UK Rail Freight and Emissions

Overview

- The rail sector has a critical role in decarbonising freight transport because it is less carbon intensive than roadway freight
- Expansion of rail coverage and freight sidings are necessary to meet freight industry needs
- Rail electrification is necessary to reduce air pollutant emissions and improve network capacity and performance
- High-speed freight trains can capture new markets for distributing time-critical and low-volume high-value goods

Introduction

Freight transport (movement of goods and bulk cargo) plays a fundamental role in supporting supply chains both domestically and internationally. The strategic importance of the UK freight sector was signified by the inclusion of logistics workers as "key workers" during the COVID-19 pandemic [1]. International freight is also vital for the UK economy which is highly reliant on international trade; the trade-to-GDP ratio stood at 55% during the year 2021 [2]. To achieve the UK's net zero target, the inland freight sector will need to rapidly decarbonise, including modal shift from road to rail and harnessing advances in new technology. This policy briefing note outlines the status of rail freight in the UK, considering benefits of a modal shift from road to rail. It also identifies future interventions that could decarbonise the UK's freight sector by 2050, with benefits for health and wider society.

Background

UK inland freight is primarily served by roadways (77% of total tonne-kilometres), waterways (14%) and railways (9%), in contrast to international freight that is overwhelmingly served by shipping (93.5%) followed by railways (6%) and aviation (0.5%) [3]. Moving freight by road is typically associated with higher external costs than by rail [4]. There are major environmental, societal, and public health benefits arising from diverting UK inland freight from roadways to railways. Successive UK governments have attempted to encourage a modal shift of freight towards railways by the means of grants to haulage firms [5]. However, the UK still lags behind EU countries in terms of proportion of freight moved by rail: only 9% of freight is moved by rail in the UK compared to the EU average of 17% [6].

Rail Freight in the UK

In 2020, 176.3 billion tonne-kilometres of freight were moved within Great Britain of which only 15.2 billion tonne-kilometres were moved by rail [7]. There are currently no rail freight services in Northern Ireland, but a revival of services is likely to be considered as a result of the "All Island Strategic Rail Review" [8].

The magnitude of tonne-kilometres moved by domestic rail has been declining from a peak of

22 billion tonne-kilometres in 2014, down to the 15.2 billion tonne-kilometres in 2020 during the COVID-19 pandemic [9],[10]. In 2021, rail freight recovered to pre-pandemic levels of 16.8 billion tonne-kilometres.

This downward trend has been primarily caused by a sharp drop in volumes of transported coal due to the widespread decommissioning of coal powerplants. Moreover, volumes of iron ore moved have been steadily reducing over the same period due to a downturn in British steel production [11]. However, simultaneously, other commodities have been increasingly moved by rail such as construction aggregate, cement, and domestic intermodal containers [9].

Benefits of Rail Freight

Freight Decarbonisation

The UK has a legally binding net zero target for 2050 [12]. Transport is the leading contributor to UK carbon emissions, responsible for 27% of total Greenhouse Gas (GHG) emissions. On-road heavy goods vehicles (HGVs) and vans each account for 16% of transport's emissions [13]. HGVs are crucial for long-distance roadway freight transport due to their high carrying capacity, whereas smaller vans are better suited for smaller freight loads and 'last-mile' deliveries.

Abating HGV emissions has proven challenging due to technical limitations and cost concerns; electric and fuel cell vehicles could offer a roadmap to decarbonise HGVs, however adoption and scalability remains uncertain [14]. Failing to effectively address this issue through new technology, improved efficiency measures and relevant policies will risk the net zero targets.

In contrast to moving freight by roads, moving freight by rail can already be done at a large-scale with a low-carbon cost using incumbent technology. Trains are more energy efficient for moving cargo than HGVs because the steel wheels of trains induce less friction than rubber HGV tyres. On average, trains emit 76% less carbon than HGVs for every tonne of freight moved [15]. Moreover, the higher energy efficiency of trains can reduce operational costs; the consultancy firm Deloitte estimated that logistics companies which used rail in 2018/2019 had operational cost savings of £1.65 Bn [16].

