Table 8: General assumptions (all commodities)

Assumption relative to 2016/17	Year	Sc A	Sc B	Sc C	Sc D	Sc E
Labour (drivers' wages for road and rail)	*2023/24*	*+16% for road +8% for rail*		*+8%*		-
	2033/34	+30% for road +22% for rail		+26%		+28% for road +24% for rail
	2043/44	+58% for road +48% for rail		+53%		+55% for road +51% for rail
Source: Work value-of-time, WebTAG table A.1.3.2, May 2018 gives +26% and +53% as a central forecast for 2033/34 and 2043/44 respectively. [2]						
HGV fuel costs (including duty)	*2023/24*	*+22%*		*+2%*		-
	2033/34	+48%		+15%		+27%
	2043/44	+53%		+20%		+32%
Source: BEIS Updated energy and emissions projections, January 2018.						
Fuel duty for road and rail	*2023/24*	*+5%*				
	2033/34	+17%				
	2043/44	+28%				
Source: Fuel and Electricity Prices and Components, WebTAG table A.1.3.7, May 2018.						
Derived rail fuel costs (including duty)	*2023/24*	*+43%*		*-1%*		
	2033/34	+86%		+14%		+40%
	2043/44	+86%		+14%		+40%
Operational days per week	*2023/24*	*No change*				
	2033/34	No change				
	2043/44	No change				
Train length (and tonnes of cargo per train) [3]	*2023/24*	*+5%*		*No change*		
	2033/34	+5%		No change		
	2043/44	+5%		No change		

[2] The hypothetical scenarios (A & B) that favour rail in terms of reducing rail costs vs road include a higher HGV wage increase vs rail wages. Two explanations for such a possible outcome are as follows:

- A possible Brexit impact whereby it is more difficult to take advantage of low Eastern European HGV wages. This will have little impact on train drivers.
- Currently there is a relatively free market for HGV drivers, with reasonably easy access for new drivers. This is less true for train drivers. In a rail-market-favouring scenario, we are assuming that the train driver market becomes more flexible with a lower cost of employing drivers. This may be brought about by the short-term impact of reduced demand in sectors such as coal

[3] We assume that there is no increase in HGV length and weight under any of the scenarios

The forecasts do not take into account the impact of planned infrastructure projects such as East-West Rail (EWR), and schemes due to be completed by the start of Control Period 6 (2019) such as longer trains on the Southampton – West Coast Main Line (WCML) route and from the Peak District.

Apart from a possible impact on HGV drivers' wages, the forecasts do not take account of the impact of Brexit because there are many uncertainties at this stage. The impact on the rail freight demand could potentially be positive or negative and impact in several different ways. For example:

- Most unitised trade with Europe is via HGV or unaccompanied road trailer on ferries thus favouring road transport within GB. European trade in lolo containers typically travels to regional ports – with the resultant short inland haul typically favouring road. However unitised trade with the rest of the world typically arrives in lolo containers at the big deep sea ports (Felixstowe, Southampton, London Gateway) and often has a long journey inland – which favours rail. A partial transfer of UK trade from European to the rest of the world could therefore result in more intermodal port traffic by rail
- Customs checks at ports could disadvantage accompanied HGV traffic which would therefore encourage European traffic to switch to Channel Tunnel through-rail, lolo containers and unaccompanied ferry routes, which are typically to rail-connected ports
- If Brexit were to reduce economic growth, this could reduce the overall demand for freight movements.

2.2 Commodity-specific assumptions

Note that all % changes are in real terms (i.e. the change in costs, if economy-wide inflation were to be zero) for the 7 years from the base year (2016/17) to 2023/24, the 17 years from 2016/17 to 2033/34 and the 27 years from 2016/17 to 2043/44.

Table 9: Variable track charges (variable usage, capacity and coal-spillage charges)

Year	Commodity	Sc A	Sc B	Sc C	Sc D	Sc E
2023/24	Construction	+16%		As per scenarios A & B, plus 25%		N/A
	Chemicals	-15%				
	Domestic Automotive	-11%				
	Domestic Intermodal	-5%				
	Metals	+7%				
	Industrial Minerals	+11%				
2033/34 and 2043/44	Domestic Automotive	-16%		As per scenarios A & B, plus 25%		As per scenarios A & B
	Domestic Intermodal	+4%				
	Other	+9%				
	Petroleum	+31%				
	Chemicals	+34%				
	Coal Other	+45%				
	Domestic Waste	+46%				
	Steel	+48%				
	Coal ESI	+62%				
	Industrial Minerals	+63%				
	Iron Ore	+73%				
	Construction Materials	+84%				
	Biomass	+93%				

Source for 2023/24: "Track Usage Price List", Network Rail for 2018/19 vs 2016/17, combined with a distance-and-tonnage-weighted average for each wagon movement in 2016/17. There is an implicit assumption that the wagon mix will not change.

Sources for 2033/34 & 2043/44:

- *"CP6 Track Usage Price List, 1718 prices (July 2018)", Network Rail* for charges to 2023/24 (end of CP6)
- *"2018 periodic review draft determination, Supplementary document – Charges and incentives: Variable usage charge consultation", ORR, June 2018*, for an indication that the changes in charges to the end of CP7 (2028/29) would continue at the same rate of increase as for the 3 final years of CP6. This document also states that the capacity charge and the coal spillage charge are to be removed in 2019/20 to partly compensate for the increase in variable usage charge.

We have therefore subtracted the capacity and the coal spillage charge costs from 2019/20 onwards. Overall this results in the variable track charges paid in 2019/20 being broadly the same as those paid in 2018/19, although the impacts vary by sector.

The ORR plan to switch from RPI to CPI as the basis for increasing charges in line with inflation. Our cost models represent real changes (i.e. as though inflation were zero), so using the preferred CPI as a measure of inflation to increase charges by should give a more accurate representation of the changes in charges that the industry will experience. We have therefore adopted the CPI-based forecasts.

Infrastructure Cost Charges (ICCs) (currently Freight Specific Charge and Freight Only Line Charge) are due to change and are being applied to biomass from 2019/20. However these are levied on commodities that are deemed to be largely inelastic to changes in track access charges (ESI coal, Biomass, Ores and the Nuclear industry), and are therefore not included as inputs into the modelled forecasts.

Note we are not assuming any real terms changes in variable track charges after the end of CP7 (2028/29).

Table 10: Other commodity-specific assumptions

<table>
<tr><th>Assumption</th><th>Year</th><th>Sc: A</th><th>Sc: B</th><th>Sc: C</th><th>Sc: D</th><th>Sc: E</th></tr>
<tr><td rowspan="3">Deep-sea unitised trade growth - for maritime containers</td><td>2023/24</td><td>+10%</td><td>+25%</td><td>+10%</td><td>+25%</td><td>-</td></tr>
<tr><td>2033/34</td><td>+35%</td><td>+55%</td><td>+35%</td><td>+55%</td><td>+45%</td></tr>
<tr><td>2043/44</td><td>+60%</td><td>+80%</td><td>+60%</td><td>+80%</td><td>+70%</td></tr>
<tr><td colspan="7">Source: MDST's World Cargo Database (WCD version date 27/10/18) for deep sea cargo giving a central forecast of +45% and +70% for 2033/34 and 2043/44 respectively.</td></tr>
<tr><td colspan="7">Container port growth for deep sea containers. In line with market demand – with the following port developments coming on stream one-by-one to cater for demand:
1. London Gateway full use of existing quay
2. Liverpool full use of existing quay
3. London Gateway full development to the west of the existing quay
4. Felixstowe South full development
5. Southampton redevelopment
In 2043/44 scenarios B &D (highest growth), all of these port expansions would be required.
Freightliner's Tilbury rail traffic is removed</td></tr>
<tr><td rowspan="3">European unitised trade growth (for short sea (European) trade including Channel Tunnel containers)[4]</td><td>2023/24</td><td>+10%</td><td>+20%</td><td>+10%</td><td>+20%</td><td>-</td></tr>
<tr><td>2033/34</td><td>+25%</td><td>+40%</td><td>+25%</td><td>+40%</td><td>+32%</td></tr>
<tr><td>2043/44</td><td>+42%</td><td>+62%</td><td>+42%</td><td>+62%</td><td>+52%</td></tr>
<tr><td colspan="7">Source: MDST's World Cargo Database (WCD version date 27/10/18) for European unitised cargo giving a central forecast of +32% and +52% for 2033/34 and 2043/44 respectively.</td></tr>
</table>

[4] For Channel tunnel container traffic (between inland GB and inland continental Europe; not Channel Tunnel shuttle traffic for HGVs), its market is assumed to grow by the forecast European unitised trade growth - e.g. +52% from 2016/17 to 2043/44 in scenario E.

Additionally factors favouring or disfavouring rail have an impact on Channel Tunnel's competitiveness versus its competition: container-carrying ships and other unitised services (accompanied HGVs and unaccompanied trailers):

- Fuel and drivers' wage price changes increase the cost of using the Channel Tunnel, but for shipping services they cause a larger proportional increase in the road costs to get to/from the ports.
- The increase in track charges disfavours Channel Tunnel versus its shipping competition, albeit this increase is only applied to the portion of the haulage within GB.
- Increased train length (scenarios A & B) reduces rail costs and thus favours Channel Tunnel versus its competition

We have NOT included any Channel-Tunnel-specific real-terms changes such as toll reductions, improvements in service quality on the French rail network, or changes to security concerns.

Table 10b: Other commodity-specific assumptions continued

Assumption	Year	Sc: A	Sc: B	Sc: C	Sc: D	Sc: E
Domestic non-bulk traffic market growth	*2023/24*	*+4.7%*	*+14.2%*	*+4.7%*	*+14.2%*	-
	2033/34	+8.3%	+35.3%	+8.3%	+35.3%	+21.8%
	2043/44	+11.6%.	+68.7%	+11.6%.	+68.7%	+40.2%
Source: Population growth (+8.3%, +11.6%. Source: ONS National Population Projections, October 2017) and GDP growth (+35.3%, 68.7%. Sources: OBR Economic and Fiscal Outlook, October 2018 and Fiscal Sustainability Report, July 2018) for 2033/34, 2043/44 respectively. Values for scenario E are the midpoint of population and GDP growth forecasts.						
MSRS grants	All	Retained		Removed		
Channel Tunnel bulks growth for all years	All	-5%	+5%	-5%	+5%	No change

Petroleum, Chemicals, Industrial Minerals, Metals and Automotive No major changes forecast in the overall markets, but fuel prices and drivers' wages will impact on rail's mode share. Overall market: Low market growth: -5%. High market growth: +5%. Central market growth (scenario E): No change			
Power station (ESI) coal: No rail traffic in 2023/24[5], 2033/34 and 2043/44 Source for 2033/34 & 2043/44 assumption: BEIS 2017 Updated Energy & Emissions Projections Annex J (v1.0 21-Nov-2017, Reference scenario) projects that electricity generation by coal will have declined to zero by 2026.			
Biomass: % increase for traffic to Drax 2033/34 & 2043/44	Low market growth (Sc A & C): -33%	High market growth (Sc B & D): +33%[6]	Base (Sc E): Stable: 6.5m tonnes
Lynemouth 2033/34 & 2043/44	Low market growth (Sc A & C): 0.70m t	High market growth (Sc B & D): 1.40m t	Base (Sc E): 1.05m tonnes
• Drax traffic is not expected to significantly increase or decrease. However their 4th unit conversion to biomass gives them the opportunity to increase traffic in the high market scenario.			

[5] As described in our May 2018 report, the BEIS projections of January 2017 that we used for our 2023/24 forecasts stated zero electricity generation from coal in 2024. However the November 2017 BEIS projections stated some significant coal-sourced generation remaining - reflecting around 1.6m of ESI coal by rail in 2023/24 (pro rata decrease from 2016 tonnes of ESI coal by rail). Some power station coal traffic by rail is therefore likely to remain in 2023/24 because coal-fired power stations can now continue to run unconstrained to the end of September 2025 if they adhere to the Industrial Emissions Directive (IED)

[6] If the recommendations in "Net-Zero – the UK's Contribution to stopping global warming" (Committee on Climate Change, May 2019) are introduced for biomass in conjunction with carbon capture, growth could be higher than we have assumed in this scenario

- Having started in Spring 2018, Lynemouth appears to be on track to achieve annual biomass traffics of just over 1 million tonnes.

Table 10c: Other commodity-specific assumptions continued

Assumption relative to 2016/17	Year	Sc: A	Sc: B	Sc: C	Sc: D	Sc: E
Construction materials market growth	*2023/24*	*+4.7%*	*+14.2% **	*+4.7%*	*+14.2% **	-
	2033/34	+8.3%	+35.3%	+8.3%	+35.3%	+21.8%
	2043/44	+11.6%	+68.7%	+11.6%	+68.7%	+40.2%
The low market growth figures (scenarios A & C) are based on population growth (Source: ONS for GB). The high market growth figures (scenarios B & D) are based on GDP growth (Source: OBR). Scenario E is the mid-point. **Construction** Construction activity appears to be volatile at present so there is uncertainty about future activity. Fuel prices and drivers' wages will impact on rail's mode share (i.e. scenarios A and B relative to scenarios C and D). The trend towards super-quarries served by rail may also increase rail's mode share; however this may be offset (at the GB level) by an increase in locally sourced secondary/ recycled materials, not served by rail. We assume that no change in rail market share results from these factors (i.e. that the super-quarries and recycling factors roughly offset each other).						
Waste, Ore, Other Coal, Other and Network Rail Engineering Rail traffics assumed largely stable into the future Low market growth: -5%. High market growth: +5%, plus 2 million tonnes of coking coal from Whitehaven Central market growth (scenario E): No change						

* Note that for 2023/24, under scenarios B and D only, an additional 20% uplift was applied to rail volumes to reflect the impact of major infrastructure schemes. This is discussed in the May 2018 report. This uplift is not applied to the 2033/34 and 2043/44 forecasts.

These assumptions were chosen using the available information at the time (October 2018). There may be subsequent changes to some of these exogenous assumptions prior to publication of the final report which have not been taken into account in the modelling and quantified results.

The forecasts therefore do not reflect changes in other official projections, forecasts and policies since October 2018, such as labour and fuel cost assumptions.

To be consistent with the 2023/24 forecasts, the base year remains 2016/17. The forecasts do not reflect changes in rail freight volumes between 2016/17 (the base year for the forecasts) and 2018/19; i.e. the base year has not been updated to 2018/19. The indications are that there have not been major changes in volumes in 2018/19 relative to 2016/17 (see table 15 with graph) albeit Lynemouth biomass power station has come on line – receiving several trains per day.

2.3 Rail-served warehousing sites

There are approximately 1 million square metres of new large-scale warehousing (warehouses of >9,000 square metres) built each year in Britain based on long term trends. We assume around 26% of this is likely to be rail-served in the rail-favouring scenarios (A and B) - i.e. equating to a build rate of around 260,000 square metres per year. For the rail dis-favouring scenarios (C and D), we assume around half the rate of development i.e. 130,000 square metres per year. Scenario E is based on the mid-point between Scenarios A & B and C & D. We believe this range is broadly in line with recent planning consents and approximately matches the observed progress and realistic aspirations of developers.

From the base year of 2016/17, this equates to the following area of additional rail-served large warehousing:

- Scenarios A & B 2033/34: 4.4 million square metres
- Scenarios C & D 2033/34: 2.2 million square metres
- Scenarios A & B 2043/44: 7.0 million square metres
- Scenarios C & D 2043/44: 3.5 million square metres
- Scenario E: Mid-point of high and low for both years

We have researched and identified a list of developing and planned additional rail-served warehousing schemes across the country, including the quantum of floor space that will realistically be developed. Schemes identified are defined as meeting one of the following criteria:

1. Sites which currently have occupied floor space, and either have consents to develop additional rail-served floor space at the same location or realistic expansion potential;
2. Sites with consents for rail-served floor space but are currently in the process of development i.e. no occupied floor space currently. Such sites may be physically under construction or with other preparatory works being undertaken;
3. Schemes which are being actively promoted by a developer, have yet to receive consent but are currently being considered by the planning system at application stage e.g. DCO application; and
4. Longer-term sites which have been allocated in Local Plans or regeneration/re-development strategies for rail-served logistics or are seeking such allocations (i.e not yet reached application stage).

Sites in the first category include the extension of DIRFT (Daventry), London Gateway and Rossington (iPort). East Midlands Gateway and Radlett are at various stages of development (category 2) while Four Ashes and South Northampton are currently at the DCO application stage (category 3). Sites in Hull and Teeside are being advanced through their respective Local Plans and regeneration strategies (category 4).

The table below presents the list of identified sites alongside the quantum of ***additional*** rail-served floor space (when compared with the 2016/7 baseline) that we expect to be developed at each site. The sites identified have been divided into two groups based on the likely timescale of development. These are:

- Early completion – we assume that the site will be fully completed and built-out by 2036/2037, meaning they are 17/20 complete by 2033/4; and
- Late completion – we assume that the site will commence development in 2023/2024, will be fully completed and built-out by 2043/2044, and that they will be 8/20 complete by 2033/2034.

In each case, we assume that large scale developments such as these generally have a 20 year build-out rate and that floor space development/occupation is slightly back-ended i.e. majority of the floor space is occupied in the second half of the 20 year build-out. This reflects the fact that early preparatory works are often required at such sites, resulting in a slight time-lag before commercial occupation commences. We have assumed that the 'early completion' sites includes those which formed part of the 2023/2024 forecasts.

Table 11: Planned Additional Rail-served Warehousing. Additional thousand square metres

	2033				2043		
	Sc A & B	Sc C & D	Sc E		Sc A & B	Sc C & D	Sc E
Early Completion							
London Gateway	638	319	478		750	375	563
Radlett	281	140	210		330	165	248
DIRFT (Daventry)	595	298	446		700	350	525
South Northamptonshire	391	196	293		460	230	345
Kegworth (East Midlands Gateway)	468	234	351		550	275	413
Ditton (3MG)	38	19	29		45	23	34
Rossington (iPort)	468	234	351		550	275	413
Mossend	156	78	117		184	92	138
sub-total	***3,034***	***1,517***	***2,275***		***3,569***	***1,785***	***2,677***
Late Completion							
Howbury Park (Dartford)	74	37	56		185	93	139
Etwall	220	110	165		550	275	413
Milton Keynes	80	40	60		200	100	150
Castle Donnington	20	10	15		50	25	38
Four Ashes (West Midlands Interchange)	296	148	222		740	370	555
Port Salford	200	100	150		500	250	375
Port Warrington	60	30	45		150	75	113
Rochdale	46	23	35		115	58	86
Seaforth	24	12	18		60	30	45
Hull Docks Extension	120	60	90		300	150	225
Wakefield	32	16	24		80	40	60
Immingham	30	15	23		75	38	56
Teesport	120	60	90		300	150	225
Avonmouth	40	20	30		100	50	75
Grangemouth	10	5	8		26	13	19
sub-total	***1,372***	***686***	***1,029***		***3,431***	***1,715***	***2,573***
Total	**4,406**	**2,203**	**3,304**		**7,000**	**3,500**	**5,250**

The sites listed above are our current best estimate of likely development. However over time, some of these sites may be delayed, fast-tracked, or dropped altogether and others may come forward. I.e. these may not be the exact locations where development will happen but they are intended to be representative of the likely extent of development in each region.

There have been developments in the market since the assumptions were decided upon for the 2023/24 forecasts (June 2017). Our latest expectations (above) no longer include Howbury Park (Dartford) and Four Ashes (West Midlands Interchange) as early completion, although we have assumed that they will both have an operational rail terminal and some warehousing in all 2033/34 and 2043/44 scenarios.

2.4 Scenario F: "Internalisation of Externalities"

One of the input components for the calculations for the Mode Shift Revenue Support (MSRS) grant scheme is "Mode Shift Benefits" (MSBs)[7]. These MSB values are based on the externalities that transport by both road and rail impose on society, and reflect the societal benefit of switching traffic from road to rail. They quantify:

> *The externalities imposed on society by road traffic (congestion and environmental damage caused by HGVs minus the taxes paid by HGVs)*
>
> *MINUS*
>
> *The externalities imposed on society by rail traffic (environmental damage caused by emissions from trains minus the taxes paid by rail freight operating companies)*

These MSBs can be calculated for any HGV journey in Great Britain.

We have added MSBs to road costs to represent the *relative* effect of applying the road and rail externality costs to all legs of all road and rail journeys. We believe this is a simple approach and uses values with which stakeholders are already familiar with. The main effect is to significantly raise road haulage costs across the network, although there are some exceptions to this, such as on motorways with low levels of congestion.

We are conscious that there are limitations to this approach such as

- The MSBs do not correspond to the latest thinking on emissions. For example there is a blanket externality cost per km for rail irrespective of location and traction type. In recent years HGV emissions have improved faster than rail locomotive emissions partly due to the faster fleet renewal for HGVs.
- Congestion is the largest component for the calculated road externalities, yet there is no equivalent component for rail. Congestion on both the road and rail networks in 2043 is likely to be different from congestion levels now - with likely higher demand, countered by the possibilities of improved infrastructure along with autonomous road vehicles, more efficient rail traffic management systems. Passenger travel demand is likely to increase but could potentially be moderated by improved teleconferencing.

