Opportunities for intermodal rail freight between North West England and the Humber Ports

Transforming Northern freight flows

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Executive Summary

This report considers how, within England, rail transport can have a greater role in transporting freight between the North West of England and Europe.

Key problems and objectives

The LHOFT[1] project has focused on developing a tool to assist businesses and government to plan the optimum routing of international freight. Businesses are looking for improved efficiency and reduced cost in transport, high levels of reliability, lower environmental impact in the short term and a technological route to decarbonisation. Government is looking for actions to support the productivity of business, reduce road congestion and reduce emissions. LHOFT aims to support businesses and government in meeting their objectives through the development of the Optimisation of Freight Transport (OFT) Platform, which enables the development and visualisation of options for routing freight.

This report considers North West England's export and import links with continental Europe, Scandinavia and the Baltic, which are critically dependent in England on road transport. The great majority of these cargos are taken by road in HGVs, either on long distance north-south motorway journeys to Dover and the Channel Tunnel, or across the Pennines via east coast ports. Businesses must take decisions on routes and mode of transport in England and on the Continent. The range of choices include English and continental ports, Roll-on Roll-off (RoRo, Figure 1) ferry and Lift on Lift off (LoLo) sea container[2] services and the Channel Tunnel, and whether to use road, rail or even barge haulage. Cargo owners are therefore faced with complex decisions about the optimum routing for their traffic, decisions that are generally made together with specialist transport service providers and forwarders.

Figure 1: Roll-on Roll off ferry service

Approach

Key to assessing the potential for switching from road to rail in the English portions of European international cargo journeys is first to understand of the scale of the overall market, and then identify which flows are candidates for transfer.

Our investigation has quantified the size of the North West's European exports and imports and developed a forecast. Historical regional export and import trade data, obtained from HMRC, have been analysed by product using Standard International Trade Classification (SITC) code. Freight flows between North West England and individual European countries have been analysed with the likely mode of transportation and port of entry/exit identified through expert assessment. Five-year forecasts of imports and exports have been generated using forecasting tools developed by the LHOFT consortium.

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[1] LHOFT - Liverpool - Humber Optimisation of Freight Transport.

[2] In this paper the term "container" is a generic term for a metal carrying unit which can be moved between modes of transport including sea, road and rail. It includes units that are classified as "swap bodies".

As import volumes exceed exports throughout our forecast period, we based our transport assessment on the scale of traffic provided by imports. We have considered the feasibility of rail having a role in providing transport, with a focus on traffic routed via the Humber ports, and the relative costs of road and rail haulage. Where major enhancements to infrastructure and rail vehicles would be needed to accommodate traffic transferred from road, we have suggested solutions. In particular, we have considered changes necessary to accommodate the transport of containers and road trailers.

In real life, the choice of mode and route will be made by cargo owners and their agents. We have identified the route options for a typical flow between North West England and continental Europe and used the OFT Platform to model cost, journey time and CO_2 emissions. We show how the options for routing can be made visible, enabling decisions on the optimum routing to be taken.

KEY FINDINGS

Size of the market for rail

HMRC's UK/EU trade statistics do not include any information relating to the UK port of entry or departure. This constrained our analysis. It would have been easier and more accurate if HMRC and DfT Ports data sets were joined up, to provide a record of the route taken by loads from origin to destination. Such information is available in HMRC's UK/non-EU trade statistics because the information is required in customs declarations. Now that the UK has left the EU and customs declarations are again required it may be possible to incorporate port information in the trade statistics going forward.

For current requirements we have made our own assessment on routings. In the absence of a clear view of the impact of Brexit on European trade, our medium term forecasts show a continuing steady volume of exports and imports. Potential train loads of traffic transferable from road to rail have been identified. On the route between North West England and the Humber ports, the early potential for three train loads of freight traffic each day has been identified.

In the medium term, on the Hull to Manchester route we see the opportunity for three trains carrying containers and tanks each day. Between Immingham[3] and North West England, the analysis suggests that between nine and 18 trains a day could be needed to move a combination of road trailer and container traffic. This does not include 'landbridge' freight moving between the EU and Ireland, which could provide additional traffic.