External Costs

External costs are those borne by wider society and the environment but are not paid or compensated for by the freight company or customer. Examples include lost productivity due to road congestion; financial losses and casualties caused by collisions; public health and climate impacts of pollutant and greenhouse gas emissions; noise pollution; loss of natural habitat due to infrastructure construction and infrastructure maintenance costs [17].

Both roadways and railways inflict external costs, but roadways are responsible for higher costs [4]. For instance, noise from railways is perceived as less intrusive than noise pollution from roadways, even at the same noise level [18]. It is estimated that rail removed the equivalent of seven million lorry journeys during the year 2018/2019 leading to safety and road congestion cost savings of around £800 million [16].

An academic report published in 2007 found that vehicle excise duty and fuel duty paid by British-registered HGVs covered only 67% of the corresponding external costs, with congestion dominating all costs at 40% [19].

HGV Driver Shortages

The UK has long faced a shortage of HGV drivers, resulting in supply chain disruption in November 2021 [20]. The government has attempted to streamline driver certification to stimulate driver hiring [21], though this chronic shortage is primarily attributed to a low rate of workforce retention. A study from Ireland found that low renumeration, poor working conditions and inadequate well-being support were amongst the leading causes of driver dissatisfaction [22].

Shifting inland freight from road to rail can help reduce disruptions caused by HGV driver shortages, as a single freight train can replace up to 76 HGVs [23].

Case Study

The British supermarket, Tesco, commenced a refrigerated goods rail service between Tilbury and Coatbridge in 2021 [50]. The 400-mile journey is served by two trains a day, each replacing 40 HGV journeys and saving 9,000 tonnes of CO_2e/year. The train is hauled by the bi-mode Class 88 locomotive which can be powered by electricity when overhead catenary is available and by diesel when unavailable [51]. It is particularly noteworthy that this service starts at the Tilbury2 rail terminal which was opened in 2020.

Future Outlook

Rail Connectivity and Capacity

In recognition of the societal benefits behind transferring freight traffic from road to rail, the Mode Shift Revenue Support (MSRS) Scheme offers companies financial grants to move bulk cargo and goods by rail within Great Britain [24]. The grant pricing is based on the disparity of external costs between the two modes. Nonetheless, the grant can be inadequate if a rail terminal is not located near the origin and destination points. For instance, research into the transport of construction aggregate in England and Wales found such schemes to only increase rail utilisation by only a few percentage points due to the lack of rail sidings and loading terminals onsite at many quarries and end-customer locations [25]. Using HGVs to bridge these gaps to rail terminal locations was often more expensive than relying on HGVs for the entire journey due to the accumulation of fixed costs from different modes. This underlines the importance of connecting more industrial sites to the rail network. Due to the limited direct connectivity of quarries to the rail network, it was found that upgrading rigid aggregate lorries to longer and newer articulated lorries would abate substantially more carbon emissions than the modal shift anticipated by current grant schemes. Longer lorries however are known to be a major concern for road safety, particularly in urban settings [26].

To meet these industrial sector requirements there is an urgent need to construct new rail lines and recommission some retired lines [27],[28]. This will not only increase rail network coverage but also opportunities for diverting rail traffic during network disturbances and therefore improve the punctuality of rail services. The relative abundance of road network coverage compared to rail, enables HGVs to avoid road obstructions, which enables road hauliers to serve time-sensitive goods [29],[30]. Moreover, rail freight in Great Britain can seldom compete with road distribution for time-sensitive goods because passenger rail services are given passage priority; the punctuality of rail freight services improved during the COVID-19 pandemic due to a drop in passenger services [10].

Rail capacity upgrades are also needed to improve utilisation of the existing network, for example freight slots through the Channel Tunnel remain largely underutilised due to the heavily congested West Coast Main Line [31]. To this end, the HS2 project is anticipated to free up freight capacity for the West Coast Main Line by displacing high-speed passenger traffic [29].