[7] www.gov.uk/government/publications/freight-mode-shift-benefit-values-technical-report-an-update

- By adding MSBs to road costs, this results in an increase in road costs to reflect road external costs relative to rail external costs. Since no additional cost is applied to rail, both road and rail costs do not reflect their absolute external costs.
- There may be additional impacts of internalising externalities that are difficult to quantify without further research such as:
    - A switch to more feeder traffic for deep sea containers (E.g. China to Rotterdam to Immingham to Manchester, instead of China to Felixstowe to Manchester)
    - Supply chains involving less transport (more local sourcing of products), particularly if the charging for externalities also applied to deep sea shipping and air cargo, and on the Continent
    - Some suppression of journeys: Costs for remotely located industries would increase making it difficult for them to compete, resulting in reductions in business and closures

We believe that applying the current MSBs is a pragmatic approach to internalising externalities that gives a broad-brush representation of relative road and rail externalities. This simple approach to scenario F represents a start to the debate on internalising externalities, from which a more sophisticated approach could be developed.

2.5 Tonnes per train by sector

The forecasts are made on an origin to destination tonnage basis. However it is useful to be able to translate these tonnes into numbers of trains. The tonnes per train depends on a number of factors. High volumes of high density cargos to and from terminals able to handle large trains are likely to result in high tonnes per train. Small volumes mean insufficient traffic will be available to fill a full-length train. Similarly it may not be worth waiting for a full trainload for high value or time-sensitive cargo. If a backload is impractical (typically possible for intermodal containers and swap bodies, but normally not practical for bulk commodities), the returning train will be empty thus halving the average tonnes of cargo per train in that market sector.

The tonnes per train varies within a commodity / sector and by origin and destination. However using the sector average gives a means of translating tonnes into an estimate of the number of trains likely to be required to carry the cargo.

The current average tonnes per train have been calculated for each commodity / sector as described below:

- All wagon movements (from Network Rail's PALADIN – see section 3.4.1) for the full year 2016/17 were grouped into trains.

- Loaded wagons have commodity / sector information attached, but empty wagons do not. For all empty wagons, the wagon movement was associated with the commodity / sector of its previous loaded movement.
- If a simple mean average of these trains was calculated, then short distance trains which impinge little on the network would have the same importance as long distance trains that cover a lot of the network.
- To represent the average use of the network, a distance-weighted mean average tonnage per train was found for each commodity / sector.

The average cargo tonnes per train by commodity / sector is shown below

Table 12: Average cargo tonnes per train by commodity / sector

Commodity / Sector	Average Cargo Tonnes per train
Intermodal	507
ESI Coal	759
Biomass	782
Waste	577
Construction materials (not spoil)	694
Spoil	590
Petroleum	943
Chemicals	478
Industrial Minerals	564
Metals	590
Automotive	91
Ores	602
Coal Other	557
Other	400
Empty returns for containers carrying bulks	161
NR Engineering	404
All commodities	**577**

Notes:

- These average cargo tonnages include the empty return. For example if all Petroleum trains were fully loaded in one direction and empty for the return, that would imply the average cargo tonnage for a ***loaded*** Petroleum train is 943 x 2 = 1,886 tonnes.
- For intermodal (and empty returns for containers carrying bulks) the average cargo tonnes per train include the weight of the container.

- For all commodities the average cargo tonnes per train exclude the weight of the locomotive and wagons

For the results tables for each commodity, the total forecast tonnes are translated into trains using these average figures.

In scenarios A & B, train lengths (and therefore tonnes per train) are assumed to increase by 5% for all commodities. In other scenarios, they are assumed to remain constant into the future.

2.6 Path utilisation, days per week and hours per day

HGVs can simply access the road network at any time, albeit potentially imposing congestion costs on existing users. However in order for freight trains to operate, they need to have agreed timetabled routes from origin to destination (“paths”). Some rail freight sectors such as intermodal operate scheduled services, so the requirement for paths is relatively predictable, and a path can be allocated for each scheduled service, with a confidence that most services will run; resulting in *high* path utilisation.

However in some sectors such as the construction sector, the demand for the cargo is more variable. In order to accommodate such variable demand, it is necessary to have several available paths – often to several different destinations, even though not all of them will be used; resulting in *low* path utilisation.

In the 2013 Freight Market Study and our 2018-produced 2023/24 forecasts, assumptions were made for each rail freight commodity / sector as to the utilisation of paths (i.e. of the allocated timetabled paths, how many are actually used). We have retained these same utilisation factors to convert trains into required paths for the base year (2016/17) and all future years.

Table 13: Path utilisation by commodity / sector

Commodity / Sector	Path utilisation
Intermodal	85%
ESI Coal	45%
Biomass	75%
Waste	50%
Construction materials (not spoil)	37%
Spoil	50%
Petroleum	56%
Chemicals	50%
Industrial Minerals	50%
Metals	51%
Automotive	50%
Ores	50%
Coal Other	45%
Other	50%
Empty returns for containers carrying bulks	50%

Source: Estimates from Network Rail in consultation with the FOCs, 2013

Note: Network Rail's engineering trains operate differently from rail freight carrying commercial cargo. NR Engineering trains are assumed to directly translate 1:1 into required paths.

Similarly in the 2013 Freight Market Study and our 2018-produced 2023/24 forecasts, assumptions were made to convert annual trains into daily trains, and daily paths into hourly paths:

- 5 operational days per week in the base year: 5 days x 52 weeks = 260 operational days per year
- an average of 18 operational hours per day.

We have retained these conversion factors for the base year (2016/17) and all future years.

In reality there will be some variation between different commodities and for different origins and destinations, and these may potentially change over time. Using these averages should give reasonably realistic estimates overall, and avoids the need to analyse each flow, and consider how these averages may change in future for existing flows and potential new traffics.

2.7 Other assumptions

- The quantified model outputs are unconstrained by capacity.

Diesel versus electric traction

No assumptions have been made in terms of a possible switch towards more electric traction, and our cost models are based on the use of diesel locomotives. This can be interpreted as an assumption that electric traction will not offer significantly lower costs when all its limitations are taken into account. However if

- more routes and terminals used by freight trains were electrified
- the cost of using electric traction rose at a slower rate than using diesel
- or environmental restrictions were put on the use of diesels

then it may become cost effective for the rail freight industry to move faster towards electric traction.

DRS have recently started operating bimode class 88 locomotives on the network. Bimode or trimode locomotives offer a compromise solution for where parts of the journey are not electrified, and diesel (and/or battery electric) can be used for these sections.

3. METHODS AND MODELS EMPLOYED

3.1 Establishing base year traffics

A base year of 2016/17 has been used as the basis of the forecasting. i.e. beginning of April 2016 to the end of March 2017.

Base year traffics have been calculated by processing Network Rail's traffic movement database (PALADIN). See section 3.4.1.

3.2 GB Freight Model (GBFM)

Our default approach for modelling any rail freight sector is to use the GB Freight Model (GBFM) - a comprehensive freight transport model available for analysing current and forecasting future freight flows to, from and within Great Britain by mode, origin/destination, routing and commodity. The latest version of the model (version 6.1) consists of several modules, including:

- A multi-dimensional base matrix, built up from several sources, which describes the origin, destination and commodity of goods moving within Great Britain and to/from Great Britain. Sources include the DfT's Continuing Survey of Road Goods Transport (CSRGT), Network Rail movement data, Revenue and Customs trade data and Maritime Statistics;
- Modal cost models, validated against industry data, which replicate transport rates in the market and can be adjusted for different factor costs;
- A calibration process that allows current mode shares to be replicated;
- A road network that allows unit loads to be assigned as a function of minimum cost paths; and
- A rail assignment model that is based upon current operating behaviour (route choice, tonnes/trains by commodity).

Once a base year model is established, future scenarios can be described by:

- Applying long-run cargo demand trends, which includes assuming different growth rates for domestic and international freight;
- Adjusting factor costs such as labour and fuel costs; and
- Adjusting land uses resulting in changes in transport costs through increasing or reducing the proportion of trip ends at rail linked sites.

For this work, planned infrastructure upgrades have not been taken into account. The forecasts (and routeings) therefore reflect the network of early 2017 and do not reflect upgrades implemented since then or planned upgrades. However the calculated costs for rail services to/from the new rail-served warehousing sites follow the same cost model as services between established terminals on the W10 gauge network (high-bridges allowing high containers and wagons). There is therefore an implicit assumption that the gauge on routes serving new warehousing sites will be upgraded to W10, or trains able to cope with lower gauge are able to run without significant additional cost.

Changes in road and rail costs due to congestion are not taken into account. Increased road costs due to worsening road congestion could encourage a mode switch from road to rail for some traffic. Similarly rail 'congestion' or capacity constraint could suppress some rail freight demand.

There are some important sectors, where components of GBFM need to be adapted, and/or different approaches adopted. Broadly the approach for most sectors is based on GBFM principles:

1. Establish the traffic in the base year
2. Consider changes to the underlying demand for the cargo (often not relating to transport)
3. Consider potential changes to origins and destinations.
4. Model the impact of changing modal economics
5. Assign results to the rail network

For the 2033/34 and 2043/44 scenarios, we are modelling unconstrained demand – without any capacity constraint.

3.3 Intermodal

Intermodal container traffics serve a diverse market, typically for non-bulk traffic, with 3 main distinct markets:

- Maritime containers
- Domestic (non-port) intermodal
- Channel Tunnel intermodal containers

3.3.1 Maritime containers

The transporting of maritime containers is an already well-established rail market with containers travelling between ports and inland terminals. This is typically traffic to/from deep sea container ports, although there are also some traffics from short sea container ports which are discussed below.

Deep sea container ports are defined here as those ports which have sufficient deep water and infrastructure to handle large container ships – typically travelling from around the world. The container shipping industry has decided that using these ports is an effective and economic way of unloading containers from these large container ships to serve Britain. Some deep sea ports are also used for short sea (European) traffic too.

We assume that deep sea container port capacity growth will keep pace with demand after 2016/17, as existing and planned developments (with planning permission) provide sufficient capacity for forecast demand up to 2043/44. This is described as a list in the assumptions section. For the modelling this is translated into additional quay metres at the deep sea ports as follows:

Table 14: Additional quay metres required at the deep sea ports to cater for trade growth

Scenario	London Gateway	Liverpool	Felixstowe	Southampton	Total
2033/34 A & C	901	850	-	-	1,751
2033/34 B & D	1,789	850	-	-	2,639
2033/34 E & F	1,345	850	-	-	2,195
2043/44 A & C	1,855	850	156	-	2,861
2043/44 B & D	1,855	850	550	494	3,749
2043/44 E & F	1,855	850	550	50	3,305

Note:

- Some of this is currently-unused capacity (as at 2016/17) that already exists at Liverpool and London Gateway.
- Some of the additional quay metres required may instead be achieved by the deepening of existing berths and/or extending the operational area available.

GBFM distributes this cargo inland in line with existing deep sea cargo inland distributions, while also incorporating the new-build warehousing as new inland destinations.

Short sea shipping for maritime containers (international traffic)

As well as deep sea container ships calling directly at British deep sea ports, some deep sea containers are transhipped at continental ports (e.g. Rotterdam) onto smaller ships that then take the containers to other British regional (feeder) ports. Container traffic through these feeder ports is assumed to retain the same (relatively small) proportion of the whole container port market as it has now.

Unitised trade between Europe and Britain is currently dominated by HGVs and trailers on roro ferries (e.g. Dover – Calais. Eurotunnel's Folkestone - Calais HGV shuttle is included in this market too). This HGV-on-ferry traffic is normally unsuitable for rail in Britain and is not considered in these forecasts. However some goods between Europe and Britain are carried in intermodal containers – which are included in the modelling as potential Channel Tunnel traffic, and traffic between British ports and inland.

Deep sea ports typically serve the whole of England and Wales and some of the Scottish market. However ports handling feeder traffic and European traffic typically serve a much more regional market. The short distances between port and regional hinterland tend to favour road instead of rail. This is why the focus for rail is on containers to/from deep sea ports. However, the regional ports handling feeder traffic and European traffic still enjoy some modal shift to rail with the assumed favourable changes in modal economics in the future in scenarios A & B.

As with the deep sea ports, it is assumed that short sea container port capacity keeps pace with demand.

Coastal Shipping (shipping between British ports)

There is also some coastal container traffic by sea between British deep sea ports and regional ports (e.g. Felixstowe to Tees and Felixstowe to Grangemouth). However coastal shipping and rail are often generally considered as largely separate markets - with rail offering a regular, quick service, and coastal shipping offering an infrequent but cheaper service for transferring deep-sea containers between ports, although there is some competition between them. Almost all coastal container traffic is between deep sea hub ports and regional ports where the real competition is between a UK and a Continental hub port. Because the main intermodal container cost changes modelled (fuel and wages increasing) would have a similar effect on coastal shipping as rail, we do not foresee significant changes in modal shares between rail and coastal shipping. Therefore we have not included coastal shipping in these calculations or modelling. We do not foresee port capacity constraints as being a limiting factor restricting the growth in coastal or feeder shipping within the time period covered by these forecasts.

Developments inland

The development of inland rail-served warehousing sites (see section 3.3.2) encourages mode switch from road to rail for maritime containers because there is no need for a local road haul between inland terminal and warehouse.

3.3.2 Assumptions for Domestic (non-port) intermodal

Domestic (non-port) intermodal trains are typically carrying fast-moving consumer goods (FMCGs) to, from and between National Distribution Centres (NDCs) and Regional Distribution Centres (RDCs) (warehouses). It is a very large transport market of nearly 1 billion tonnes per year, currently dominated by road. For rail it is a relatively small but growing market. As land use planning policy encourages more new-build, large warehousing sites to be rail-served, for any rail journey to/from such a warehouse, a local road haul is not required. This cost saving makes rail an increasingly viable option.

We describe our assumptions on where new large warehousing will be built in section 2.3. It is difficult to accurately predict which rail-served warehousing sites will be developed and come on-stream by particular years. The sites listed in section 2.3 may not be the exact locations where development will happen but they are intended to be representative of the likely extent of development in each region.

3.3.3 Channel Tunnel through-rail intermodal containers

The Channel Tunnel is in competition with ferry and lolo services to/from the continent. Hence the market is very elastic – highly sensitive to costs and service quality.

The cost change assumptions described in table 8 and table 10 (with its footnote) for road versus rail for each scenario impact on Channel Tunnel traffics as well as the assumptions on market growth.

3.3.4 Methodology for intermodal containers and swap bodies

GBFM v6.1 incorporates an input of large warehousing development. Each site's stock turnover is based on land area and type of warehouse (with RDCs having double the stock turnover per square metre of NDCs). For NDCs, incoming cargoes are assumed to come from around the country and as imports. Their outgoing cargoes are to RDCs across the country. For RDCs, incoming cargoes are from NDCs and imports. Outgoing cargoes are more focussed on the local area.

If these are rail-served warehousing sites, intermodal rail services are set up in the model to/from existing intermodal rail freight terminals (including at the ports) and other new rail-served warehousing sites to give the opportunity for rail to attract traffic from road.

The true generalised cost of a rail service per container unit is dependent on the traffic volume. High traffic volumes mean full, long, frequent, direct trains resulting in a low generalised cost to the user. However low volumes mean infrequent services (which may not be well suited to the needs of the logistics industry), or the need to transfer cargo at a hub en-route (splitting up and joining sections of trains, or transferring containers from one train to another) with associate time and cost penalty.

An iteration is therefore performed in the modelling process; Initially all services are costed irrespective of assigned traffic using our generic cost model. A positive feedback is introduced whereby well used services experience a cost reduction, and lightly used services have an additional cost applied to them. This encourages more traffic to be attracted to already-well-used services, and further discourages the use of lightly-used services.

3.3.5 Cost models and mode share

For all movements (between ports, rail-served warehouses and non-rail-served sites), road and rail cost models are applied along with a mode choice algorithm, which take into account

- the distance
- the volumes involved (more tonnage = more frequent services = more attractive for rail)
- whether the origin and destination are rail-served (no need for a road haul to/from a local rail terminal)

The road & rail cost models are built up from the individual cost components that a road or rail haulier experiences and include

- Capital cost of vehicles & interest rates
- Depreciation
- Fuel cost with associated consumption rate
- Taxes and duty
- Maintenance & insurance
- Labour costs – e.g. drivers' wages
- Overheads and office costs
- Track access charges (rail)

Assumptions include

- Mean speed
- Annual distance travelled per vehicle and hours operational
- Hours worked per employee
- Tonnes of cargo carried per vehicle
- Asset utilisation

Also included for rail journeys are the terminal charges at both ends, along with an internal site shunt where the origin or destination is on-site, and a local road haul where the origin or destination is off-site. If the journey is rail-served at both ends, the overall cost is therefore *lower*. If the rail journey is *not* rail-served at either end, the cost is *higher*.

As described in the earlier assumptions section, several components of the cost model are forecast to change from the base year.

The model outputs the tonnes of non-bulk cargo by road and rail between each port, each rail-served warehouse and non-rail-served sites for the forecast year.

Rail traffic to/from non-rail-served sites will have to use a local intermodal terminal. This may be an existing terminal or a terminal associated with one of the new rail-served warehousing sites. For each origin zone to destination zone traffic, the lowest generalised cost rail service is found (incorporating local road hauls if required). Once the rail mode share (versus road) for that origin-to-destination is found using a Logit model, all rail traffic is allocated to that service.

3.3.6 Integrating the model's results with present day traffics

As new rail-served warehousing sites with intermodal terminals are built, they will effectively be in competition with existing nearby intermodal terminals. In the very long term, in general, the transport cost savings associated with having on-site warehousing are likely to favour the terminals with on-site warehousing. However at least in the medium term, most existing terminals without on-site warehousing are likely to continue to operate.

To represent this inertia, we make the simple assumption (where there is forecast intermodal rail growth), that all existing terminal to terminal intermodal tonnages at least maintain their base year traffic levels. The model's forecast tonnages are then scaled down and added to the existing traffics such that the *total* forecast intermodal tonnage for ports and domestic is in line with the model's original total forecast tonnage.

This is not a perfect solution because competition from new rail-served warehousing sites could potentially lead to traffic reductions at some existing terminals - e.g. Rossington iPort could potentially take some of Doncaster's traffic. However this simple approach avoids the need for a site-by-site analysis of the competitive dynamics between new rail-served warehousing sites and existing intermodal terminals.

3.4 Modelling limitations

In an ideal world where the model was able to accurately reflect all factors affecting rail freight, the model's output would exactly reflect real world traffics. However a model is a simplification of the real world that attempts to reflect the most important drivers that are likely to affect rail freight volumes. We would expect some differences between the model's output and the real world, and we comment on those differences below.

One key omission from the FMS modelling of real world conditions is capacity constraint. For example, the model may forecast unconstrained volumes above those observed on key routes that are capacity constrained such as the Felixstowe branch line and the cross country route via Ely.

The model assumes an equilibrium has been reached such that the market has fully adjusted to the costs in the forecast year. However in reality, the market can take time to adjust.

3.4.1 Comparison to ORR published tonnes lifted figures

The source of the rail tonnes lifted figures in this report is PALADIN billing data provided to us by Network Rail. We process this data to generate an origin-destination database by filtering out double-counting and en-route terminals, to arrive at just one cargo tonnage record from wagon journey start to wagon journey finish. Our overall tonnage for 2016/17 is 85.8 million tonnes, of which 8.2 million is coal.

Rail tonnes lifted data is also published by the ORR. The data is sourced separately from each of the largest 4 Freight Operating Companies (FOCs) (DB Cargo, Freightliner, Direct Rail Services (DRS) and GB Railfreight)[8]. Their total (79.4 million tonnes) does not include the smaller operators (such as Colas and Devon & Cornwall Railways) and is slightly below our total (85.8 million tonnes). They report 12.0 million tonnes of coal (compared to our 8.3m t). It is difficult to directly compare these coal figures because there may be other cargo categories associated with the coal industry that some FOCs may have included within the coal business sector such as gypsum, limestone and pulverised fly ash, and possibly biomass.

If the ORR data was available at greater disaggregation (both by commodity and geographically for origins and destinations), it would be possible to investigate the differences further.

[8] Source: ORR Freight rail usage quality report: www.orr.gov.uk/__data/assets/pdf_file/0016/22903/freight-usage-quality-report.pdf

4. SUMMARY RESULTS

4.1 Historical context

To put the forecasts into context, the rail freight tonnes by sector from 2004/05 to 2016/17 is shown in the table and graph below. Even though the base year for the forecasts remains 2016/17 to be consistent with our 2023/24 forecasts reported in May 2018, time has moved on so we have now extended this data to include 2017/18 and a representation of 2018/19 (which is actually 12 months to the end of February, not to the end of March).