Cost of road and rail transport

Road freight faces cost challenges, including those arising from driver shortages, road and port congestion, and the need to reduce CO_2 and other emissions. The technology to decarbonise HGVs and the future possibility of "emission taxes" may increase haulage costs.

Rail freight faces general cost pressures too, but counterbalancing these are some major cost efficiency initiatives which are currently underway. The route to decarbonisation is becoming clear, principally with electric haulage, which should offer lower costs than with the current diesel traction.

These trends will change the balance of decisions facing businesses on whether to use road or rail haulage. Our work provides evidence that rail could be able to offer business lower costs than road on trans-Pennine hauls. As a further benefit, rail could be a cost effective means to decarbonise freight transport.

[3] Where not stated, in this report Immingham and Killingholme are considered as one port.

Rail network capacity and capability

Rail faces problems of constrained route capacity and limited flexibility in loading gauge[4] if a step change increase in freight is to be transported on busy railways across the North of England. Where investments in new capabilities are necessary, we have identified possible solutions.

We expect more rail routes will be gauge cleared to allow the international standard "high cube[5]" containers to be carried in long, efficient train loads. Additional network capacity will provide more paths for freight trains to run at the times that customers need them, and with high levels of resource efficiency. Of particular interest for businesses in the North West is the route between Liverpool, Manchester and the east coast ports, which we expect to be gauge cleared for high cube container trains in parallel with Network Rail's Transpennine Route Upgrade (TRU). But this has not been confirmed by Government.

However, capacity "pinch points" are likely to remain either side of the Pennines, particularly where routes pass through major urban areas where high frequency passenger services operate. The problem is particularly acute in Manchester. These congestion points restrict the number and length of trains that can operate, and cause freight train journeys to "stop and start" to avoid other traffic. These factors have a significant detrimental impact on capacity, journey times, costs and the potential emission savings of using rail instead of road.

The most significant opportunity to switch traffic from road to rail would come if a rail route could be available to allow road trailers to be carried on rail wagons. In addition to the high gauge, the route could be optimised for freight transport, ensuring short journey times and very productive use of resources. Faster journeys would reduce costs by allowing improved locomotive, vehicle and crew productivity. We have developed a notional route to allow the train service and capacity options to be considered, and to provide input to the visualisation exercise carried out using the OFT Platform.

The notional route provides additional capacity and gauge clearance for road trailers on trains but avoids many of the complexities associated with an attempt to adapt very busy mainlines on the existing rail network. The route would involve large capital expenditure but appears to have the potential to build in many benefits for other freight traffic aside from that serving the Humber ports, and for passengers.

Enabling business, operators and government to make choices

The decisions on route and mode for international freight traffic involve very complex analysis and modelling. We have used the results from our analysis and train service development to create illustrative options. These have been modelled through the OFT Platform, and the results visualised to make clear the key factors that inform choices. These are reported in section 7.

The modelling we have carried out to drive the visualisations covers cost, journey time and CO_2. The visualisations show the trade-offs when decisions are made about ports, ferry routes, distance and mode of overland haulage. They use 2019 data for their inputs, but the OFT Platform is designed to be flexible, allowing users to specify the value of inputs.

A next step could be to model and visualise future year changes in these input factors so that the impact on freight routing and mode decisions can be considered. Examples of the application could include changes in rail and road infrastructure, port and sea ferry routes, shipping costs and emissions.

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[4] The maximum height and width for railway vehicles and their loads.

[5] High cube units are those with an external height of 9'6" (2.896m), an external width of 2.55m and length of 13.65m. The mix of imperial and metric measurements has long been accepted in the world-wide transport industry.

RECOMMENDATIONS

Our recommendations are in six areas:

1. Investigate and develop options for a range of potential future year changes in the key factors that drive choice in freight load routing and mode for Northern England's European imports and exports. The potential changes should include new port infrastructure and sea ferry routes, greater port and shipping service utilisation, additional capacity and schedule intensification on existing ferry routes, technology for decarbonisation of rail, road and sea transport, and provision of rail infrastructure to allow continental road trailers to be carried on trains between the Humber and North West England.

2. Identify options for additional road-rail intermodal terminal capacity to the west of Manchester, with road links to the city, M62 and M6. This would enable the switch of freight from road to rail, and position terminal capacity to support the use of decarbonised road transfers for short distances to and from business premises.