High-Speed Freight

The current state of rail freight is best suited to high-volume cargo flows, with regards to achieving profitable operation. Moreover, railway timetabling is relatively inflexible when compared to HGV usage, which makes the latter more suitable for fluctuating cargo volumes. To remedy this shortcoming, some companies attempt to combine their cargo to achieve a train's minimum load, though this is limited by their geographical proximity and potential conflicts of interest [32]. More frequent high-speed freight trains which carry a smaller load per journey would be more suitable for low-volume and time-sensitive cargos. Though high-speed freight trains are expected to be more expensive than lorries which makes them better suited for high-value cargo goods [33].

Reducing Rail Emissions

Average HGV exhaust emissions have considerably dropped since the early 1990s due to the tightening of European road emission regulations; a trend that is expected to continue [34]. Furthermore, all new HGV sales in the UK after the year 2040 are expected to be zero tailpipe (exhaust) emission vehicles [35].

Railway exhaust emissions have also been tightened under non-road mobile machinery (NRMM) regulations [36], albeit at a slower rate compared to road vehicles [37]. Newer stricter NRMM regulations do not apply onto older diesel trains which currently make up the majority of the UK's freight rolling stock. The rail sector requires accelerated efforts to decarbonise and reduce pollutant emissions. Indeed, a study from the USA has shown that newer HGVs emit only marginally more black carbon than older diesel trains per unit cargo moved [38].

In 2021 Network Rail published its Traction Decarbonisation Strategy [39] which clearly prioritises phasing out diesel trains and expanding network electrification. 'Zero-emission' fuel alternatives such as hydrogen could play a role in the future but are as yet limited in terms of driving range and tonnage [40].

In addition to decarbonisation, replacing diesel propulsion with electrification has the added benefit of faster and higher tonnage freight trains. This would improve network capacity and reduce passage conflicts with passenger trains. Moreover, phasing out diesel would improve working conditions for rail workers, as diesel exhaust fumes are known to be carcinogenic and harmful for human health [41].

Freight trains also emit non-exhaust emissions during operation which (unlike exhaust emissions) remain unregulated [42]. An emission source common amongst all trains is that of mechanical brake particulates [43]; however, its extent is less severe in trains with dynamic braking or electric trains equipped with regenerative braking. Brake dust collection devices were previously proposed to address this issue but have not been implemented [44].

Cargo transported on-board a freight train is also a potential source of non-exhaust emissions. Dry and loose cargo can be exposed to the wind during motion, generating free particle emissions into the surroundings. Hopper wagons that carry coal [45] as well as iron ore, construction aggregate and gravel [46] are amongst the main concern in this regard. Mitigation measures include altering the top loading profile of the cargo to an aerodynamic shape and spraying dust suppressant on top after loading the cargo [47]. However, these measures alone fail to completely eliminate emissions.

Digital Automatic Coupling

Currently freight wagons are coupled and checked manually prior to dispatch in rail marshalling yards which entails a person physically walking along the train. Digital automatic coupling (DAC) promises to automate much of this process which would reduce preparation time and the need for manual labour [48]. Research has found that DAC can play a role in increasing rail's market freight share due to an improvement in operational costs and line capacity [49].

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References

[1] G. Wilson, "COVID-19: UK Logistics workers classed as 'key workers'," SupplyChain, 17 May 2020. [Online]. Available: https://supplychaindigital.com/logistics/covid-19-uk-logistics-workers-classed-key-workers. [Accessed 12 August 2022].

[2] "Trade (%of GDP) - United Kingdom," The World Bank, [Online]. Available: https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS?locations=GB. [Accessed 12 August 2022].

[3] Department for Transport, "Transport Statistics Great Britain: 2021," GOV.UK, 16 December 2021. [Online]. Available: https://www.gov.uk/government/statistics/transport-statistics-great-britain-2021/transport-statistics-great-britain-2021. [Accessed 10 September 2022].

[4] D. J.Forkenbrock, "Comparison of external costs of rail and truck freight transportation," Transportation Research Part A: Policy and Practice, vol. 35, no. 4, pp. 321-337, 2001.

[5] Department for Transport, "Mode shift benefit values," Department for Transport, 28 January 2022. [Online]. Available: https://www.gov.uk/government/publications/freight-mode-shift-benefit-values-technical-report-an-update/mode-shift-benefit-values-update. [Accessed 18 August 2022].