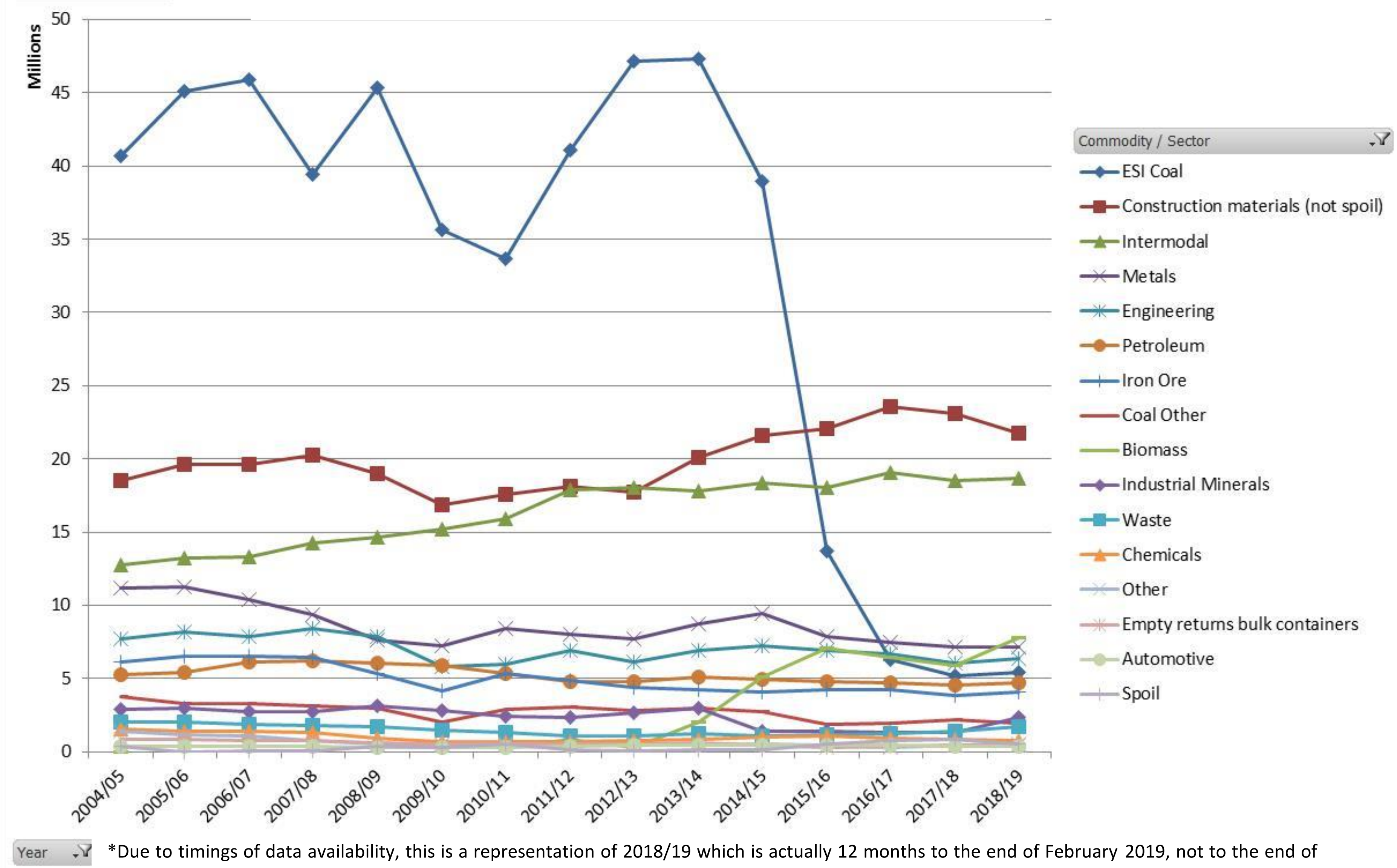
The main historical change is that ESI (power station) coal used to dominate rail freight, but is now a relatively minor part of the overall picture. Construction dipped in the recession but then recovered strongly. Intermodal rail grew up to the recession and then performed well through the recession, but has since been reasonably stable overall. The lack of growth is partly due to capacity constraint and disruptive changes in port choices by the deep sea shipping lines.

Table 15: Rail freight TONNES by sector from 2004/05 to 2018/19*. Million tonnes per year

Sector	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19*
Intermodal	12.7	13.3	13.3	14.2	14.6	15.2	15.9	17.9	18.0	17.8	18.4	18.1	19.1	18.5	18.6
ESI Coal	40.7	45.1	45.9	39.5	45.4	35.7	33.7	41.1	47.1	47.4	38.9	13.7	6.3	5.2	5.5
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8	0.3	2.1	5.1	7.1	6.5	5.9	7.8
Waste	2.1	2.0	1.9	1.8	1.7	1.5	1.3	1.1	1.1	1.3	1.1	1.2	1.2	1.4	1.7
Construction	18.9	19.6	19.6	20.3	19.4	17.2	18.1	18.3	17.8	20.2	21.8	22.6	24.3	24.0	22.3
of which spoil	0.4	0.0	0.0	0.1	0.4	0.3	0.6	0.1	0.0	0.1	0.2	0.5	0.7	0.9	0.5
Petroleum	5.3	5.4	6.1	6.2	6.1	5.9	5.3	4.8	4.8	5.1	5.0	4.8	4.7	4.5	4.7
Chemicals	1.6	1.4	1.4	1.3	0.9	0.7	0.7	0.7	0.8	0.8	1.0	1.1	0.9	0.9	0.8
Ind' Minerals	2.9	3.0	2.8	2.8	3.1	2.8	2.4	2.4	2.6	3.0	1.4	1.4	1.3	1.3	2.4
Metals	11.1	11.3	10.4	9.3	7.6	7.3	8.4	8.0	7.7	8.8	9.4	7.8	7.4	7.2	7.1
Automotive	0.4	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.4	0.4	0.4
Ores	6.1	6.5	6.5	6.5	5.4	4.2	5.4	4.9	4.4	4.2	4.1	4.3	4.3	3.8	4.1
Coal Other	3.7	3.3	3.3	3.2	3.0	2.1	2.9	3.1	2.8	3.0	2.8	1.9	2.0	2.2	2.0
Other	1.4	1.2	1.1	0.8	0.5	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.3	0.4	0.5
Empty return bulk containers	0.9	0.8	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.6	0.5	0.3	0.4	0.5	0.5
NR Engineering	7.7	8.2	7.9	8.4	7.9	5.8	6.0	6.9	6.2	7.0	7.2	6.9	6.7	6.0	6.4
Total	**115.4**	**121.3**	**121.3**	**115.5**	**116.6**	**99.7**	**101.7**	**111.3**	**115.1**	**122.1**	**117.7**	**92.2**	**85.8**	**82.3**	**84.8**
Total excluding ESI coal	*74.7*	*76.3*	*75.4*	*76.0*	*71.2*	*64.0*	*68.1*	*70.2*	*68.0*	*74.8*	*78.7*	*78.4*	*79.5*	*77.1*	*79.4*

*Due to timings of data availability, this is a representation of 2018/19 which is actually 12 months to the end of February, not to the end of March

Figure 3 **Rail freight TONNES from 2004/05 to 2018/19* by sector**



*Due to timings of data availability, this is a representation of 2018/19 which is actually 12 months to the end of February 2019, not to the end of March

4.2 Forecasts

This section presents the unconstrained forecast rail freight demand results for scenarios A-F. The tables and charts below cover the forecast annual rail freight tonnes, annual tonne kms, daily trains and hourly paths required by sector for:

- actual traffic in 2016/17 base year
- scenario A: Factors which favour rail relative to road, with low market growth
- scenario B: Factors which favour rail relative to road, with high market growth
- scenario C: Factors which disfavour rail relative to road, with low market growth
- scenario D: Factors which disfavour rail relative to road, with high market growth
- scenario E: Central assumptions neither favouring or disfavouring rail relative to road, with central market growth
- scenario F: As scenario E, but with internalisation of external costs

These show results for 2023/24 (in italics) as taken from our May 2018 results (not including E & F), 2033/34 and 2043/4.

Table 16: Rail freight TONNES forecast for 2023/24 scenarios by sector. Thousand tonnes per year

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	16,213	24,252	27,133	15,320	17,077
Domestic Intermodal	2,481	8,009	8,606	3,281	3,493
Channel Tunnel Intermodal	374	529	578	420	458
ESI Coal	6,284	-	-	-	-
Biomass	6,470	8,464	13,045	8,464	13,045
Waste	1,226	1,165	1,287	1,165	1,287
Construction materials	24,286	33,133	43,383	22,887	29,967
of which spoil	735	997	1,306	733	960
Petroleum	4,710	4,822	5,330	4,470	4,940
Chemicals	899	934	1,032	863	954
Industrial Minerals	1,335	1,580	1,747	1,162	1,284
Metals	7,441	8,226	9,092	6,965	7,698
Automotive	450	468	583	437	548
Ores	4,259	4,046	4,472	4,046	4,472
Coal Other	1,955	1,857	4,052	1,857	4,052
Other	334	368	407	319	353
Empty returns for containers carrying bulks	413	397	439	393	434
NR Engineering	6,657	6,324	6,990	6,324	6,990
Total	**85,786**	**104,574**	**128,175**	**78,371**	**97,052**

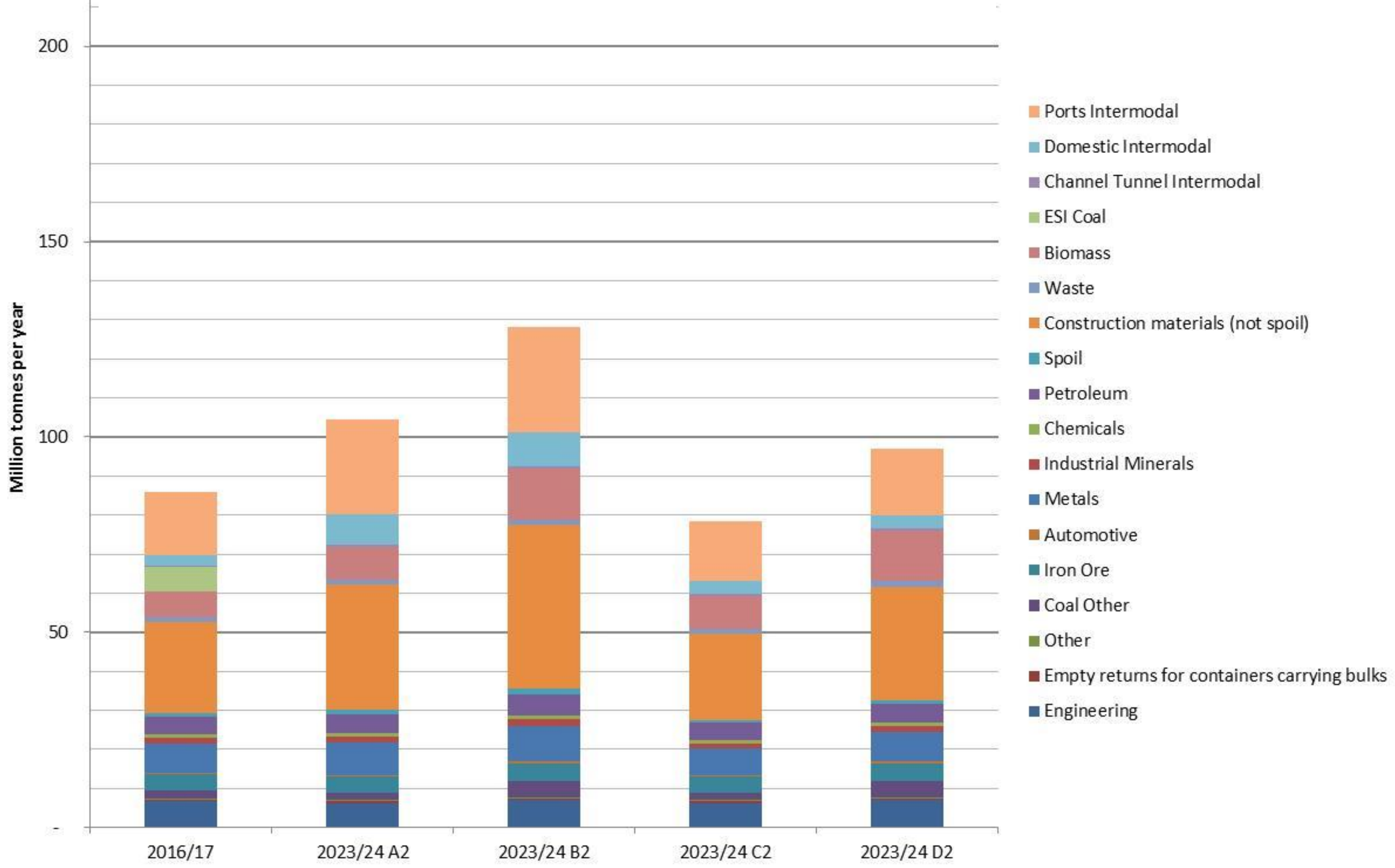
Table 17: Rail freight TONNES forecast for 2033/34 scenarios by sector. Thousand tonnes per year

Sector	Actual 2016/17	2033/34 A	2033/34 B	2033/34 C	2033/34 D	2033/34 E	2033/34 F
Ports Intermodal	16,213	38,505	42,549	25,920	28,759	31,756	47,832
Domestic Intermodal	2,481	10,096	12,440	3,311	4,576	6,046	18,465
Channel Tunnel Intermodal	374	690	773	534	598	621	930
ESI Coal	6,284	-	-	-	-	-	-
Biomass	6,470	5,013	10,026	5,013	10,026	7,520	7,520
Waste	1,226	1,165	1,287	1,165	1,287	1,226	1,226
Construction materials	24,286	36,348	45,410	23,028	28,769	35,869	51,277
of which spoil	735	1,075	1,344	507	633	1,060	1,428
Petroleum	4,710	4,891	5,406	4,611	5,097	5,025	5,391
Chemicals	899	949	1,048	866	958	968	1,082
Industrial Minerals	1,335	1,618	1,789	1,177	1,301	1,518	1,858
Metals	7,441	8,455	9,345	7,281	8,047	8,433	9,319
Automotive	450	487	538	461	509	493	549
Ores	4,259	4,046	4,472	4,046	4,472	4,259	4,259
Coal Other	1,955	1,857	4,052	1,857	4,052	1,955	1,955
Other	334	404	446	343	380	383	385
Empty returns for containers carrying bulks	413	400	443	395	437	418	418
NR Engineering	6,657	6,324	6,990	6,324	6,990	6,657	6,657
Total	**85,786**	**121,248**	**147,013**	**86,333**	**106,258**	**113,145**	**159,122**

Table 18: Rail freight TONNES forecast for 2043/44 scenarios by sector. Thousand tonnes per year

Sector	Actual 2016/17	2043/44 A	2043/44 B	2043/44 C	2043/44 D	2043/44 E	2043/44 F
Ports Intermodal	16,213	51,844	56,596	35,099	39,321	42,879	61,493
Domestic Intermodal	2,481	16,724	23,633	5,203	9,026	10,933	27,613
Channel Tunnel Intermodal	374	811	925	641	732	746	1,091
ESI Coal	6,284	-	-	-	-	-	-
Biomass	6,470	5,013	10,026	5,013	10,026	7,520	7,520
Waste	1,226	1,165	1,287	1,165	1,287	1,226	1,226
Construction materials	24,286	47,903	72,412	37,782	57,113	53,338	63,182
of which spoil	735	1,294	1,956	1,042	1,575	1,496	1,714
Petroleum	4,710	5,064	5,597	4,833	5,341	5,209	5,459
Chemicals	899	1,009	1,116	928	1,025	1,025	1,109
Industrial Minerals	1,335	1,759	1,944	1,448	1,600	1,732	1,912
Metals	7,441	8,788	9,713	7,950	8,786	8,897	9,460
Automotive	450	497	549	479	529	509	555
Ores	4,259	4,046	4,472	4,046	4,472	4,259	4,259
Coal Other	1,955	1,857	4,052	1,857	4,052	1,955	1,955
Other	334	413	456	355	393	394	396
Empty returns for containers carrying bulks	413	401	443	396	438	419	419
NR Engineering	6,657	6,324	6,990	6,324	6,990	6,657	6,657
Total	**85,786**	**153,617**	**200,212**	**113,518**	**151,132**	**147,696**	**194,307**

Figure 4: Rail freight TONNES forecast for 2023/24 scenarios by sector



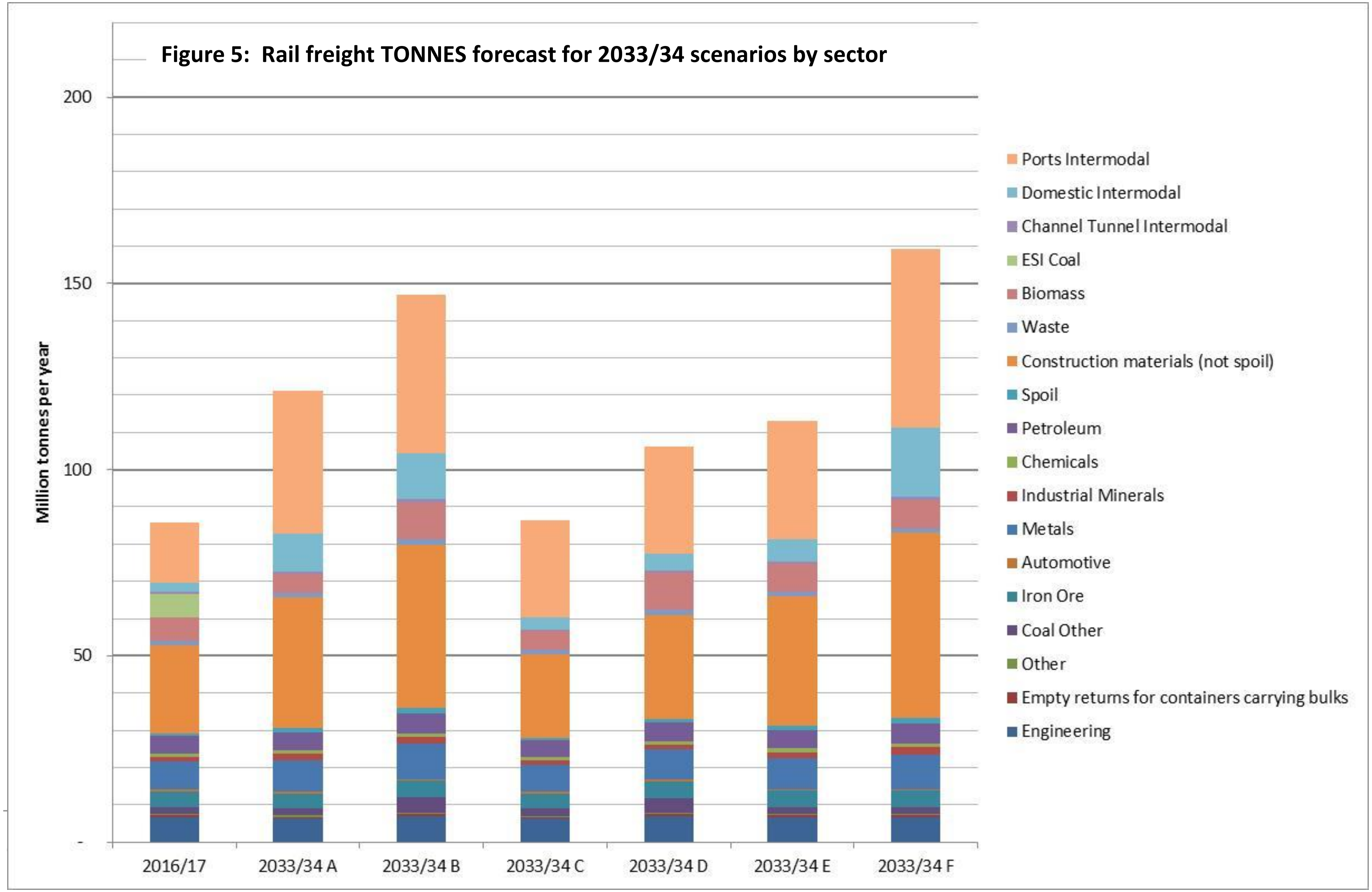


Figure 5: Rail freight TONNES forecast for 2033/34 scenarios by sector
Million tonnes per year
200
150
100
50
-
2016/17
2033/34 A
2033/34 B
2033/34 C
2033/34 D
2033/34 E
2033/34 F
Ports Intermodal
Domestic Intermodal
Channel Tunnel Intermodal
ESI Coal
Biomass
Waste
Construction materials (not spoil)
Spoil
Petroleum
Chemicals
Industrial Minerals
Metals
Automotive
Iron Ore
Coal Other
Other
Empty returns for containers carrying bulks
Engineering