3. Consider whether a Manchester by-pass railway, avoiding conflict with routes intensively used by passenger trains, could allow more freight trains to avoid the city centre and access road-rail transfer terminal sites. This would provide route capacity for additional freight trains to operate. It could also improve the cost efficiency of rail freight by allowing more productive use of locomotives, crews and wagons – a benefit that can be shared with businesses through lower transport costs.

4. Improve data availability for study of mode choice and routing of the UK's European imports and exports, by including port of entry and departure in HMRC Trade data. Consider how to join up the HMRC Trade and DfT Ports data. alongside the PRB Associates Short Sea Freight RoRo and LoLo Capacity Analysis. This would enable robust analysis of trade flows, identification of opportunities for route and mode change and improved forecasts. Data on full origin to destination freight journeys is key to this analysis.

5. Continue development of tools like the OFT Platform, allowing visualisation of choices for businesses, transport operators, infrastructure planners and government. This will enable them to test and understand the dynamics of options for decisions on mode and route.

6. Use the approach to analysis and visualisation through the OFT Platform described in this report, to consider options for infrastructure enhancement. This will provide clear explanation of the choices that need to be made that meet the twin priorities of higher business efficiency and decarbonisation.

Contents

1 Introduction

1.1 LHOFT project

The LHOFT project has, at its heart, the development of a visualisation tool to enable cargo owners, transport operators and government to optimise the transport of freight between northern England and Europe. The project aims to encourage a change in the routing of import and export freight. Through an understanding of the existing freight flows, the needs of UK business and the potential for improvements, the project has created a collaborative platform that can be used to model different transport modes and routings for loads.

1.2 Rail in the LHOFT project

The LHOFT 'rail' workstream has involved cross-team working between business, transport and academic members of the project team. The principal task has been to support the development and testing of the OFT Platform.

Part of our approach has been to consider three scenarios where European import/export freight could be moved by in the UK by train:

- Scenario 1 - without enhancement of the network.
- Scenario 2 - with minor enhancements to the network and terminals.
- Scenario 3 - with major enhancements to the network and terminals.

Scenario 1 considered what can be achieved with the rail network as it is. It involved freight train operators working with port and terminal operators, shipping lines and logistics service providers. They investigated how containers, which are currently road hauled to and from the Humber ports, could be transferred to rail between the ports and Manchester.

In Scenario 2, LHOFT partner Kraft Heinz worked with freight train operators and Network Rail to establish feasible minor changes to the network and terminal arrangements to allow transfer of containerised traffic from road to the rail between Hull and Wigan.

Scenarios 1 and 2, involving the decision makers in customers and transport operators in reviewing the opportunities for transfer of 'real life' freight traffic from road to rail, have provided very helpful knowledge about the current cost competitiveness of rail.

Here we report on Scenario 3, which considers the opportunities for major investment in rail to enable transfers of freight traffic from road.   The authors of this report and contact details are listed in Appendix D.

2 Approach

2.1 Introduction

The work described here uses data and operational analysis, lessons learned through the earlier LHOFT research, and the OFT Platform. It explores how rail can provide solutions to some of the key transport challenges faced by business, and the scope for major rail infrastructure and freight train service improvements for European export and import traffic in the North of England. In particular, it considers the opportunities for rail to better serve North West England's European import-export traffic via the Humber ports.

2.2 Questions to be addressed

The approach we have taken has been to seek answers to four questions:

1. What is the size of the market for rail, and is it sufficient to allow efficient train loads of traffic to be assembled?
2. Will rail be cost competitive with road haulage?
3. How can the traffic be accommodated on the rail network?
4. How can the different mode and route options be visualised to businesses, transport operators and government, informing them and enabling them to take decisions?

SIZE OF THE MARKET FOR RAIL

A priority for this workstream has been to identify the potential market size for switching from road to rail, to give confidence in the potential for train loads of traffic.

COST OF ROAD AND RAIL

The routing and transport mode of most freight movements are decided by cargo owners and their agents, principally on the basis of the door to door price, and the speed and quality of transit. Increasingly, the route to decarbonisation is becoming a priority. We have identified opportunities for rail to respond in these areas, to become the mode of choice for many cargo owners in transport the North West's export and import trade with Europe.