[6] eurostat, "Modal split of freight transport," eurostat, 4 April 2022. [Online]. Available: https://ec.europa.eu/eurostat/databrowser/view/tran_hv_frmod/default/table?lang=en. [Accessed 17 September 2022].

[7] Office of Rail and Road, "Table 1350 - Rail freight market share," 9 June 2022. [Online]. Available: https://dataportal.orr.gov.uk/statistics/usage/freight-rail-usage-and-performance/table-1350-rail-freight-market-share/. [Accessed 13 August 2022].

[8] Department for Infrastructure, "All Island Strategic Rail Review - Consultation Document," November 2021. [Online]. Available: https://www.infrastructure-ni.gov.uk/consultations/consultation-paper-all-island-strategic-rail-review. [Accessed 10 September 2022].

[9] Office of Rail and Road, "Table 1310 - Freight moved by commodity," 9 June 2022. [Online]. Available: https://dataportal.orr.gov.uk/statistics/usage/freight-rail-usage-and-performance/table-1310-freight-moved-by-commodity/. [Accessed 13 August 2022].

[10] Office of Rail and Road, "Freight Rail Usage and Performance 2020-21 Quarter 4," 27 May 2021. [Online]. Available: https://dataportal.orr.gov.uk/statistics/usage/freight-rail-usage-and-performance/. [Accessed 13 August 2022].

[11] C. Rodes and G. Hutton, "UK steel industry: statistics and policy," House of Commons Library, 18 June 2021. [Online]. Available: https://commonslibrary.parliament.uk/research-briefings/cbp-7317/. [Accessed 9 September 2022].

[12] Department for Business, Energy & Industrial Strategy, "Net Zero Strategy: Build Back Greener," GOV.UK, 19 October 2021. [Online]. Available: https://www.gov.uk/government/publications/net-zero-strategy. [Accessed 1 September 2022].

[13] Department for Transport GOV.UK, "Transport and environment statistics: Autumn 2021," Department for Transport, 19 October 2021. [Online]. Available: https://www.gov.uk/government/statistics/transport-and-environment-statistics-autumn-2021/transport-and-environment-statistics-autumn-2021. [Accessed 14 August 2022].

[14] Advanced Propulsion Centre UK, "Heavy Goods >3.5t & Off-Highway Vehicle Roadmap 2020," 1 February 2021. [Online]. Available: https://www.apcuk.co.uk/app/uploads/2021/09/https___www.apcuk_.co_.uk_app_uploads_2021_02_Exec-summary-Product-Roadmap-HGV-and-Off-highway-final.pdf. [Accessed 1 September 2022].

[15] Office of Rail and Road, "Rail emissions," 19 August 2021. [Online]. Available: https://dataportal.orr.gov.uk/statistics/infrastructure-and-emissions/rail-emissions/. [Accessed 13 August

2022].

[16] National Rail Rail Delivery Group, "Rail Freight: Building a Stronger, Greener Future for Britain," July 2021. [Online]. Available: https://www.raildeliverygroup.com/about-us/publications/12827-2021-07-rail-freight-future-for-britain/file.html. [Accessed 12 August 2022].

[17] Atkins and Jacobs, "TSTR0009 Updating Marginal External Costs of Road Freight," December 2019. [Online]. Available: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/865553/marginal-external-costs-technical-report.pdf. [Accessed 1 September 2022].

[18] J. M. Fields and J. G. Walker, "The Response to Railway Noise in Residential Areas in Great Britain," Journal of Sound and Vibration, pp. 177-255, 1982.

[19] M. Piecyk and A. C. McKinnon, "Internalising the External Costs of Road Freight Transport in the UK," November 2007. [Online]. Available: https://www.abtslogistics.co.uk/green-logistics-resources/1fbb59ff-3e5a-4011-a41e-18deb8c07fcd_Internalisation%20report%20(final).pdf. [Accessed 5 September 2022].