Figure 6: Rail freight TONNES forecast for 2043/44 scenarios by sector

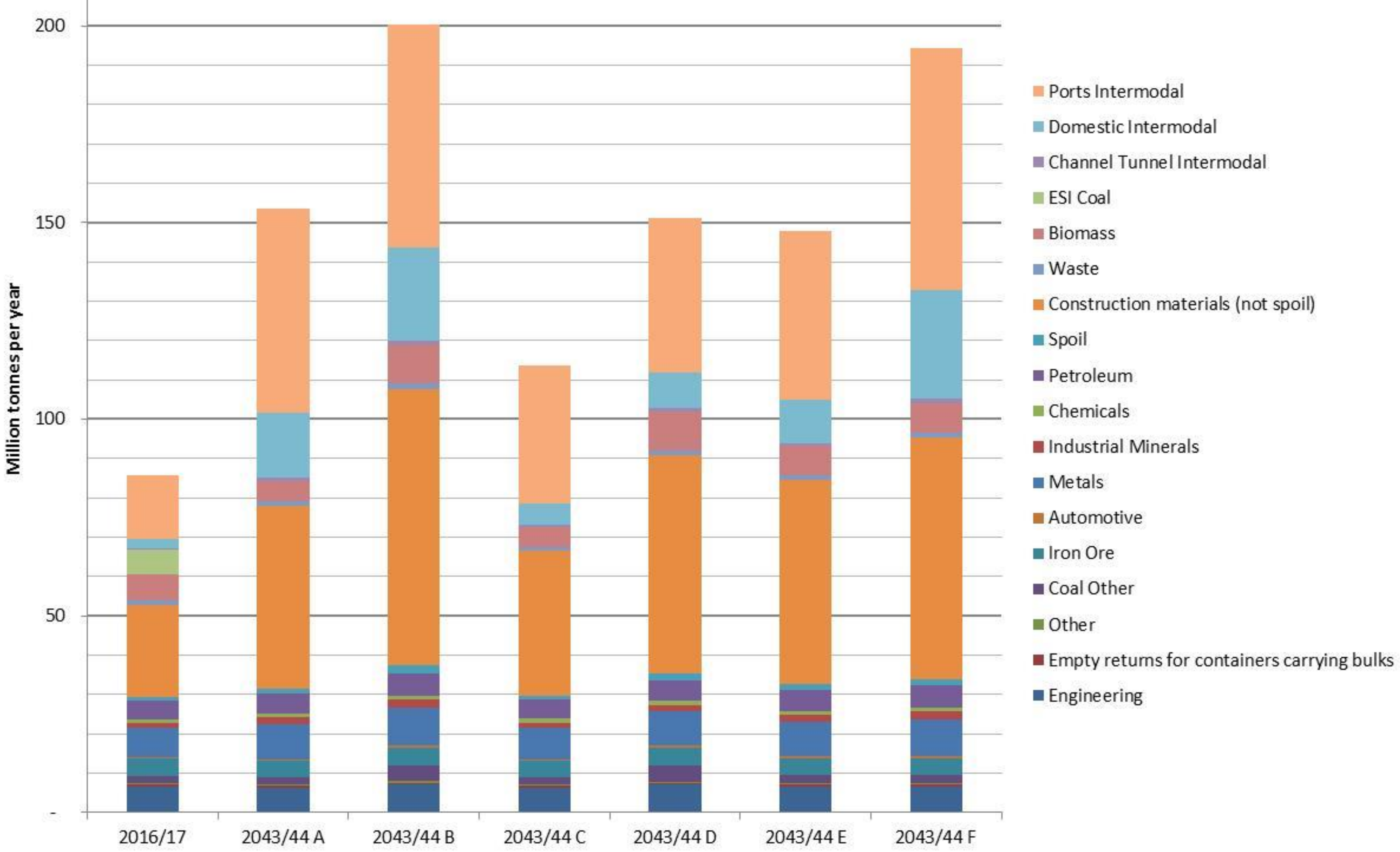


Table 19: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector. Million tonne kms per year

Sector	*2016/17[9]*	*2023/24 A2*	*2023/24 B2*	*2023/24 C2*	*2023/24 D2*
Ports Intermodal	*5,612*	*8,165*	*9,108*	*5,279*	*5,885*
Domestic Intermodal	*1,136*	*3,466*	*3,726*	*1,526*	*1,631*
Channel Tunnel Intermodal	*94*	*133*	*145*	*106*	*115*
ESI Coal	*1,158*	-	-	-	-
Biomass	*853*	*1,093*	*1,673*	*1,093*	*1,673*
Waste	*215*	*204*	*225*	*204*	*225*
Construction materials	*4,342*	*5,242*	*6,863*	*4,070*	*5,330*
of which spoil	*94*	*127*	*166*	*94*	*123*
Petroleum	*1,134*	*1,141*	*1,261*	*1,075*	*1,188*
Chemicals	*142*	*152*	*168*	*137*	*152*
Industrial Minerals	*234*	*262*	*289*	*213*	*236*
Metals	*1,587*	*1,706*	*1,886*	*1,465*	*1,620*
Automotive	*146*	*149*	*180*	*141*	*171*
Ores	*156*	*148*	*164*	*148*	*164*
Coal Other	*267*	*254*	*783*	*254*	*783*
Other	*101*	*112*	*124*	*97*	*107*
Empty returns for containers carrying bulks	*69*	*68*	*75*	*66*	*73*
NR Engineering	*1,714*	*1,628*	*1,800*	*1,628*	*1,800*
Total	***18,962***	***23,923***	***28,472***	***17,502***	***21,152***

[9] The 18.96 billion tonne kms figure agrees with the ORR data. See the ORR's published table "Freight moved - Table 13.7" (https://dataportal.orr.gov.uk/browsereports) and add the total (excluding infrastructure) (17.25) and the infrastructure (1.71) figures

Table 20: Rail freight TONNE KMS forecast for 2033/34 scenarios by sector. Million tonne kms per year

Sector	Actual 2016/17	2033/34 A	2033/34 B	2033/34 C	2033/34 D	2033/34 E	2033/34 F
Ports Intermodal	5,612	14,568	16,365	9,939	11,304	12,419	18,379
Domestic Intermodal	1,136	4,073	5,173	1,433	1,916	2,517	8,384
Channel Tunnel Intermodal	94	174	194	134	151	156	234
ESI Coal	1,158	-	-	-	-	-	-
Biomass	853	638	1,275	638	1,275	956	956
Waste	215	204	225	204	225	215	215
Construction materials	4,342	5,530	6,909	3,804	4,752	5,634	7,142
of which spoil	94	136	170	63	78	135	180
Petroleum	1,134	1,152	1,273	1,098	1,214	1,189	1,257
Chemicals	142	153	170	137	152	156	176
Industrial Minerals	234	272	301	215	237	262	305
Metals	1,587	1,757	1,942	1,477	1,632	1,731	1,894
Automotive	146	154	170	147	163	157	174
Ores	156	148	164	148	164	156	156
Coal Other	267	254	783	254	783	267	267
Other	101	124	137	105	116	117	118
Empty returns for containers carrying bulks	69	69	77	67	74	71	71
NR Engineering	1,714	1,628	1,800	1,628	1,800	1,714	1,714
Total	**18,962**	**30,898**	**36,958**	**21,428**	**25,957**	**27,717**	**41,443**

Table 21: Rail freight TONNE KMS forecast for 2043/44 scenarios by sector. Million tonne kms per year

Sector	Actual 2016/17	2043/44 A	2043/44 B	2043/44 C	2043/44 D	2043/44 E	2043/44 F
Ports Intermodal	5,612	19,332	21,541	13,702	15,717	16,721	23,389
Domestic Intermodal	1,136	6,362	9,574	2,151	3,817	4,521	11,922
Channel Tunnel Intermodal	94	204	233	161	184	188	275
ESI Coal	1,158	-	-	-	-	-	-
Biomass	853	638	1,275	638	1,275	956	956
Waste	215	204	225	204	225	215	215
Construction materials	4,342	6,547	9,896	5,286	7,990	7,478	8,609
of which spoil	94	162	245	131	198	188	215
Petroleum	1,134	1,178	1,302	1,134	1,254	1,219	1,267
Chemicals	142	163	180	148	163	165	180
Industrial Minerals	234	302	333	256	283	293	319
Metals	1,587	1,813	2,004	1,601	1,770	1,816	1,923
Automotive	146	156	172	151	167	161	175
Ores	156	148	164	148	164	156	156
Coal Other	267	254	783	254	783	267	267
Other	101	126	140	108	120	120	121
Empty returns for containers carrying bulks	69	70	77	67	74	72	72
NR Engineering	1,714	1,628	1,800	1,628	1,800	1,714	1,714
Total	**18,962**	**39,124**	**49,699**	**27,638**	**35,786**	**36,061**	**51,560**

Figure 7: Rail freight TONNE KMS forecast for 2023/24 scenarios by sector

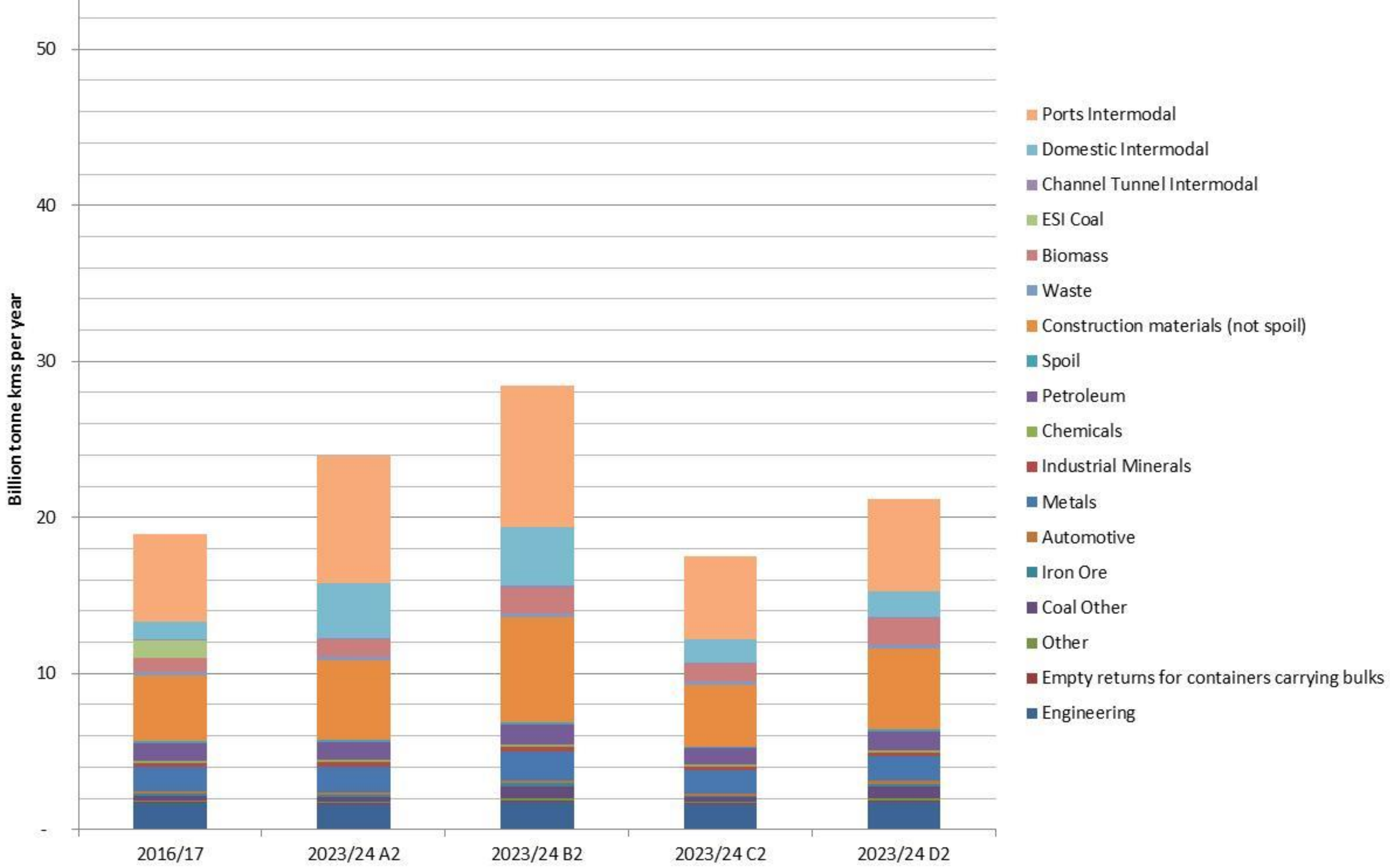


Figure 8: Rail freight TONNE KMS forecast for 2033/34 scenarios by sector

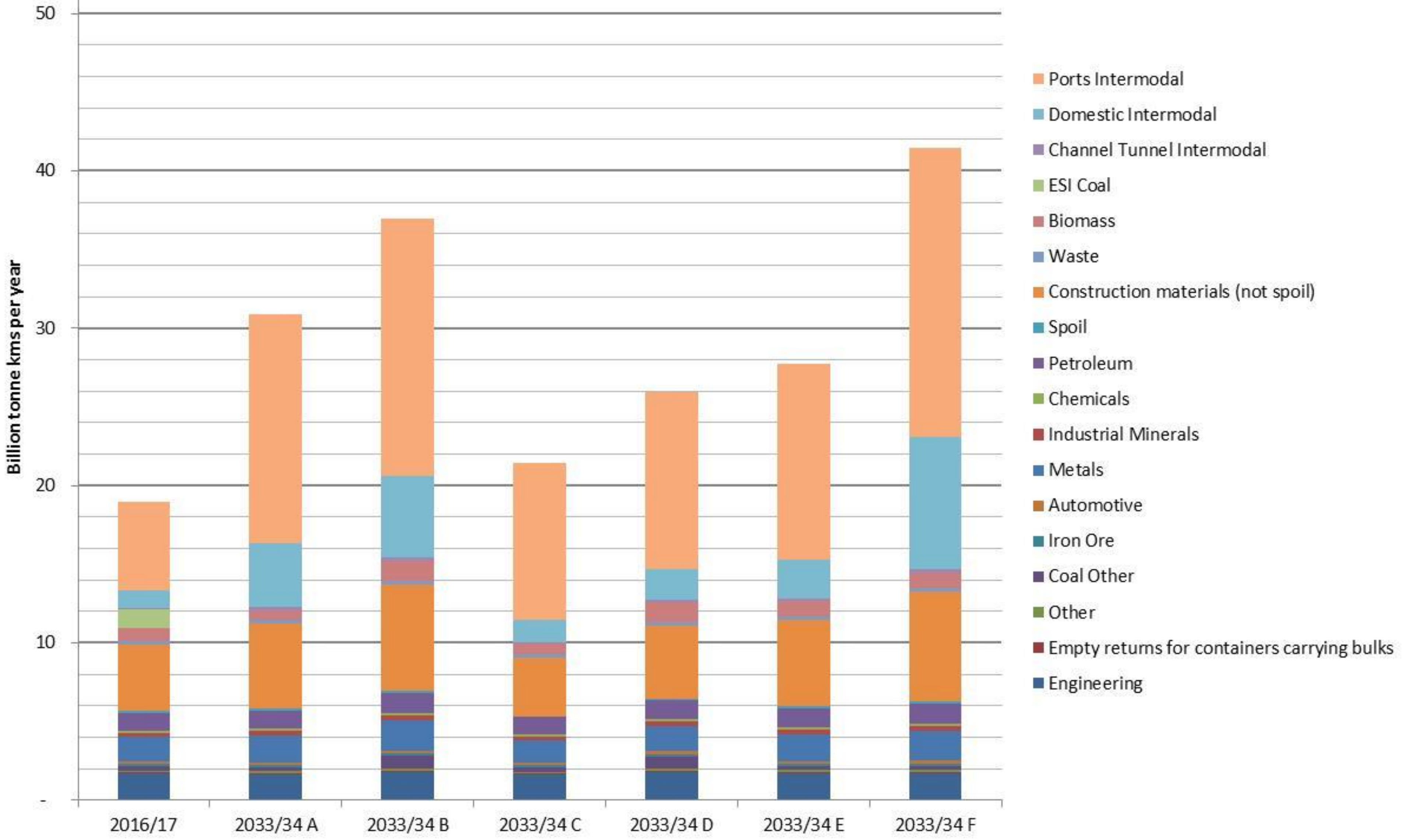


Figure 9: Rail freight TONNE KMS forecast for 2043/44 scenarios by sector

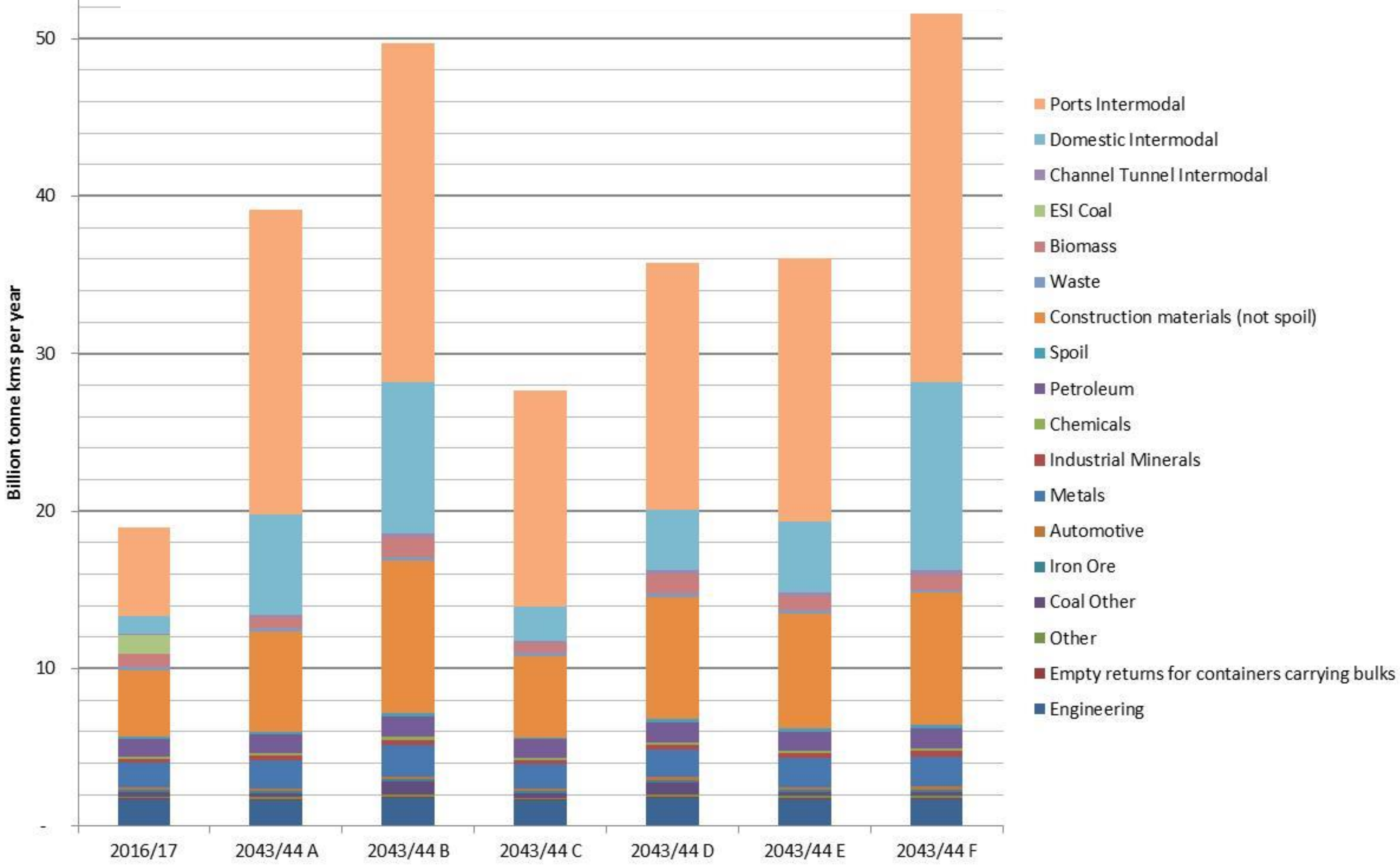


Table 22: Rail freight DAILY TRAINS forecast for 2023/24 scenarios by sector

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	*123*	*175*	*196*	*116*	*129*
Domestic Intermodal	*19*	*58*	*62*	*25*	*26*
Channel Tunnel Intermodal	*3*	*4*	*4*	*3*	*3*
ESI Coal	*32*	-	-	-	-
Biomass	*32*	*40*	*61*	*42*	*64*
Waste	*8*	*7*	*8*	*8*	*9*
Construction materials	*135*	*176*	*230*	*128*	*167*
of which spoil	*5*	*6*	*8*	*5*	*6*
Petroleum	*19*	*19*	*21*	*18*	*20*
Chemicals	*7*	*7*	*8*	*7*	*8*
Industrial Minerals	*9*	*10*	*11*	*8*	*9*
Metals	*49*	*51*	*56*	*45*	*50*
Automotive	*19*	*19*	*23*	*18*	*23*
Ores	*27*	*25*	*27*	*26*	*29*
Coal Other	*13*	*12*	*27*	*13*	*28*
Other	*3*	*3*	*4*	*3*	*3*
Empty returns for containers carrying bulks	*10*	*9*	*10*	*9*	*10*
NR Engineering	*63*	*57*	*63*	*60*	*67*
Total	***572***	***672***	***813***	***530***	***646***

Note:

- These daily trains figures include empty return trains for bulk commodities.
- They are derived from the tonnes data, using the "Average cargo tonnes per train by commodity / sector" table (table 12) and operational days per year figures in sections 2.5 and 2.6.