Comment from Business
"KraftHeinz is a major mover of freight to and from our facilities in Wigan in the UK. Currently the vast majority is done by road from a variety of inbound ports both in the North and the South of the country. We support this initiative as it will help to remove some of the challenges faced when moving freight onto the railways. Creating more flexibility in every leg of a journey can only help in our quest to move freight more sustainably."
Stuart Alldridge, Senior Logistics Execution Manager, The Kraft Heinz Company

RAIL NETWORK CAPACITY AND CAPABILITY

Rail faces the problems of route capacity and loading gauge if more freight is to be transported on busy railways across the North of England. Where investments in new capabilities are necessary, we have identified possible solutions.

ENABLING BUSINESS, OPERATORS AND GOVERNMENT TO MAKE CHOICES

The choices of route and mode for international freight are very complex. We have used some of the results from our analysis to create illustrative options that have been modelled through the OFT Platform, and so visualised for businesses, operators and government.

2.3 Challenges

First, we will consider some of the challenges facing road and rail transport, and the impact these may have on the potential for switching traffic between modes. Then we move on to find answers to the four important questions.

3 Challenges

Businesses in the North seek improved efficiencies in freight transport to and from Europe. Currently they often have to rely on long road haulage trips over congested motorways to south coast ports. More use of local northern ports and, when cost effective, making use of more efficient rail transport could offer lower costs, greater reliability and reduced emissions.

3.1 Key challenge

North of England businesses ask us "how can we reduce reliance on long overland road haulage trips to south coast ports, use our local northern ports more, and why can't this traffic be carried by rail?"

3.2 Road haulage

Within England, the transport of export and import freight between North West England and continental Europe has two principal characteristics. It is:

- Dominated by road haulage.
- Primarily routed via short sea routes and the Channel Tunnel.

Goods are carried in containers and road trailers, with road trailers in the majority.

Road haulage faces many challenges. There is pressure from cargo owners to optimise transport plans and reduce costs, improve reliability and reduce carbon footprint. In the short term there will be the response to COVID-19 and Brexit and, in the medium term, increased road traffic congestion, growing shortages of lorry drivers and the need to reduce environmental impacts. In the longer term, there will be the need to find an affordable and efficient solution for decarbonisation of HGVs.

Road Haulage Statistics

The Government intends that the UK will be CO_2 net-zero by 2050. 17% of transport emissions are HGV related, but they make up just 5% of vehicle miles driven. The freight industry remains fragmented due to competitive pressures. 30% of total domestic travel, or 5.3 billion miles, is empty, and the average truck is only 60% laden. Less than 7% of freight is moved by intermodal rail. Stakeholders work in isolation. As a result, logistics costs are higher. Shippers pay more for transport and emissions are higher.

Source: DfT Road haulage statistics; Table RF SO 125, 2019.

3.3 Rail haulage

Rail freight is active in handling bulk and deep sea container traffic at UK ports. Containers are transferred between road vehicles, rail and ship by cranes at terminals and ports. Rail in Britain has been very successful in serving the deep sea container market. The relatively long distances covered, the rail loading gauge on north-south mainlines offering clearance for international high cube containers, well placed existing northern terminals and good connections into the ports serving deep sea shipping have contributed to this success.

But rail in England has generally been seen as uncompetitive with road for European international intermodal freight. This is because:

- The need for a road trip to or from a rail transfer terminal at the English end of the journey, together with the short haulage distance to the ports serving European ferries, has historically made road transport more cost effective.
- Many rail freight journey times are slow, causing poor resource utilisation and increasing rail's costs.
- Many cargo owners and shippers use international standard high cube containers. Currently, the loading gauge is very restricted on parts of the national rail network, including the direct routes across the Pennines. This limits the traffic that can be carried to the portion of the potential demand that can be carried in bulk trains, low height containers and tanks.

- Most loads are required by customers to travel in road trailers. However, apart from HS1 between London and the Channel Tunnel, road trailers cannot be carried on the British national rail network.
- Route capacity for additional freight trains through congested urban areas, especially in Manchester and on trans-Pennine routes, severely limits the number of trains that can be operated.