[20] "HGV Driver Shortage – The Causes, the Facts and the Potential Solutions," Recruitment and Employment Confederation, 1 February 2022. [Online]. Available: https://www.rec.uk.com/our-view/news/news-our-business-partners/hgv-driver-shortage-causes-facts-and-potential-solutions. [Accessed 16 September 2022].

[21] Department for Transport, "HGV driver shortage: UK government response," GOV.UK, [Online]. Available: https://www.gov.uk/government/topical-events/hgv-driver-shortage-uk-government-response. [Accessed 1 September 2022].

[22] C. Ji-Hyland and D. Allen, "What do professional drivers think about their profession? An examination of factors contributing to the driver shortage," International Journal of Logistics Research and Applications, pp. 231-246, 2020.

[23] S. Walton, "Fresh calls to solve UK truck driver shortage with increased rail freight," RailFreight, 8 June 2022. [Online]. Available: https://www.railfreight.com/railfreight/2022/06/08/fresh-calls-to-solve-uk-truck-driver-shortage-with-increased-rail-freight/. [Accessed 12 August 2022].

[24] Department for Transport, "Mode shift benefit values: calculating benefits technical reports," 28 January 2022. [Online]. Available: https://www.gov.uk/government/publications/freight-mode-shift-benefit-values-technical-report-an-update.

[25] C. Zuo, M. Birkin, G. Clarke, F. McEvoy and A. Bloodworth, "Reducing carbon emissions related to the transportation of aggregates: Is road or rail the solution?," Transportation Research Part A: Policy and Practice, vol. 117, p. November, 2018.

[26] Campaign for Better Transport, "Calls to restrict dangerous longer lorries as Government set to allow more onto UK roads," Campaign for Better Transport, 26 January 2017. [Online]. Available: https://bettertransport.org.uk/media/26-january-2017-longer-lorries. [Accessed 17 August 2022].

[27] Campaign for Better Transport - MTRU, "Potential Reductions in Congestion on the Strategic Road Network from Alternatives to HGV Use," April 2015. [Online]. Available: https://bettertransport.org.uk/research. [Accessed 18 August 2022].

[28] Campaign for Better Transport, "The Case for Expanding the Rail Network," January 2019. [Online]. Available: https://bettertransport.org.uk/reopenings. [Accessed 18 August 2022].

[29] Arup, "Future potential for modal shift in the UK rail freight market," 1 September 2016. [Online]. Available: https://www.arup.com/perspectives/publications/research/section/future-potential-for-modal-shift-in-the-uk-rail-freight-market. [Accessed 14 August 2022].

[30] "Freight on Road: Why EU Shippers Prefer Truck to Train," 1 March 2015. [Online]. Available: https://www.europarl.europa.eu/RegData/etudes/STUD/2015/540338/IPOL_STU(2015)540338_EN.pdf. [Accessed 17 August 2022].

[31] P. Aditjandra, T. Zunder, D. Islam and E. Vanaale, "Investigating Freight Corridors Towards Low Carbon Economy: Evidence from the UK," Procedia - Social and Behavioral Sciences, vol. 48, pp. 1865-1876, 2012.

[32] D. M. Z. Islam and T. H. Zunder, "Experiences of rail intermodal freight transport for low-density high value (LDHV) goods in Europe," European Transport Research Review, 2018.

[33] M. Boehm, M. Arnz and J. Winter, "The potential of high-speed rail freight in Europe: how is a modal shift from road to rail possible for low-density high value cargo?," European Transport Research Review, vol. 13, no. 4, 2021.

[34] Department for Transport, "ENV0302: Average emissions from road vehicles in urban conditions: Great Britain," December 2021. [Online]. Available: https://www.gov.uk/government/statistical-data-sets/energy-and-environment-data-tables-env#pollutants-emissions-and-noise-env03. [Accessed 9 September 2022].

[35] "UK confirms pledge for zero-emission HGVs by 2040 and unveils new chargepoint design," Department for Transport, 11 November 2021. [Online]. Available: https://www.gov.uk/government/news/uk-confirms-pledge-for-zero-emission-hgvs-by-2040-and-unveils-new-chargepoint-design. [Accessed 9 September 2022].