Table 23: Rail freight DAILY TRAINS forecast for 2033/34 scenarios by sector

Sector	Actual 2016/17	2033/34 A	2033/34 B	2033/34 C	2033/34 D	2033/34 E	2033/34 F
Ports Intermodal	123	278	307	197	218	241	363
Domestic Intermodal	19	73	90	25	35	46	140
Channel Tunnel Intermodal	3	5	6	4	5	5	7
ESI Coal	32	-	-	-	-	-	-
Biomass	32	23	47	25	49	37	37
Waste	8	7	8	8	9	8	8
Construction materials	135	193	241	128	160	200	286
of which spoil	5	7	8	3	4	7	9
Petroleum	19	19	21	19	21	21	22
Chemicals	7	7	8	7	8	8	9
Industrial Minerals	9	11	12	8	9	10	13
Metals	49	52	58	47	52	55	61
Automotive	19	20	22	19	21	21	23
Ores	27	25	27	26	29	27	27
Coal Other	13	12	27	13	28	13	13
Other	3	4	4	3	4	4	4
Empty returns for containers carrying bulks	10	9	10	9	10	10	10
NR Engineering	63	57	63	60	67	63	63
Total	**572**	**796**	**951**	**599**	**724**	**769**	**1,086**

Note:

- These daily trains figures include empty return trains for bulk commodities.
- They are derived from the tonnes data, using the "Average cargo tonnes per train by commodity / sector" table (table 12) and operational days per year figures in sections 2.5 and 2.6.

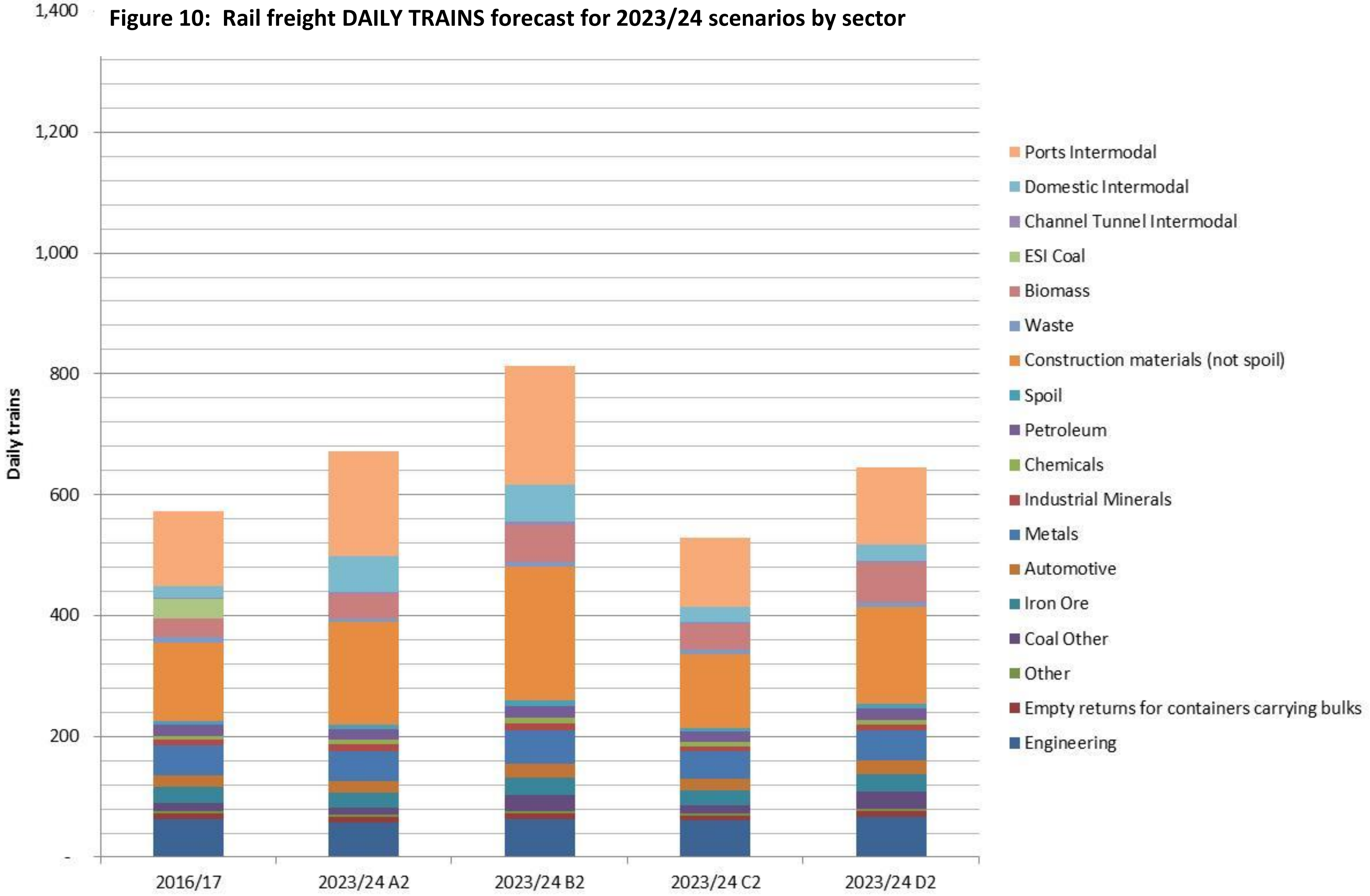
Table 24: Rail freight DAILY TRAINS forecast for 2043/44 scenarios by sector

Sector	Actual 2016/17	2043/44 A	2043/44 B	2043/44 C	2043/44 D	2043/44 E	2043/44 F
Ports Intermodal	123	374	409	266	298	325	466
Domestic Intermodal	19	121	171	39	68	83	209
Channel Tunnel Intermodal	3	6	7	5	6	6	8
ESI Coal	32	-	-	-	-	-	-
Biomass	32	23	47	25	49	37	37
Waste	8	7	8	8	9	8	8
Construction materials	135	254	384	211	318	297	352
of which spoil	5	8	12	7	10	10	11
Petroleum	19	20	22	20	22	21	22
Chemicals	7	8	9	7	8	8	9
Industrial Minerals	9	11	13	10	11	12	13
Metals	49	55	60	52	57	58	62
Automotive	19	20	22	20	22	21	23
Ores	27	25	27	26	29	27	27
Coal Other	13	12	27	13	28	13	13
Other	3	4	4	3	4	4	4
Empty returns for containers carrying bulks	10	9	10	9	10	10	10
NR Engineering	63	57	63	60	67	63	63
Total	**572**	**1,006**	**1,282**	**774**	**1,006**	**995**	**1,328**

Note:

- These daily trains figures include empty return trains for bulk commodities.
- They are derived from the tonnes data, using the "Average cargo tonnes per train by commodity / sector" table (table 12) and operational days per year figures in sections 2.5 and 2.6.

Figure 10: Rail freight DAILY TRAINS forecast for 2023/24 scenarios by sector



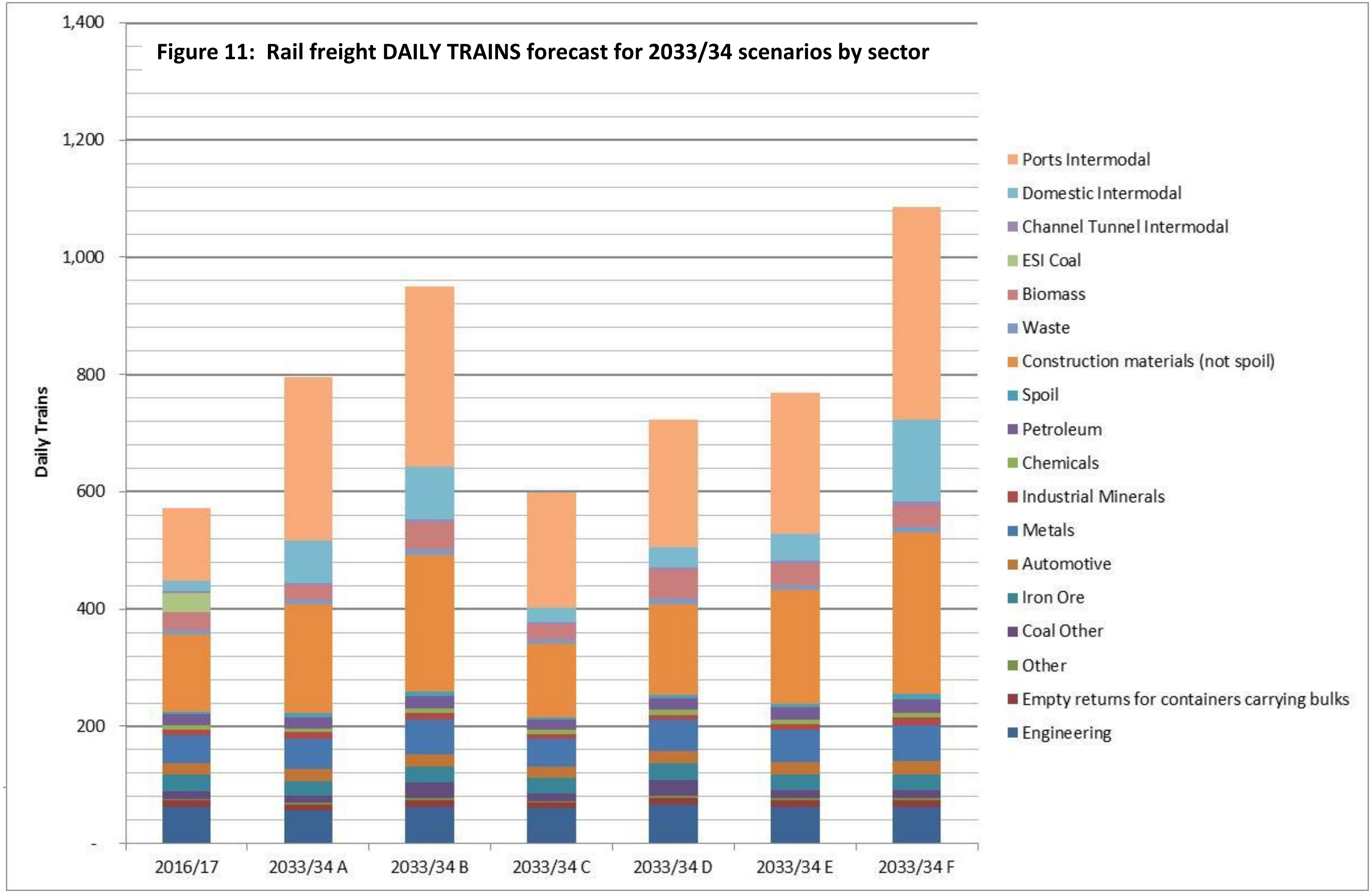


Figure 11: Rail freight DAILY TRAINS forecast for 2033/34 scenarios by sector
1,400
1,200
1,000
800
600
400
200
-
Daily Trains
2016/17
2033/34 A
2033/34 B
2033/34 C
2033/34 D
2033/34 E
2033/34 F
Ports Intermodal
Domestic Intermodal
Channel Tunnel Intermodal
ESI Coal
Biomass
Waste
Construction materials (not spoil)
Spoil
Petroleum
Chemicals
Industrial Minerals
Metals
Automotive
Iron Ore
Coal Other
Other
Empty returns for containers carrying bulks
Engineering

Figure 12: Rail freight DAILY TRAINS forecast for 2043/44 scenarios by sector

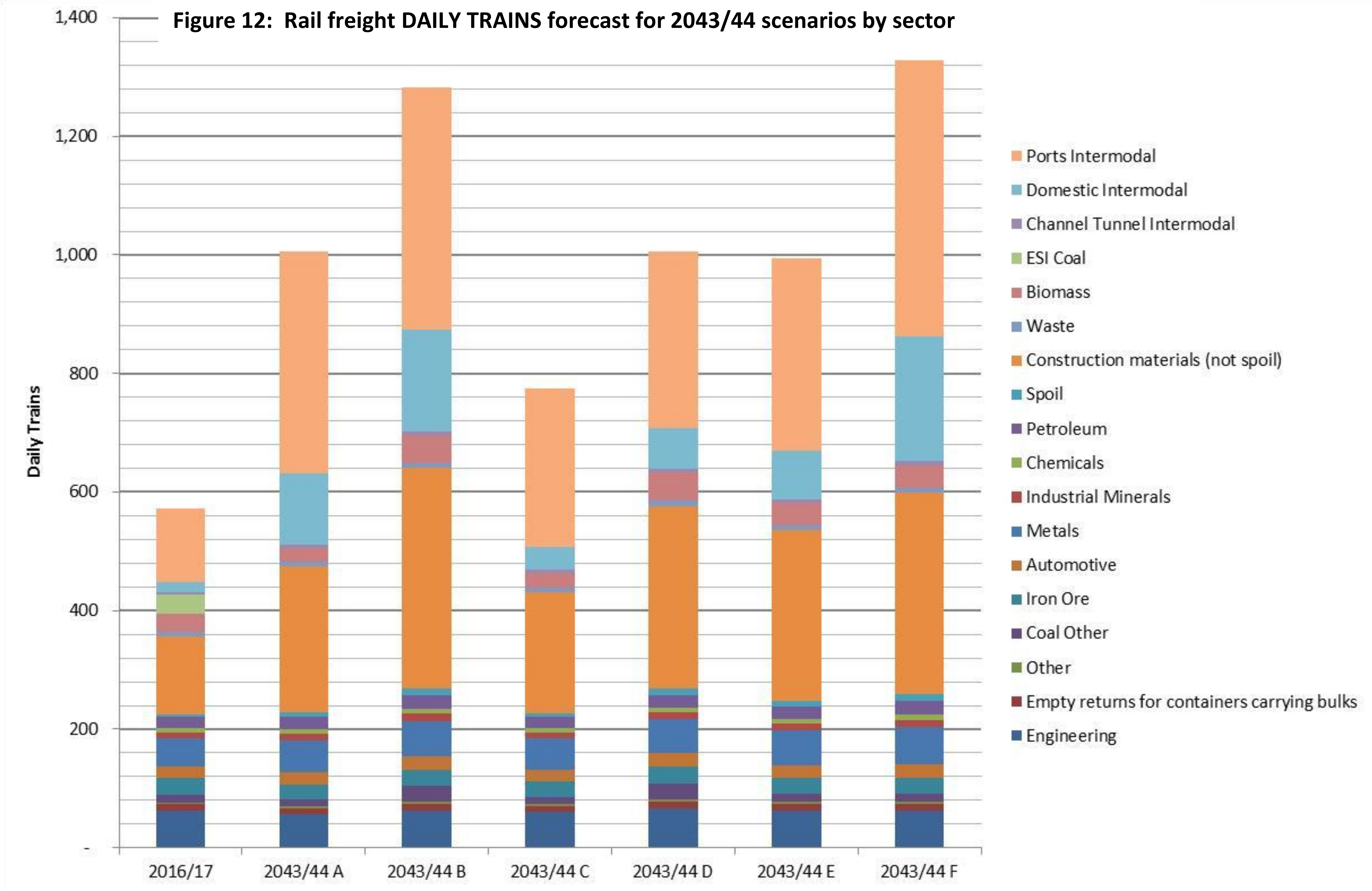


Table 25: Rail freight HOURLY PATHS forecast for 2023/24 scenarios by sector

Sector	2016/17	2023/24 A2	2023/24 B2	2023/24 C2	2023/24 D2
Ports Intermodal	*8.0*	*11.4*	*12.8*	*7.6*	*8.5*
Domestic Intermodal	*1.2*	*3.8*	*4.1*	*1.6*	*1.7*
Channel Tunnel Intermodal	*0.2*	*0.2*	*0.3*	*0.2*	*0.2*
ESI Coal	*3.9*	-	-	-	-
Biomass	*2.4*	*2.9*	*4.5*	*3.1*	*4.8*
Waste	*0.9*	*0.8*	*0.9*	*0.9*	*1.0*
Construction materials	*20.1*	*26.2*	*34.3*	*19.0*	*24.9*
of which spoil	*0.5*	*0.7*	*0.9*	*0.5*	*0.7*
Petroleum	*1.9*	*1.9*	*2.1*	*1.8*	*2.0*
Chemicals	*0.8*	*0.8*	*0.9*	*0.8*	*0.9*
Industrial Minerals	*1.0*	*1.1*	*1.3*	*0.9*	*1.0*
Metals	*5.3*	*5.6*	*6.1*	*4.9*	*5.5*
Automotive	*2.1*	*2.1*	*2.6*	*2.0*	*2.6*
Ores	*3.0*	*2.7*	*3.0*	*2.9*	*3.2*
Coal Other	*1.7*	*1.5*	*3.3*	*1.6*	*3.5*
Other	*0.4*	*0.4*	*0.4*	*0.3*	*0.4*
Empty returns for containers carrying bulks	*1.1*	*1.0*	*1.1*	*1.0*	*1.2*
NR Engineering	*3.5*	*3.2*	*3.5*	*3.3*	*3.7*
Total	***57.6***	***65.7***	***81.1***	***52.0***	***64.7***

Note:

- These hourly path figures are derived from the daily trains data, using the “Path utilisation by commodity / sector” table and the 18 hours per day figure in section 2.6.

Table 26: Rail freight HOURLY PATHS forecast for 2033/34 scenarios by sector

Sector	Actual 2016/17	2033/34 A	2033/34 B	2033/34 C	2033/34 D	2033/34 E	2033/34 F
Ports Intermodal	8.0	18.2	20.1	12.8	14.3	15.7	23.7
Domestic Intermodal	1.2	4.8	5.9	1.6	2.3	3.0	9.1
Channel Tunnel Intermodal	0.2	0.3	0.4	0.3	0.3	0.3	0.5
ESI Coal	3.9	-	-	-	-	-	-
Biomass	2.4	1.7	3.5	1.8	3.7	2.7	2.7
Waste	0.9	0.8	0.9	0.9	1.0	0.9	0.9
Construction materials	20.1	28.7	35.9	19.1	23.9	29.8	42.5
of which spoil	0.5	0.7	0.9	0.4	0.5	0.8	1.0
Petroleum	1.9	1.9	2.1	1.9	2.1	2.0	2.2
Chemicals	0.8	0.8	0.9	0.8	0.9	0.9	1.0
Industrial Minerals	1.0	1.2	1.3	0.9	1.0	1.1	1.4
Metals	5.3	5.7	6.3	5.2	5.7	6.0	6.6
Automotive	2.1	2.2	2.4	2.2	2.4	2.3	2.6
Ores	3.0	2.7	3.0	2.9	3.2	3.0	3.0
Coal Other	1.7	1.5	3.3	1.6	3.5	1.7	1.7
Other	0.4	0.4	0.5	0.4	0.4	0.4	0.4
Empty returns for containers carrying bulks	1.1	1.0	1.1	1.1	1.2	1.1	1.1
NR Engineering	3.5	3.2	3.5	3.3	3.7	3.5	3.5
Total	**57.6**	**75.1**	**91.0**	**56.6**	**69.2**	**74.5**	**103.0**

Note:

- These hourly path figures are derived from the daily trains data, using the "Path utilisation by commodity / sector" table and the 18 hours per day figure in section 2.6.

Table 27: Rail freight HOURLY PATHS forecast for 2043/44 scenarios by sector

Sector	Actual 2016/17	2043/44 A	2043/44 B	2043/44 C	2043/44 D	2043/44 E	2043/44 F
Ports Intermodal	8.0	24.5	26.7	17.4	19.5	21.2	30.5
Domestic Intermodal	1.2	7.9	11.2	2.6	4.5	5.4	13.7
Channel Tunnel Intermodal	0.2	0.4	0.4	0.3	0.4	0.4	0.5
ESI Coal	3.9	-	-	-	-	-	-
Biomass	2.4	1.7	3.5	1.8	3.7	2.7	2.7
Waste	0.9	0.8	0.9	0.9	1.0	0.9	0.9
Construction materials	20.1	37.9	57.2	31.3	47.4	44.3	52.4
of which spoil	0.5	0.9	1.4	0.8	1.1	1.1	1.2
Petroleum	1.9	2.0	2.2	2.0	2.2	2.1	2.2
Chemicals	0.8	0.9	1.0	0.8	0.9	0.9	1.0
Industrial Minerals	1.0	1.3	1.4	1.1	1.2	1.3	1.4
Metals	5.3	5.9	6.6	5.6	6.2	6.3	6.7
Automotive	2.1	2.2	2.5	2.2	2.5	2.4	2.6
Ores	3.0	2.7	3.0	2.9	3.2	3.0	3.0
Coal Other	1.7	1.5	3.3	1.6	3.5	1.7	1.7
Other	0.4	0.4	0.5	0.4	0.4	0.4	0.4
Empty returns for containers carrying bulks	1.1	1.0	1.1	1.1	1.2	1.1	1.1
NR Engineering	3.5	3.2	3.5	3.3	3.7	3.5	3.5
Total	**57.6**	**94.3**	**124.9**	**75.3**	**101.2**	**97.7**	**124.5**

Note:

- These hourly path figures are derived from the daily trains data, using the "Path utilisation by commodity / sector" table and the 18 hours per day figure in section 2.6.