3.4 Routes to the ports

The North West's European export and import freight depends critically on HGVs making long distance journeys along congested motorways including the M62, M6, M1, M25, M2 and M20. Businesses in the North have three principal routes for moving freight to and from Europe, via:

- South coast ports and the Channel Tunnel.
- North Thameside and East Anglia ports.
- East coast ports.

South coast ports and the Channel Tunnel

All freight movements to the short sea crossings of the south coast ports and the Channel Tunnel are made by road in England. Congestion is a major problem. The M1 and M6 connect to the M25 then M2 or M20 to reach the Channel Tunnel Folkestone terminal and Dover. There are multiple sections of the routes with regular, severe congestion. Nevertheless, hauliers find these routes attractive because of the short sea crossings, high frequency ferry and tunnel train services, and the direct route offered to France and southern Europe.

There are substantial flows of containers by rail between North West England and Southampton, but the great majority of demand is for deep sea rather than European transit.

North Thameside and East Anglia ports

Road freight movements between North West England and the North Thameside and East Anglia ports suffer from many of the congestion problems of those to the south coast. The North Thameside ports, London Gateway and Felixstowe have been served by increasing numbers of trains linking them with rail terminals in the north, including Manchester.

East coast ports

The M62 provides the principal east-west route over the Pennines, connecting Liverpool and Manchester with Leeds, Bradford, Hull and (via M18 and M180) to the east coast port of Immingham. Any congestion or problems on the motorway can have implications for moving freight.

There are no intermodal trains currently operating east-west across the Pennines.

4 Market

This section considers the size and characteristics of the North West's export and import trade.

It seeks to answer the question: "What is the size of the market for rail, and is it sufficient to allow train loads of traffic to be assembled?"

4.1 Introduction

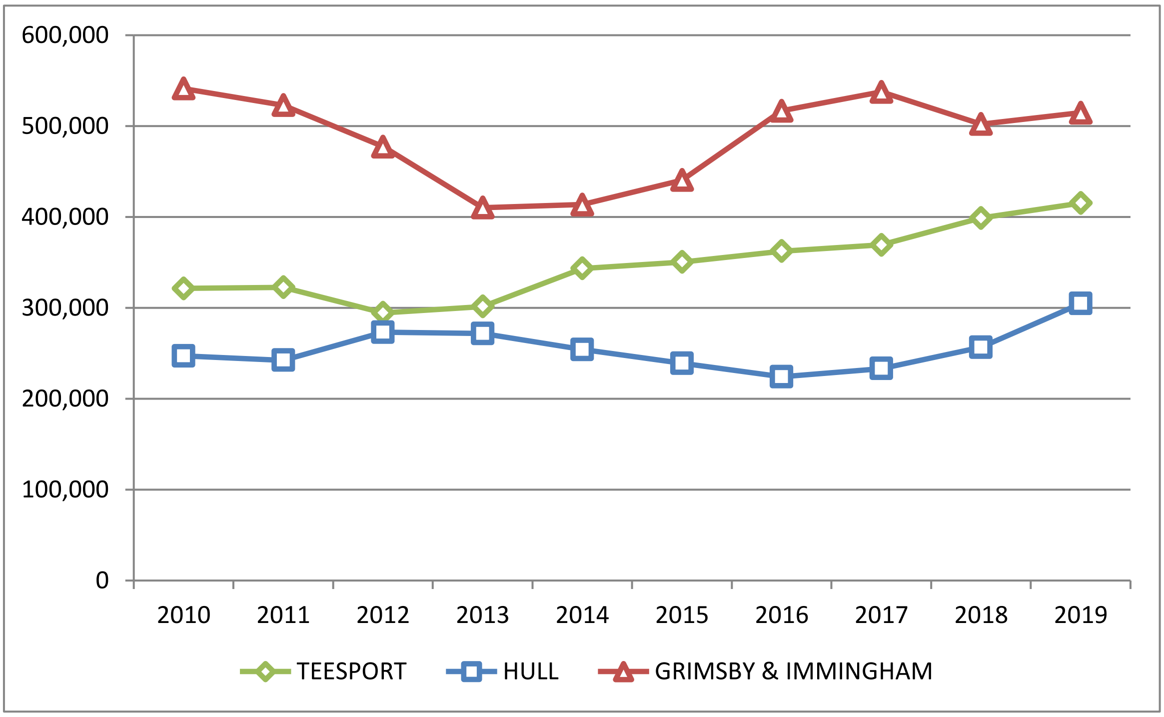
The North West of England is a powerhouse in the UK economy, with complex transport logistics connecting it with Europe. However, the published data for European export and import transport do not provide a detailed picture of how freight flows through the road, rail and sea network. In particular, there is no clear view of the ports used for this traffic.