[36] European Commission, "Emissions from non-road mobile machinery," [Online]. Available: https://single-market-economy.ec.europa.eu/sectors/automotive-industry/environmental-protection/non-road-mobile-

machinery_en. [Accessed 15 September 2022].
[37] Department for Transport, "ENV0301: Air pollutant emissions by transport mode: United Kingdom," 16 December 2021. [Online]. Available: https://www.gov.uk/government/statistical-data-sets/energy-and-environment-data-tables-env#pollutants-emissions-and-noise-env03. [Accessed 16 September 2022].
[38] T. Krasowsky, N. Daher, C. Sioutas and G. Ban-Weiss, "Measurement of particulate matter emissions from in-use locomotives," Atmospheric Environment, vol. 113, pp. 187-196, 2015.
[39] Network Rail, "Traction Decarbonisation," 31 July 2020. [Online]. Available: https://www.networkrail.co.uk/wp-content/uploads/2020/09/Traction-Decarbonisation-Network-Strategy-Interim-Programme-Business-Case.pdf. [Accessed 17 August 2022].
[40] R. Pipoli, "North American railway companies work on hydrogen-powered locomotive," Reuters, 19 December 2021. [Online]. Available: https://www.reutersevents.com/downstream/engineering-and-construction/north-american-railway-companies-work-hydrogen-powered-locomotive. [Accessed 27 October 2022].
[41] E. Garschick, F. Laden, J. Hart, B. Rosner, T. Smith, D. Dockery and F. Speizer, "Lung Cancer in Railroad Workers Exposed to Diesel Exhaust," Environmental Health Perspectives, vol. 112, no. 15, p. November, 2004.
[42] A. Piscitello, C. Bianco, A. Casasso and R. Sethi, "Non-exhaust traffic emissions: Sources, characterization, and mitigation measures," Science of Total Environment, vol. 766, 2021.
[43] S. Abbasi, A. Jansson, U. Sellgren and U. Olofsson, "Particle Emissions From Rail Traffic: A Literature Review," Critical Reviews in Environmental Science and Technology, vol. 43, no. 23, pp. 2511-2544, 2013.
[44] M. Hascoët and L. Adamczak, "At source brake dust collection system," Results in Engineering, vol. 5, 2020.
[45] D. Jaffe, J. Putz, G. Hof, J. Hee, D. A. Lommers-Johnson, F. Gabela, J. Fry, B. Ayres, M. Kelp and M. Minsk, "Diesel particulate matter and coal dust from trains in the Columbia River Gorge, Washington State, USA," Atmospheric Pollution Research, vol. 6, no. 6, pp. 946-952, 2015.
[46] P. Sturm, D. Fruhwirt and H. Steiner, "Impact of dust loads in long railway tunnels: In-situ measurements and consequences for tunnel facilities and operation," Tunnelling and Underground Space Technology, vol. 122, 2022.
[47] BNSF Railway, "Coal Dust Frequently Asked Questions," BNSF Railway, [Online]. Available: https://www.bnsf.com/ship-with-bnsf/energy/coal/coal-dust.html. [Accessed 5 September 2022].
[48] Shift2Rail, "Digital Automatic Coupling: Delivery Programme," [Online]. Available: https://rail-research.europa.eu/wp-content/uploads/2021/04/DAC-Factsheet_EN.pdf. [Accessed 15 August 2022].
[49] T. Pollehn, M. Ruf and R. Konig, "Evaluating the effects of automation components in service networks of rail freight," Journal of Rail Transport Planning & Management, vol. 20, 2022.
[50] Tesco plc, "A cool move to keep emissions on track," Tesco plc, 16 December 2021. [Online]. Available: https://www.tescoplc.com/news/2021/a-cool-move-to-keep-emissions-on-track/. [Accessed 14 August 2022].
[51] G. Nott, "Is Tesco on the right track with its supply chain trains?," The Grocer, 20 March 2022. [Online]. Available: https://www.thegrocer.co.uk/supply-chain/is-tesco-on-the-right-track-with-its-supply-chain-trains/665706.article. [Accessed 25 October 2022].