Figure 13: Rail freight HOURLY PATHS forecast for 2023/24 scenarios by sector

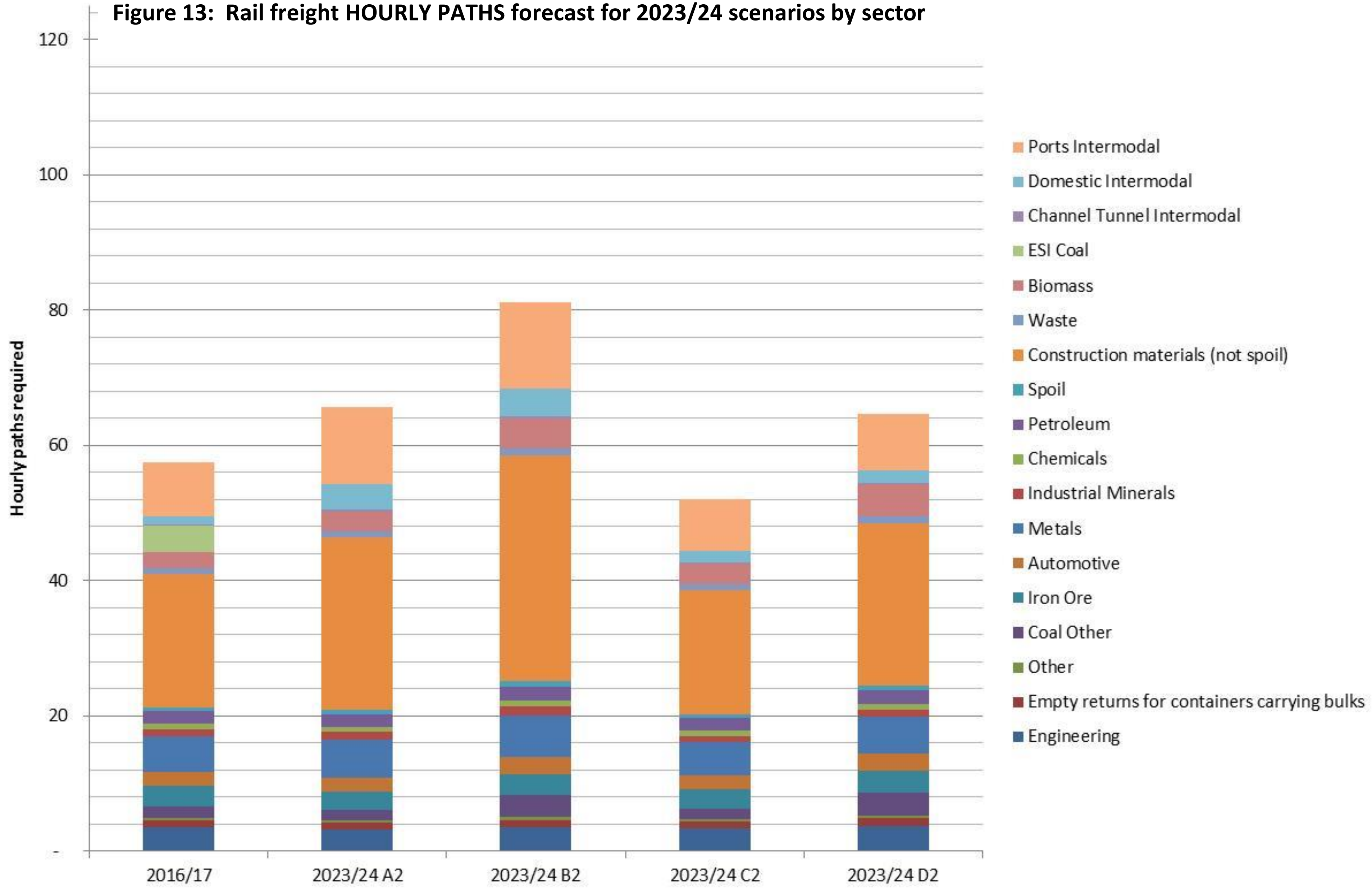


Figure 14: Rail freight HOURLY PATHS forecast for 2033/34 scenarios by sector

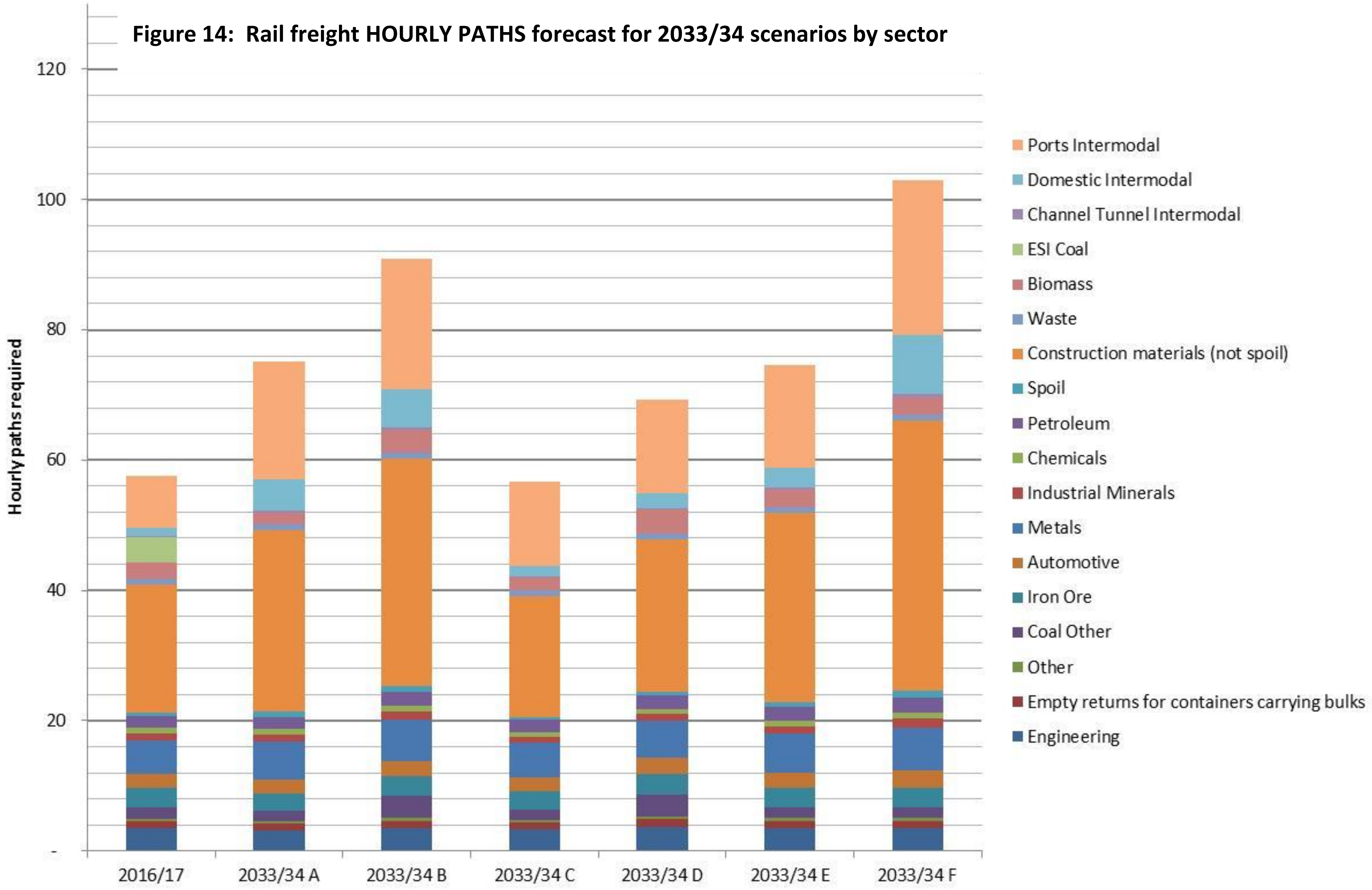
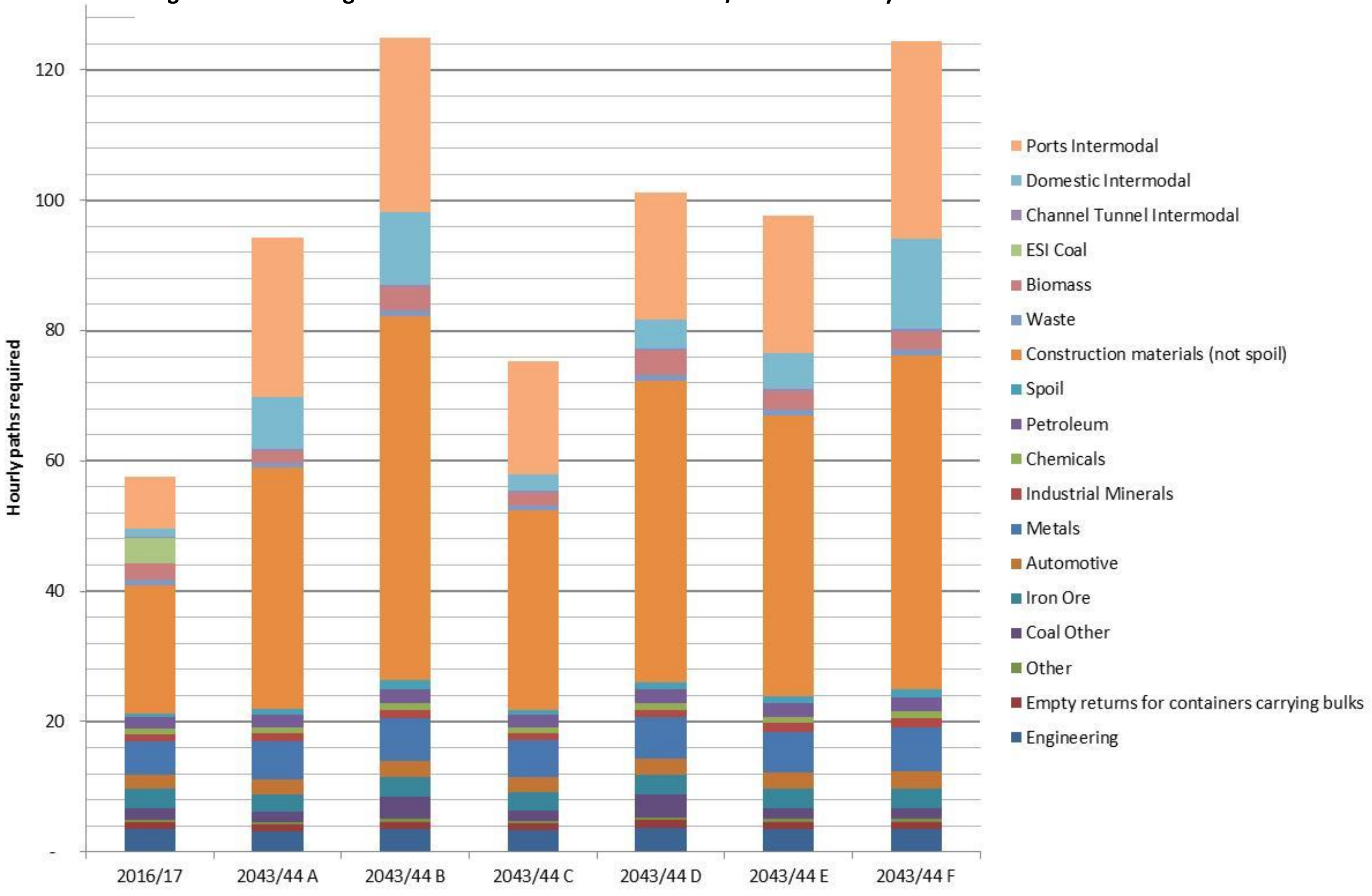


Figure 15: Rail freight HOURLY PATHS forecast for 2043/44 scenarios by sector



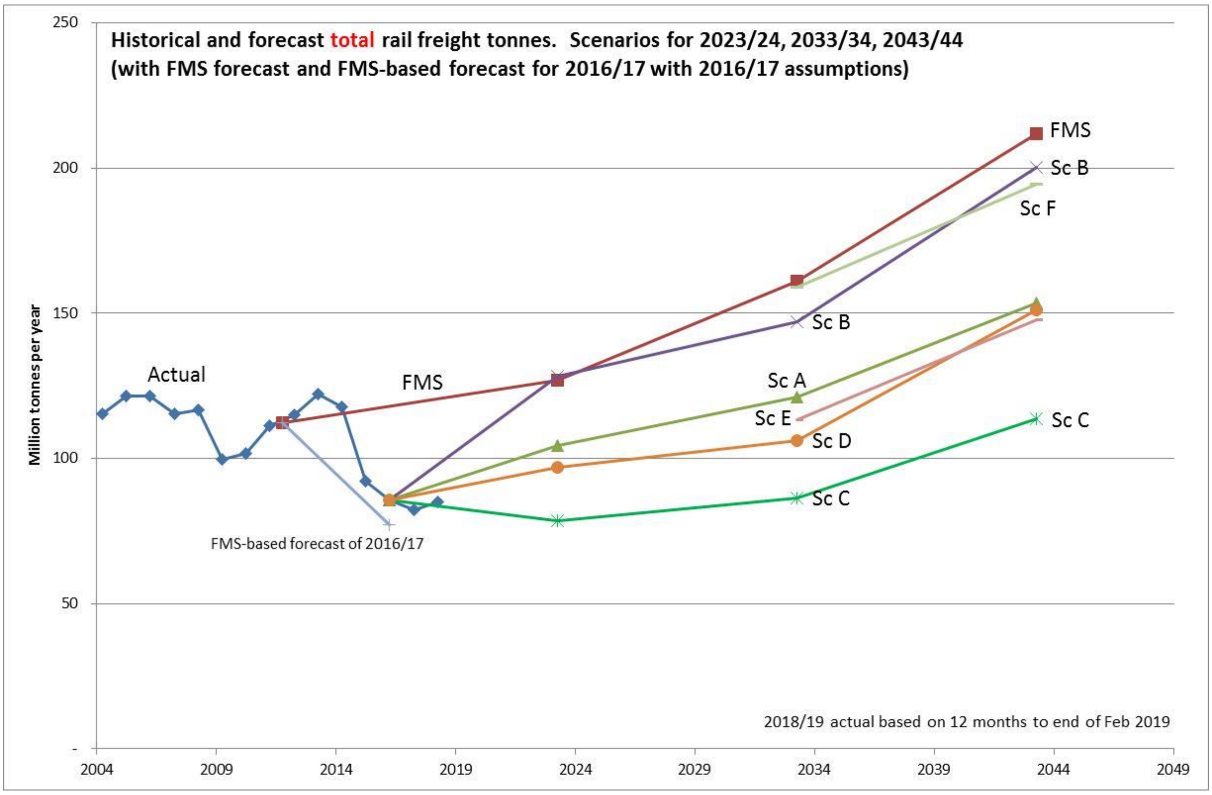
4.3 Comparison with Freight Market Study (FMS)

The table and graph below shows how the new 2023/24, 2033/34 and 2043/44 scenarios compare with the FMS forecasts, along with the historical traffics from 2004/05. It also shows what the FMS forecasts would have been for 2016/17 if out-turn assumptions for 2016/17 had been input into the FMS models.

Table 28: Comparison of new forecasts with the FMS

Scenario	Million Tonnes
2016/17 actual	85.8
2023/24 A2: Factors favouring rail, low market growth	*104.6*
2023/24 B2: Factors favouring rail, high market growth	*128.2*
2023/24 C2: Factors disfavouring rail, low market growth	*78.4*
2023/24 D2: Factors disfavouring rail, high market growth	*97.1*
2023/24 Average of A2, B2, C2 & D2	*102.0*
2023/24 A3: A2 with capacity constraint	*101.5*
2023/24 B3: B2 with capacity constraint	*119.7*
2033/34 A: Factors favouring rail, low market growth	121.2
2033/34 B: Factors favouring rail, high market growth	147.0
2033/34 C: Factors disfavouring rail, low market growth	86.3
2033/34 D: Factors disfavouring rail, high market growth	106.3
2033/34 E: Central	113.1
2033/34 F: Internalisation of external costs	159.1
2043/44 A: Factors favouring rail, low market growth	153.6
2043/44 B: Factors favouring rail, high market growth	200.2
2043/44 C: Factors disfavouring rail, low market growth	113.5
2043/44 D: Factors disfavouring rail, high market growth	151.1
2043/44 E: Central	147.7
2043/44 F: Internalisation of external costs	194.3
2012 actual (from FMS) (12 months to the end of September 2012)	112.4
2016/17 forecast from FMS base with 2016/17 assumptions	77.1
Original FMS central case forecast for 2023/24	127.0
Original FMS central case forecast for 2033/34	161.1
Original FMS central case forecast for 2043/44	211.7

Figure 16



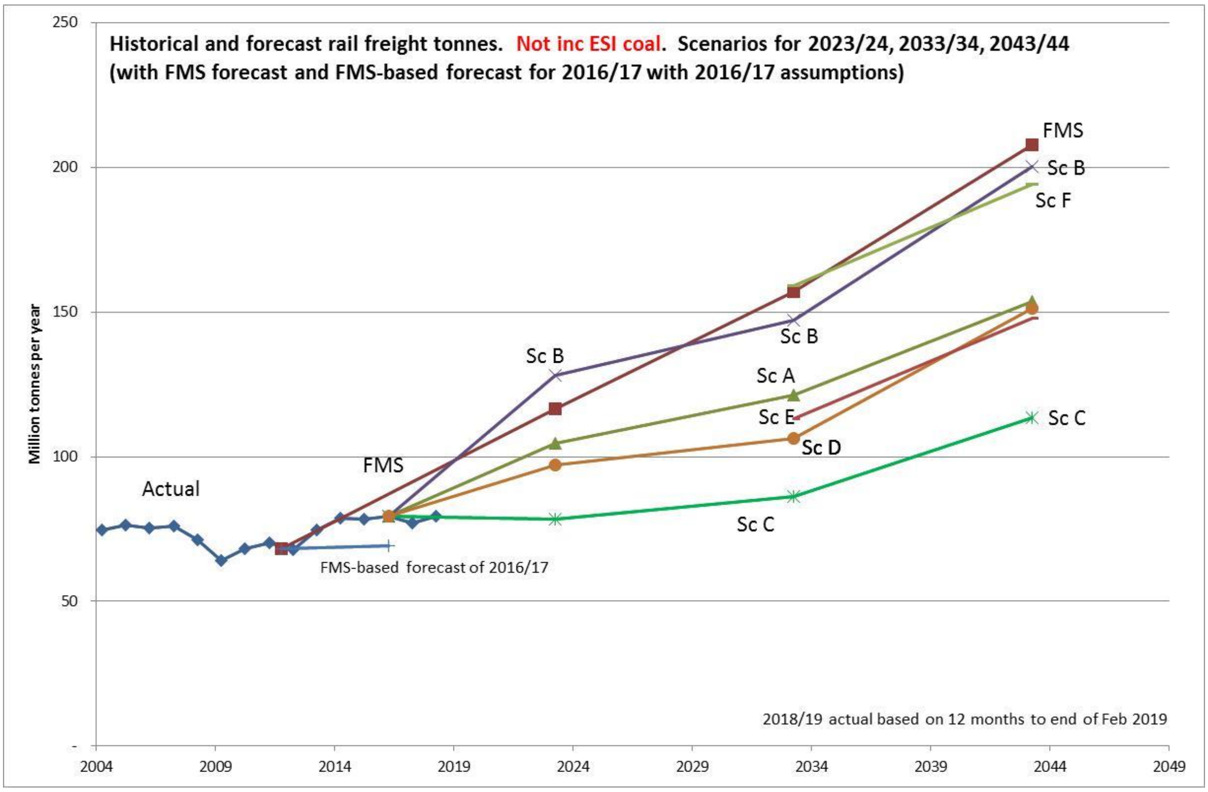
Note the "FMS-based forecast of 2016/17" line shows what a forecast of 2016/17 would have been (77 m tonnes) using

- the FMS base year (12 months to the end of September 2012)
- input assumptions that reflect the true outcome in 2016/17 (such as lower fuel prices)
- the forecasting methods used in the FMS

See our May 2018 report on 2023/24 forecasts for further details.