4.2 Containers and road trailers

Over the years, businesses and transport providers have focused much attention on fine tuning their choice of equipment and mode for the transport of European exports and imports.

Figure 2 shows that the total throughput of containers at east coast ports, and Figure 3 'unaccompanied'[6] road trailers, and the changes over 9 years. In 2019, 1,234,669 containers and 728,575 unaccompanied trailers passed through the ports. Steady growth is shown in containers through Teesport and unaccompanied trailers through South Humberside ports.

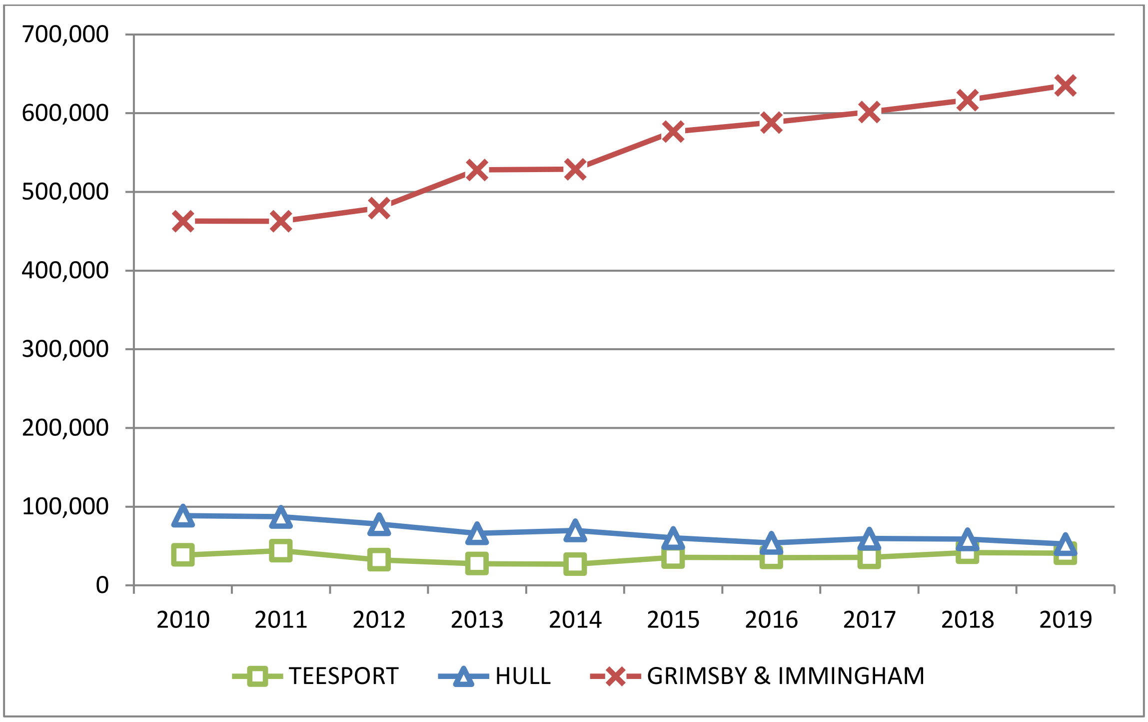
Figure 2: Total throughput of containers at east coast ports 2010-2019



Source: DfT 2019 Port Statistic. DfT statistics describe the south Humberside port group of Grimsby, Immingham and Killingholme as "Grimsby and Immingham".

[6] 'Accompanied' road trailers have a tractor unit and driver who travels with the load throughout the journey, including on the ferry crossing. 'Unaccompanied' road trailers are collected by a tug from a trailer park at port of loading, and moved on to the ferry. At the arrival port, they are hauled off the ferry by another tug and taken to a trailer park where they are then collected and taken forward to destination by an HGV tractor unit or piggyback train.