ESI (power station) coal has historically been a volatile commodity – and is no longer forecast to be carried by rail in these forecast scenarios. The graph below shows an equivalent graph but with ESI coal excluded. Note that the graph *does* include biomass, which reflects conversion of power stations from coal to biomass.

Figure 17



The FMS forecasts of 2013 were at the top end of the range of our new forecasts. Our new forecasts show:

- Lower growth in intermodal traffics due to the less favourable revised input assumptions for rail costs versus road costs (particularly lower fuel costs), and a lower extent to which we assume rail-served distribution parks will be developed.
- Lower biomass growth (the FMS had 14m tonnes)
- Higher construction materials growth due to a larger assumed growth in the overall market than previously forecast in the FMS

5. COMMENTARY ON FORECAST RESULTS

The results from the modelling of the 6 2033/34 and 2043/44 capacity-unconstrained scenarios demonstrate that differences in exogenous circumstances have a large effect on the rail freight industry. If the factors that *favour* rail come to pass with high market growth (scenario B), there will be overall significant growth of 133% by 2043/44, but if the factors that *disfavour* rail come to pass with low market growth (scenario C), there will be only an overall slight increase in rail freight tonnage of 1% to 2033/34 and of 32% to 2043/44. Unsurprisingly the result for the high market growth scenarios (scenarios B & D) show larger traffic volumes than their respective low market growth scenarios (scenarios A & C).

5.1 Coal & Biomass

ESI coal is eliminated as per the defined assumptions. Some of the large increases in "coal other" and biomass in scenarios B & D are due to commodity-specific defined input assumptions:

- growth at Drax with Lynemouth coming on-stream
- and the new planned coal flow from Cumbria to East Coast ports in Northern England.

5.2 Construction materials

Construction materials also had a defined assumption about market growth in the high-market-growth scenarios (in line with GDP: up 68.7% to 2043/44). However more than half of the construction materials growth in scenario B is due to the rail mode share increases resulting from the rail-favouring assumptions (increased fuel and wage costs and slightly longer trains).

In scenario C (disfavouring rail and low market growth) in 2033/34, the model results suggest that rail would lose some of its construction materials traffic due to the significant increase in variable track access charges (+130%). When producing results, the model implicitly assumes that a market equilibrium has been reached. However the present-day reality is that the industry is buying wagons and investing in infrastructure on the expectation of growth, and that track charges will probably not significantly increase further to this extent. This gives some stability to the market. Another factor not included in the modelling is that several super-quarries have planning restrictions on their road freight volumes, thus limiting the scope to which they could easily switch mode to road. Both of these factors suggest that if the assumptions in scenario C were to come to pass, the slight decline that the model suggests may not materialise in the real world.

Higher variable access charges in 2033/34 partly explain why there is a fall in construction materials volumes between 2023/24 and 2033/34 under scenario D (see tables 16 and 17). Another factor is that the uplift which was applied to the 2023/24 forecasts to reflect the impact of major infrastructure schemes was not applied in 2033/34 (or 2043/44).

5.3 Intermodal

Ports intermodal shows large growth for scenarios A & B due to the inland rail-served warehousing, high trade growth, increased fuel and wage costs, slightly longer trains and retention of MSRS grants. For scenario C, despite lower trade growth (+35% in 2033/34), lower fuel price growth, lower HGV drivers' wage growth, no change in train length, and removing MSRS, traffic is still up 60% (equivalent to 2.8% per year), helped by inland rail-served warehousing and increased fuel and wage costs.

The huge potential market for domestic non-bulk traffic is currently largely untapped by rail, starting from a very low base. Domestic intermodal follows a similar pattern to ports intermodal but is particularly boosted by the building of rail-served warehousing which removes the need for a local road haul between warehouse and terminal. The market can easily switch between road and rail and is highly price sensitive as shown by the large difference between the scenarios in 2043/44: +110% in scenario C and +1000% in scenario F where rail is particularly boosted by the charging of externalities to road and rail.

As with the construction sector, there may be some inertia in the intermodal market, with the industry taking some time to adjust, such that growth may take a few years to catch up with the potential traffic that the modelling suggests is available, particularly for scenarios A, B and F.

Scenario F is built on the central forecast (scenario E), with extra transport costs representing the internalisation of external costs. Following our MSB-based approach (see section 2.4), these extra costs would increase road costs much more than rail costs. This encourages further mode switch from road to rail: an extra 32% of total rail tonnes in 2043/44. For those highly elastic commodities which can easily switch between road and rail (such as intermodal containers), there is a larger switch to rail with an additional 65%.

5.4 Other commodities

The forecasts for sectors such as metals, ores and petroleum are relatively stable under all scenarios, compared with those for intermodal and construction materials, for example. This reflects the assumptions used for these scenarios as noted above (e.g. no major changes in the overall markets or modest (5%) reductions or increases). It is recognised that it is a possibility that some of these sectors may experience larger falls in overall markets, due to factors such as further declines in the steel industry (for the metals and ores sectors) and electrification / decarbonisation of road transport (for the petroleum sector). This, in turn, could lead to larger falls in these sectors than under scenarios A and C, for example. While this represents a downside risk for the forecasts, there is also an upside risk that the forecasts are too low because they do not include any forecasts for new markets – see below.

5.5 Potential new markets

There is concern about local air pollution, climate change and congestion on the roads, along with economic drivers such as increased fuel costs and drivers' wages making road more expensive. In this environment, there may be further opportunities for rail freight growth away from the traditional sectors.

With the combined socio-economic trends toward urban repopulation, same-day delivery and urban convenience grocery retail formats, demand for delivery of consumer goods into urban areas is growing. In parallel, concerns over urban air quality and road congestion are challenging established means of distribution; so too the loss of legacy urban distribution space to the very residential development fuelling population growth. Against such a backdrop promoters believe there is an opportunity for the development of a rail haul offer for consignments of consumer goods directly into urban centres for onward distribution by zero-carbon delivery vehicles.

Under such a scenario, lighter weight, higher speed (which on some routes would make pathing them amongst passenger trains easier), shuttle frequency freights services could link established national distribution facilities directly into urban logistics hubs developed on the railway estate or potentially exploit out of hours opportunities at major passenger termini.

Our existing freight model is not currently configured to forecast this sector, so this potential new market is not quantified in this report. However there may be scope to undertake some quantified modelling and analysis in future.

6. ASSIGNMENTS TO THE RAIL NETWORK

It can be easier to visualise the impact of these forecasts by assigning the base year and forecast traffic to the rail network. It is often more meaningful to describe the number of freight trains on each route, rather than the tonnage. In terms of capacity and timetabling, the number of hourly paths required on each route is often the most useful means of quantifying rail freight demand.

All freight trains using the network are assigned to the network for each of the 365 days separately in the base year 2016/17. For each individual train, the traffic is scaled up in line with the origin to destination by commodity tonnage forecasts. This ensures that for each train, the routing and the tonnes per train are maintained in the forecasts (i.e. base year routings are assumed to continue). In scenarios A & B, all base year traffics are subject to the 5% increased tonnage per train, so the number of trains required to carry the same cargo is scaled by 1.0/1.05.

The maps show the routes that the trains actually take in the base year; primary routes as well as timetabled secondary and diversionary routes. For example for trains from Southampton to the West Midlands and beyond, the main route is via Winchester with many trains, and the main diversionary route is via Laverstock junctions with just a handful of trains. For all commodities (excluding additional intermodal), because the base year assignments include the diversionary routes, these same diversionary routes are included in the forecasts.

The exception to this is for forecast ***additional*** intermodal traffic, because this is often to/from new sites for which there are no base year trains to scale up. For intermodal trains, the current average cargo tonnage per train is 507 tonnes.

By default routes for ***additional*** intermodal traffic are assumed to be along the shortest path between origin and destination sites, along a route with a loading gauge of at least W8 – for example Felixstowe to the West Midlands and North West is via Peterborough and Nuneaton, not London. Diversionary routes are not considered. However for various terminal to terminal flows, we have stipulated specific en-route 'via-points', to ensure that those routes are more realistic – with a preference for W10 routes; ***Additional*** intermodal traffic on the ECML is routed along the GN/GE route via Lincoln.

No active re-routings have been considered. For example ***existing*** trains on the East Coast Main Line (ECML) have NOT been diverted to the GN/GE route via Lincoln and ***existing*** trains using cross-London routes have NOT been diverted to the cross-country Felixstowe to Nuneaton route. We have not taken account of planned schemes such as East West Rail.

As the assignments are unconstrained forecasts of demand, the routings for all trains do not take into account any future timetabling / capacity issues etc. There is therefore the potential to re-route some of these forecast freight trains onto less congested routes where appropriate.

Once a freight train assignment has been made for each day in the base year and each forecast scenario and year, they can be averaged to give a daily average for each year. There are fewer freight trains on Saturdays, Sundays and on bank holidays, so to give a more representative picture of the typical weekday traffic volumes, all Saturdays, Sundays and bank holidays are discarded when calculating the daily average.

In the raw train movement data, each train route travelled is recorded as a series of en-route 'via-points' including the origin and destination. The network does not yet include every origin and destination location (Stanox) code in the network. Therefore some trains do not appear to start at the correct location on their branch line, and only appear at the first recognised junction. For example trains from Peak Forest Cemex in Derbyshire appear to start at Chinley East junction. The assignment maps are therefore best suited to quantifying traffic on main lines rather than branch lines.

Figures 18, 19 and 20 show daily trains (sum of both directions) for

- 2016/17
- 2033/34 scenario E (Central forecast)
- 2043/44 scenario E (Central forecast)

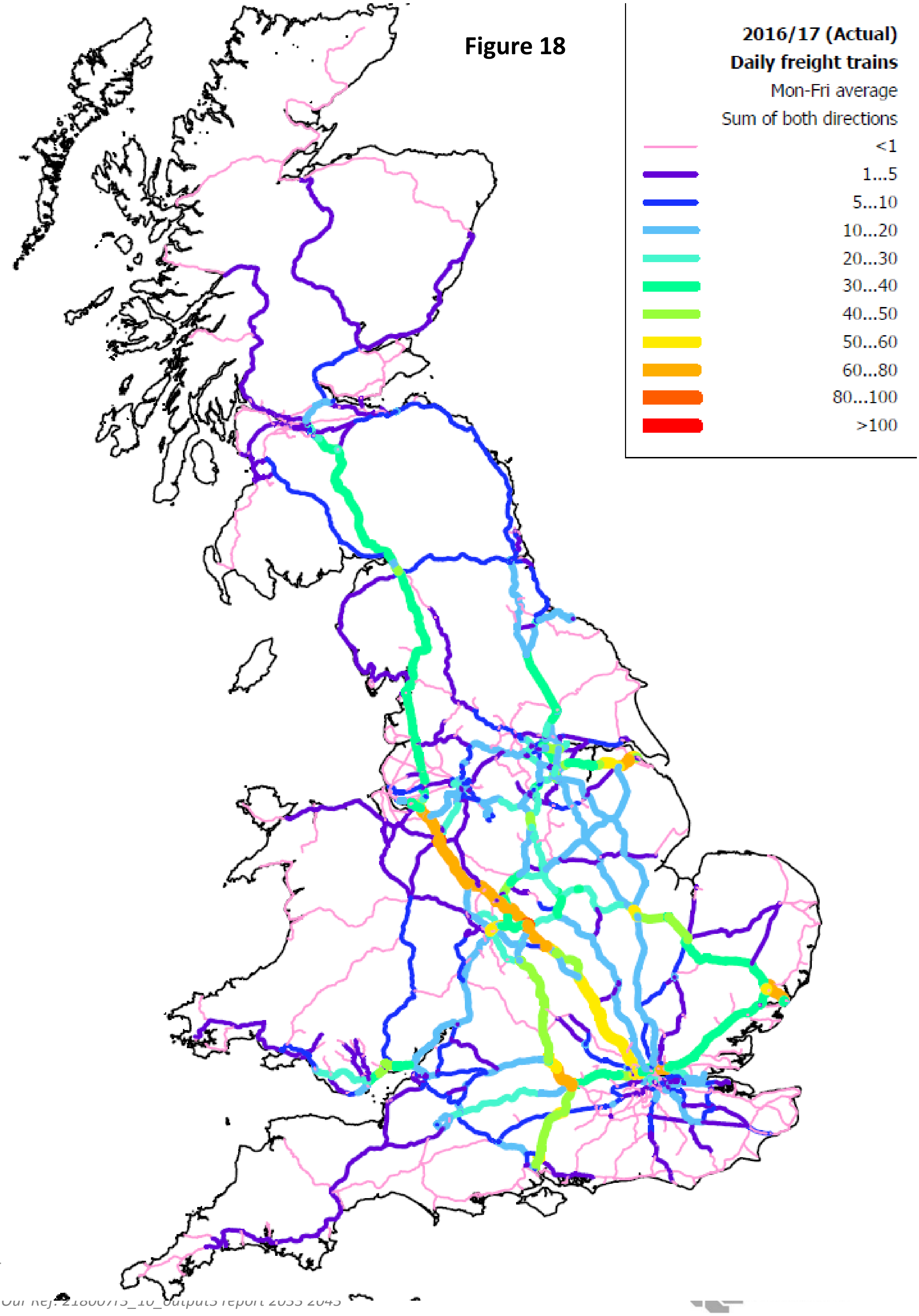


Figure 18
2016/17 (Actual)
Daily freight trains
Mon-Fri average
Sum of both directions
<1
1...5
5...10
10...20
20...30
30...40
40...50
50...60
60...80
80...100
>100

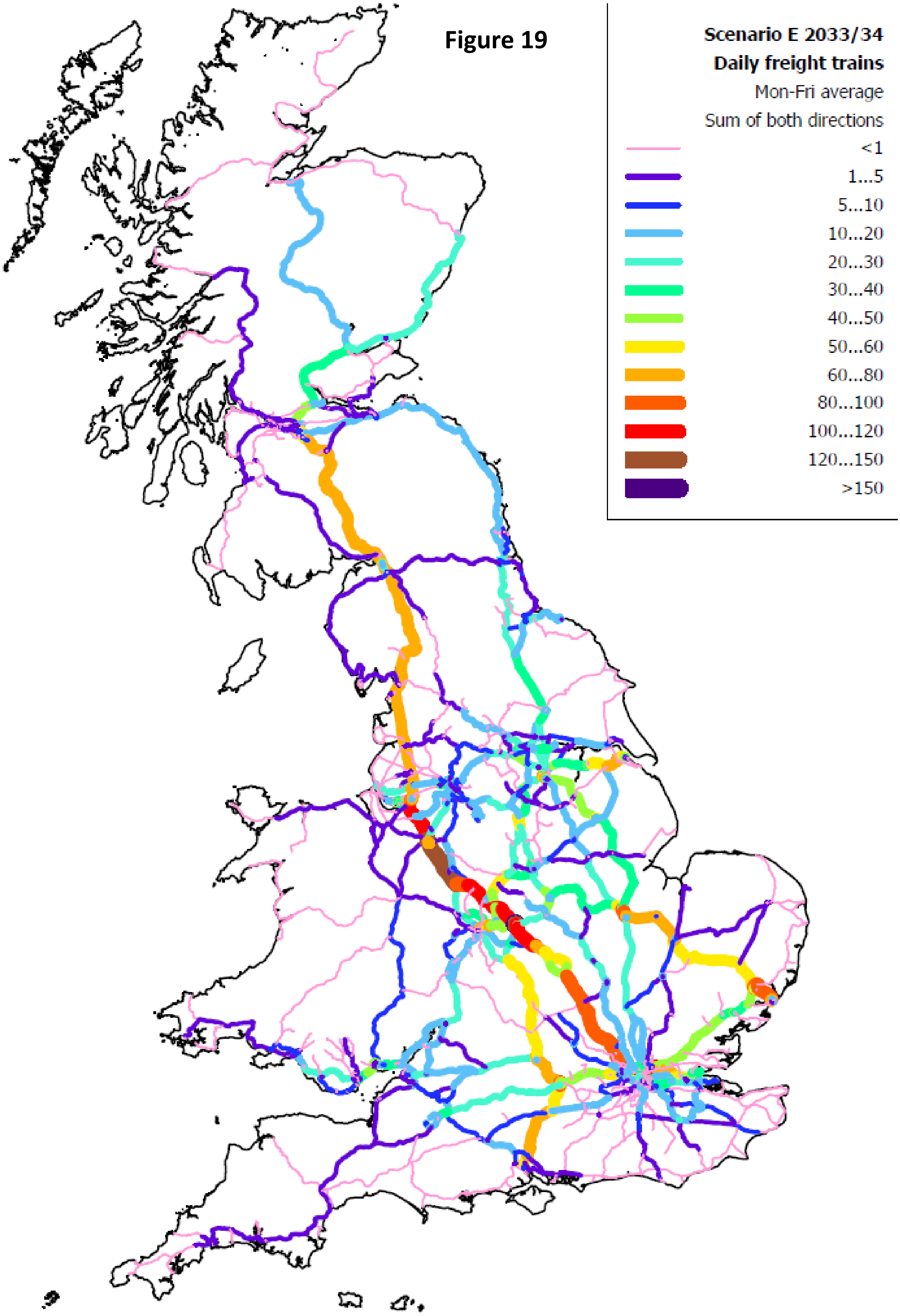
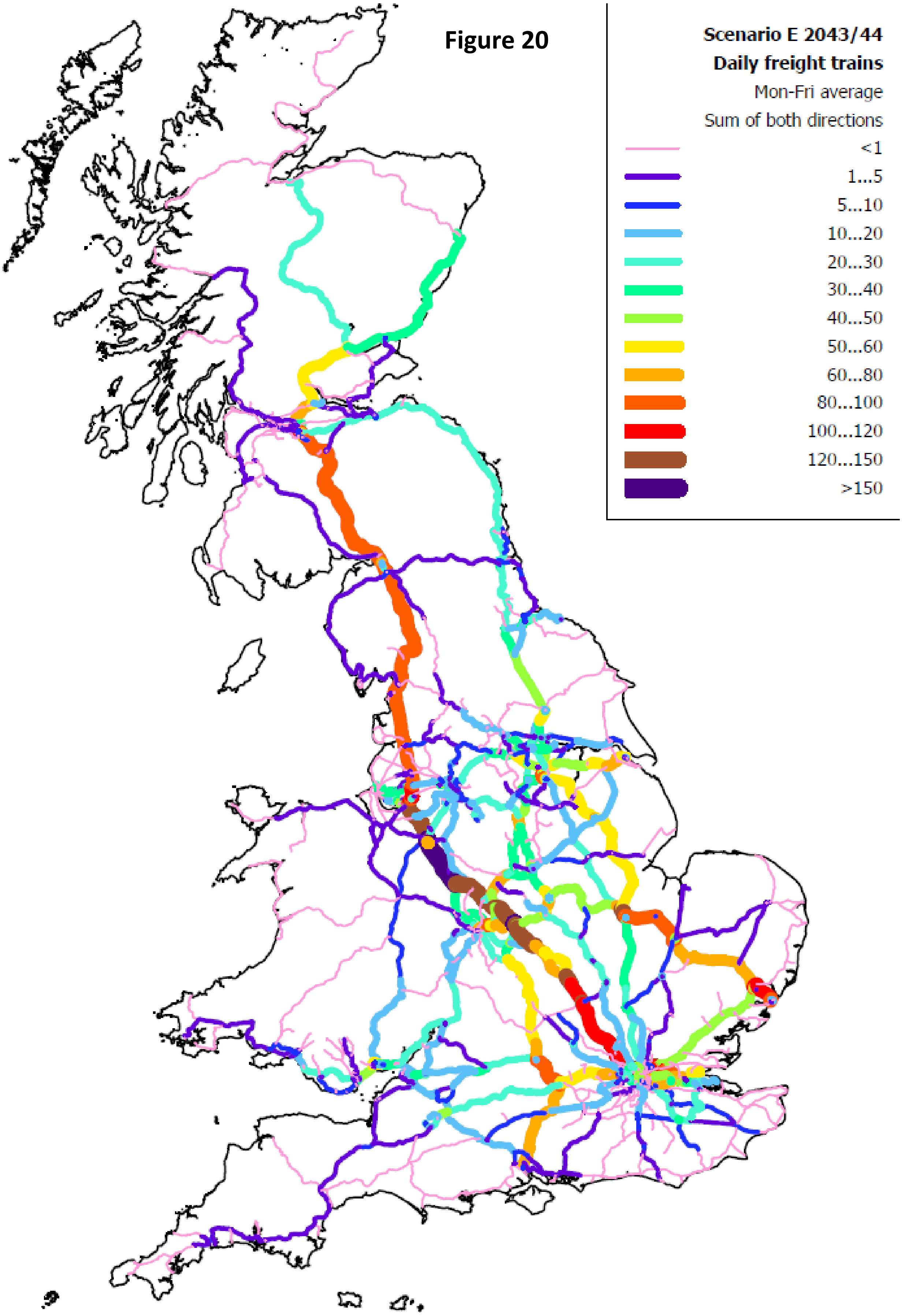


Figure 19
Scenario E 2033/34
Daily freight trains
Mon-Fri average
Sum of both directions
<1
1...5
5...10
10...20
20...30
30...40
40...50
50...60
60...80
80...100
100...120
120...150
>150

Figure 20



MDS Transmodal

7. RAIL MARKET SHARES

In the base year (2016/17) there were 1.4 billion tonnes lifted and 148 billion tonne kms by road (source: DfT's Continuing Survey of Road Goods Transport (CSRGT)[10]). Therefore the base year rail mode share is 5.7% by tonnes and 11% by tonne kms.

Road traffic data for individual commodities / sectors is not always available in a consistent way to enable a direct comparison of road versus rail traffics. For example it is difficult to precisely define a road equivalent for rail's "domestic intermodal", and road data does not distinguish between ESI (power station) coal and "other coal".

However an indication of the road traffic and therefore rail's mode shares is given below for each rail sector. For the base year this is based on the rail data and the DfT's CSRGT. For 2023/24, 2033/34 and 2043/44, the road data is scaled up/down using the sectoral market growths described in the assumptions.

Table 29: 2016/17. Million tonnes by road and rail by sector, and rail mode shares

Sector	Rail	Road	Total	Rail mode share	Notes
Automotive	0.4	39.0	39.4	1.1%	
Biomass	6.5	19.0	25.5	25%	1
Chemicals	0.9	47.0	47.9	1.9%	
Coal Other	2.0	6.0	8.0	25%	2
Construction materials (inc spoil)	24.3	323.0	347.3	7.0%	
Empty returns for containers carrying bulks	0.4	0.0	0.4	100%	3
NR Engineering	6.7	0.0	6.7	100%	
ESI Coal	6.3	0.0	6.3	100%	4
Industrial Minerals	1.3	4.0	5.3	25%	5
Channel Tunnel Intermodal	0.4	0.0	0.4	100%	
Domestic Intermodal	2.5	652.8	655.3	0.4%	6
Ports Intermodal	16.2	79.2	95.4	17%	7
Ores	4.3	0.0	4.3	100%	
Metals	7.4	43.0	50.4	15%	
Other	0.3	0.0	0.3	100%	8
Petroleum	4.7	42.0	46.7	10.1%	
Waste	1.2	171.0	172.2	0.7%	
Grand Total	**85.8**	**1,426**	**1,512**	**5.7%**	

[10] In March 2018 the DfT corrected their published CSRGT data from 2011 quarter 2 onwards; which resulted in a reduction of 24% in their reported total tonnes lifted by road in 2016. The revised figures are used in these tables – including correcting the 2023/24 table from the version in our May 2018 report.

Notes:

1. Road tonnes probably includes more than just biomass, so rail's mode share is probably understated
2. Some road coal may perhaps be to power stations
3. Not easy to find equivalent tonnage in road data
4. Some road coal may perhaps be to power stations, so the true rail share may be slightly lower than 100%
5. Difficult to define consistently with road data
6. Assumed to be the non-bulk cargoes, although difficult to consistently define for road
7. Road deduced from DfT's Port Freight Statistics minus transhipment and rail traffic. For Tonne km mode share, average length of haul for road is calculated based on adjusted CSRGT data
8. Difficult to define consistently

Table 30: Rail mode shares for the base year and 2023/24 scenarios. Tonnes

		2023/24					
Sector	*2016/17*	*A2*	*B2*	*C2*	*D2*	*A3*	*B3*
Automotive	*1.1%*	*1.2%*	*1.4%*	*1.2%*	*1.3%*	*1.2%*	*1.1%*
Biomass	*25%*	*31%*	*41%*	*31%*	*41%*	*31%*	*40%*
Chemicals	*1.9%*	*2.1%*	*2.1%*	*1.9%*	*1.9%*	*2.0%*	*2.0%*
Coal Other	*25%*	*25%*	*39%*	*25%*	*39%*	*25%*	*39%*
Construction materials (inc spoil)	*7.0%*	*9.1%*	*11%*	*6.3%*	*7.6%*	*8.9%*	*11%*
Empty returns for containers carrying bulks	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
NR Engineering	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
ESI Coal	*100%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Industrial Minerals	*25%*	*31%*	*31%*	*23%*	*23%*	*31%*	*31%*
Channel Tunnel Intermodal	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Domestic Intermodal	*0.4%*	*1.2%*	*1.2%*	*0.5%*	*0.5%*	*1.1%*	*1.1%*
Ports Intermodal	*17%*	*23%*	*23%*	*15%*	*15%*	*21%*	*19%*
Ores	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Metals	*15%*	*17%*	*17%*	*15%*	*15%*	*17%*	*17%*
Other	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*
Petroleum	*10%*	*11%*	*11%*	*10%*	*10%*	*11%*	*11%*
Waste	*0.7%*	*0.7%*	*0.7%*	*0.7%*	*0.7%*	*0.7%*	*0.7%*
Grand Total	***5.7%***	***6.7%***	***7.5%***	***5.1%***	***5.7%***	***6.5%***	***7.0%***

Note: For derivation of 2016/17 figures, see table 29.

Table 31: Rail mode shares for the base year and 2033/34 scenarios. Tonnes

		2033/34					
Sector	2016/17	A	B	C	D	E	F
Automotive	1.1%	1.3%	1.3%	1.2%	1.2%	1.2%	1.4%
Biomass	25%	21%	35%	21%	35%	28%	28%
Chemicals	1.9%	2.1%	2.1%	1.9%	1.9%	2.0%	2.3%
Coal Other	25%	25%	39%	25%	39%	25%	25%
Construction materials (inc spoil)	7.0%	9.7%	9.7%	6.1%	6.1%	8.5%	12.1%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	25%	32%	32%	23%	23%	28%	35%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	0.4%	1.4%	1.4%	0.5%	0.5%	0.8%	2.3%
Ports Intermodal	17%	30%	29%	20%	19%	23%	35%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	15%	18%	18%	15%	15%	17%	18%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	10%	11%	11%	10%	10%	11%	12%
Waste	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Grand Total	**5.7%**	**7.5%**	**7.6%**	**5.4%**	**5.5%**	**6.4%**	**9.0%**

Note: For derivation of 2016/17 figures, see table 29

Table 32: Rail mode shares for the base year and 2043/44 scenarios. Tonnes

		2043/44					
Sector	2016/17	A	B	C	D	E	F
Automotive	1.1%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%
Biomass	25%	21%	35%	21%	35%	28%	28%
Chemicals	1.9%	2.2%	2.2%	2.0%	2.0%	2.1%	2.3%
Coal Other	25%	25%	39%	25%	39%	25%	25%
Construction materials (inc spoil)	7.0%	12%	12%	10%	10%	11%	13%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	25%	35%	35%	29%	29%	32%	36%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	0.4%	2.3%	2.1%	0.7%	0.8%	1.2%	3.0%
Ports Intermodal	17%	34%	33%	23%	23%	26%	38%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	15%	18%	18%	17%	17%	18%	19%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	10%	11%	11%	11%	11%	11%	12%
Waste	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Grand Total	**5.7%**	**9.2%**	**8.7%**	**6.8%**	**6.6%**	**7.4%**	**9.8%**

Note: For derivation of 2016/17 figures, see table 29

Table 33: 2016/17. Billion tonne kilometres by road and rail by sector, and rail mode shares

Sector	Rail	Road	Total	Rail mode share
Automotive	0.1	5.2	5.3	2.7%
Biomass	0.9	2.1	3.0	29%
Chemicals	0.1	6.4	6.5	2.2%
Coal Other	0.3	0.6	0.9	31%
Construction materials (inc spoil)	4.3	21.6	25.9	17%
Empty returns for containers carrying bulks	0.1	0.0	0.1	100%
NR Engineering	1.7	0.0	1.7	100%
ESI Coal	1.2	0.0	1.2	100%
Industrial Minerals	0.2	0.3	0.6	41%
Channel Tunnel Intermodal	0.1	0.0	0.1	100%
Domestic Intermodal	1.1	75.6	76.8	1.5%
Ports Intermodal	5.6	15.7	21.4	26%
Ores	0.2	0.0	0.2	100%
Metals	1.6	5.1	6.7	24%
Other	0.1	0.0	0.1	100%
Petroleum	1.1	4.0	5.1	22%
Waste	0.2	10.9	11.1	1.9%
Grand Total	**19.0**	**147.5**	**166.5**	**11%**

See notes to above table "2016/17. Million tonnes by road and rail by sector, and rail mode shares"

Table 34: Rail mode shares for the base year and 2023/24 scenarios. Tonne Kilometres

		2023/24					
Sector	*2016/17*	*A2*	*B2*	*C2*	*D2*	*A3*	*B3*
Automotive	2.7%	2.9%	3.2%	2.8%	3.1%	2.7%	2.6%
Biomass	29%	34%	45%	34%	45%	34%	44%
Chemicals	2.2%	2.4%	2.4%	2.2%	2.2%	2.4%	2.3%
Coal Other	31%	31%	69%	31%	69%	31%	69%
Construction materials (inc spoil)	17%	19%	23%	15%	18%	19%	22%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	41%	48%	48%	39%	39%	48%	47%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	1.5%	4.3%	4.3%	1.9%	1.9%	4.2%	4.0%
Ports Intermodal	26%	35%	35%	23%	23%	32%	28%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	24%	27%	27%	23%	23%	27%	27%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	22%	24%	24%	22%	22%	24%	24%
Waste	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
Grand Total	**11%**	**14%**	**15%**	**10%**	**11%**	**13%**	**14%**

Note: For derivation of 2016/17 figures, see table 33

Table 35: Rail mode shares for the base year and 2033/34 scenarios. Tonne Kilometres

		2033/34					
Sector	2016/17	A	B	C	D	E	F
Automotive	2.7%	3.0%	3.0%	2.9%	2.9%	2.9%	3.3%
Biomass	29%	23%	38%	23%	38%	31%	31%
Chemicals	2.2%	2.5%	2.5%	2.2%	2.2%	2.4%	2.7%
Coal Other	31%	31%	69%	31%	69%	31%	31%
Construction materials (inc spoil)	17%	20%	20%	14%	14%	18%	23%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	41%	50%	50%	40%	40%	46%	53%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	1.5%	4.9%	5.0%	1.7%	1.8%	2.7%	9.0%
Ports Intermodal	26%	51%	49%	34%	34%	40%	59%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	24%	28%	28%	23%	23%	26%	28%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	22%	24%	24%	23%	23%	23%	25%
Waste	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
Grand Total	**11%**	**17%**	**17%**	**12%**	**12%**	**14%**	**21%**

Note: For derivation of 2016/17 figures, see table 33

Table 36: Rail mode shares for the base year and 2043/44 scenarios. Tonne Kilometres

		2043/44					
Sector	2016/17	A	B	C	D	E	F
Automotive	2.7%	3.1%	3.1%	3.0%	3.0%	3.0%	3.3%
Biomass	29%	23%	38%	23%	38%	31%	31%
Chemicals	2.2%	2.6%	2.6%	2.4%	2.4%	2.5%	2.7%
Coal Other	31%	31%	69%	31%	69%	31%	31%
Construction materials (inc spoil)	17%	23%	23%	18%	18%	21%	24%
Empty returns for containers carrying bulks	100%	100%	100%	100%	100%	100%	100%
NR Engineering	100%	100%	100%	100%	100%	100%	100%
ESI Coal	100%	0%	0%	0%	0%	0%	0%
Industrial Minerals	41%	56%	56%	47%	47%	51%	56%
Channel Tunnel Intermodal	100%	100%	100%	100%	100%	100%	100%
Domestic Intermodal	1.5%	7.4%	7.4%	2.5%	2.9%	4.2%	11.1%
Ports Intermodal	26%	57%	56%	40%	41%	46%	64%
Ores	100%	100%	100%	100%	100%	100%	100%
Metals	24%	29%	29%	25%	25%	27%	29%
Other	100%	100%	100%	100%	100%	100%	100%
Petroleum	22%	24%	24%	23%	23%	24%	25%
Waste	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
Grand Total	**11%**	**21%**	**20%**	**15%**	**14%**	**17%**	**24%**

Note: For derivation of 2016/17 figures, see table 33

8. SENSITIVITY TEST G: A "EUROPEAN GAUGE" FREIGHT ROUTE

"European gauge" is taken to be a sufficiently generous loading gauge that would allow larger wagons to be carried including "Piggyback": HGV trailers on rail wagons – which cannot normally be accommodated on the British rail network.

We have tested an indicative concept of a European gauge route rather than a specific new route, connecting the end of the Channel Tunnel Rail Link (CTRL) in East London via North London, the East Midlands, South Yorkshire, Southwest Manchester, Carlisle and Glasgow, linking to Thames and Humber ports.

Being a dedicated freight route potentially means that longer, heavier trains could be carried, with a faster end-to-end journey time because they would not need to wait in passing loops for timetabled slots between passenger trains on the classic network. Rail unit costs would be reduced because assets would be used more intensively.

This route would have the capacity to cater for likely demand. This additional capacity would be for the benefit of both freight trains using the route and for passenger trains because there would be fewer freight trains to have to share the existing routes with.

We have tested four distinct markets for a potential European gauge freight route – building on the 2043/44 high market growth, favouring rail scenario (scenario B):

- International piggyback (HGV trailers on rail wagons) through the Channel tunnel and to/from ports (Thames and Humber). These are modelled as equivalent to inland extensions of unaccompanied ferry services to/from the continent – to inland terminals in East London, West London, Leicestershire, South Yorkshire, Greater Manchester and the Scottish Central Belt
- Domestic piggyback - directly diverting HGVs off the road network. These are modelled with just the HGV trailers carried by rail: i.e. not the HGV cab with driver, because this would involve the weight of the cab being carried around unnecessarily, and the driver's time during transit. This is similar to existing intermodal rail services where there needs to be a local road haul at each end to transfer the cargo from the original origin to the origin rail terminal, and then from the destination rail terminal to the final destination.
- Rail journeys that operate solely on the freight route with the opportunity for longer, heavier, higher-gauge trains. This was modelled by assuming 50% longer trains (instead of 5% longer) and 80kph instead of 50kph average speeds.
- Existing non-Piggyback Channel Tunnel type services but with longer, heavier, higher-gauge trains. As above, this was modelled by assuming 50% longer trains (instead of 5% longer) and 80kph instead of 50kph average speeds

The various markets are forecast to attract the following tonnes:

Table 37: European gauge freight route potential market. Thousand tonnes per year

Sector	Thousand Tonnes
Piggyback Humber ports	4,990
Piggyback Thames ports	4,297
Piggyback Channel Tunnel	1,036
Piggyback Domestic	8,880
Non-Piggyback Channel Tunnel	4,079
Solely on freight route	10,210
Total	**33,492**

If we were to assume the current average cargo tonnes per train (577 tonnes), along with 260 operational days per year, and an average of 18 operational hours per day (see sections 2.5 & 2.6), this annual tonnage would equate to 223 trains per day or 12 trains per hour on the route. However these train counts would probably be slightly lower because of the potential for higher tonnes per train along the route meaning slightly fewer trains are required to carry the same tonnage.

The availability of these new transport offerings to the market would detract from "classic" rail's market – reducing it by 11.7 million tonnes. The net additional rail freight traffic would therefore be 21.8 million tonnes per year.

Some "classic" rail freight traffic is also likely to divert onto the route for part of its journey. Because some of its journey would be on the classic network, the trains would not be able to be longer, heavier, higher-gauge trains, so there would be unlikely to be significant user cost savings. However the principal benefit of switching these trains to the freight route may be to relieve capacity.

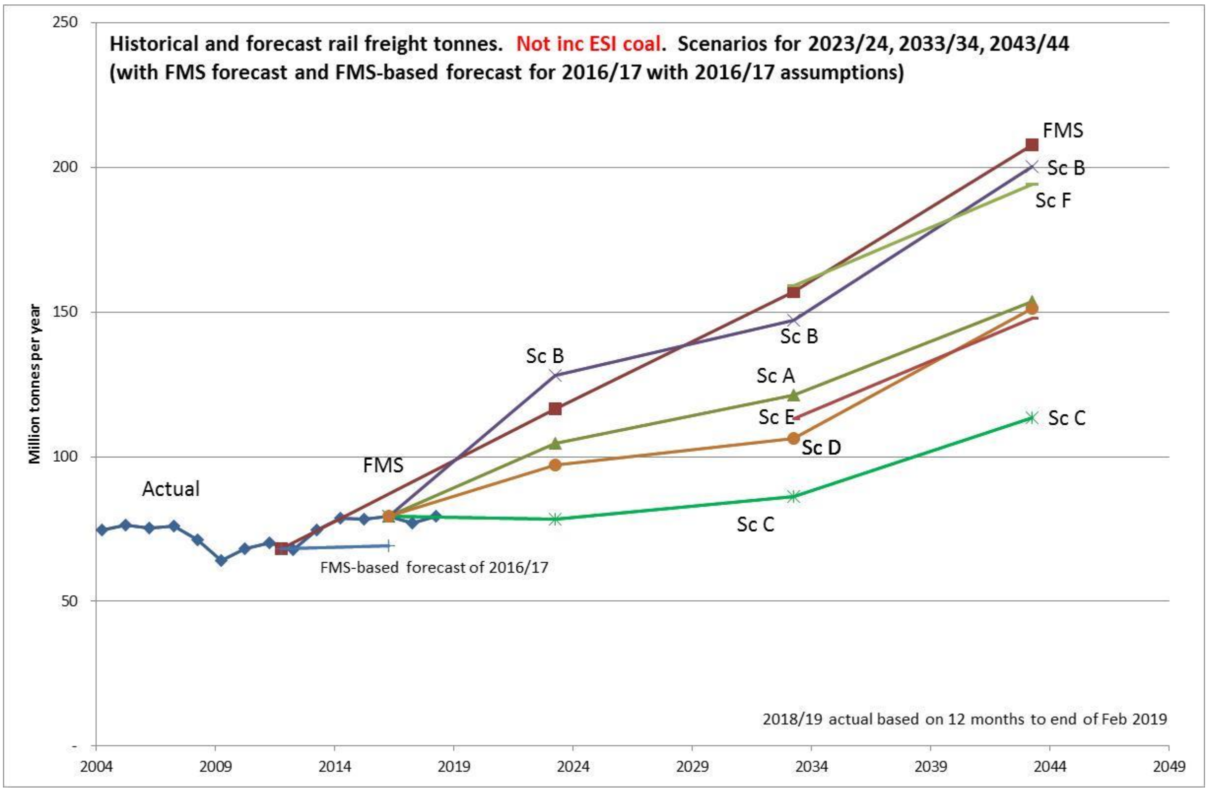
9. CONCLUSION

This report describes rail freight forecast demand results for 4 different 2023/24 scenarios (taken from our May 2018 report on 2023/24 forecasts), 6 2033/34 scenarios and 6 2043/44 scenarios spanning factors favouring rail to factors disfavouring rail, and low market growth to high market growth with scenario F representing internalisation of external costs. These are presented in terms of tonnes, tonne kms, daily trains and hourly paths required. Sensitivity test G (European gauge freight route) is also presented.

The rail-favouring scenarios (A, B and F) show significant growth in demand across the network. However in reality there are likely to be capacity constraints at some locations. We have not conducted any capacity constraint for 2033/34 and 2043/44 for this study.

ESI (power station) coal has historically been a volatile commodity – and is no longer forecast to be carried by rail in these forecast scenarios. The graph below show how the new scenarios compare with the FMS forecasts, along with the historical traffics from 2004/05 but with ESI coal excluded.

Figure 21



The FMS forecasts of 2013 were at the top end of the range of our new forecasts. Our new forecasts show:

- Lower growth in intermodal traffics due to the less favourable revised input assumptions for rail costs versus road costs, and a lower extent to which we assume rail-served distribution parks will be developed.
- Lower biomass growth (the FMS had 14m tonnes)
- Higher construction materials growth due to a larger assumed growth in the overall market than previously forecast

The report describes the assumptions and methods for the various sectors, along with a market share analysis.

These forecasts demonstrate that differences in exogenous circumstances can have a large impact on the rail freight industry, with the total 2043/44 forecast rail freight tonnage ranging from 114 million tonnes in scenario C to 200 million tonnes in scenario B. Scenario E (central scenario) results in 148 million tonnes in 2043/44. This is equivalent to a 2.0% growth per year from 2016/17, or a 2.3% growth per year if ESI coal is excluded.

Fuel prices in particular impact on rail's ability to compete with road – with high fuel prices adversely affecting road more than rail, thus encouraging a switch from road to rail. Drivers' wages are also important, as is the development of rail-served warehousing for domestic intermodal traffic.

It should be noted that the model implicitly includes the assumption that the market will have fully adapted to the market conditions input into the model. However in the real world, many of the investments in assets are long-term – which gives the rail freight sector some inertia. The market is therefore unlikely to have fully adapted to very different conditions over a 7 year period to 2023/24, although in the longer term, if the market players foresee the changes we have assumed (such as increased availability of rail served warehousing sites, higher fuel and drivers' wage costs) and believe that rail capacity will be available to justify the necessary investments, the market should be able to adapt in the long term.