Figure 3: Total throughput of unaccompanied road trailers at east coast ports 2010-2019



Source: DfT 2019 Port Statistic. DfT statistics describe the south Humberside port group of Grimsby, Immingham and Killingholme as "Grimsby and Immingham".

4.3 Accompanied and unaccompanied loads

Products are normally carried 'door to door' in unit loads from the forwarder's premises to the destination. In some cases, mid-journey transhipment[7] takes place at a port or remote warehouse where some value is added – this might involve further packaging of the product or adding extra product to the load.

Urgent and time critical loads conveyed through Humber ports are usually carried in 'accompanied' trailers, where the trailer, hauling tractor unit and driver stay together. Unaccompanied import loads are moved from the Humber by haulage contractors. Some are UK haulage companies, and others are companies linked to the shipping lines who offer a full transport package to the consignor – examples are A2B and DFDS. Once product is delivered, the haulier or shipping line will arrange the repatriation of the container or trailer. Usually this is done by obtaining another load and may involve the unit leaving the UK by a different port to that of entry.

4.4 Trailers, tanks and containers

The choice of unit type is important in considering the potential for rail to have a role in Britain. European road trailers can be carried on continental trains, but not in the North of England because of the restricted loading gauge. Containers and tanks can be carried on British trains, but the routes that are cleared for them are limited by infrastructure constraints.

The choice between road trailer, tank and container has been driven by business and shippers' attempts at optimisation. For example, polymers, liquids and gases are carried in tank containers. Automotive and steel products are loaded to trailers or containers according to route, size and weight.

Most of the remaining traffic moving through the Humber ports is carried on pallets and achieving a highly efficient loading pattern for each unit has been a major factor driving choice. The position is

[7] Moving goods from one ship or transport unit to another.

complicated by different pallet sizes: standard CHEP[8] 1200x1000mm and European 800x1000mm. Loaded pallets are conveyed in a trailer or container with an internal loading floor normally measuring 13.5m long and between 2.44m and 2.5m wide. There are variations in trailer and container designs depending on the optimisation of the units to undertake their intended roles, for example units providing refrigeration.

Trailers offer the ability to load and unload through side curtains, which suits rapid and efficient handling of goods at terminals. Most containers only allow 'end' loading and discharge. However, while containers are suitable for some traffic, they carry a weight penalty which is significant in limiting their ability to accommodate heavier loads. Once the weight of the container or trailer is taken into account, the maximum container payload is around 26 tonnes, while the maximum trailer payload is up to 29 tonnes.

A high proportion of cargos travel in trailers not containers because, since the 1950s, domestic land-based freight in Europe has moved from rail to road, so the road vehicle has become the dominant unit of movement. This unit became articulated, with a diesel-powered tractor hauling a 'curtain' sided trailer to enable maximum flexibility of loading product. Most European trailers are 13.65m length x 2.55m width x 4.0m height above road.

While containers quickly replaced manual loading of deep sea cargoes, for many journeys within the UK and Europe the road trailer remains unbeaten in terms of flexibility and economy.

4.5 Market size and routing

A three-stage method has been used to calculate the size of the market using:

1. Analysis of 2019 HMRC data to understand the quantity of freight to be moved[9].
2. Selection of a subset of European and nearby countries whose trade with the North West England is likely to include substantial traffic via east coast ports, and production of a forecast[10].
3. Allocation of traffic flows to UK ports of arrival or departure[11].

4.6 Quantity of freight to be moved

The data on 2019 freight flows were extracted from the HMRC trade data files, which allow the user to choose a bespoke data set. Given the interest in regional freight flows and, in particular, freight flows to and from the North West of England, regional data was extracted. For each UK region (nine English regions along with Scotland, Wales and Northern Ireland), quarterly data was extracted on the total tonnage of imports and exports to foreign countries broken down by SITC[12] code to SITC level 2. This enabled an in-depth investigation of regional trade.

The raw HMRC data was manipulated into data arrays to enable straightforward data visualisation of tonnage by region, country, product and time for both imports and exports. Exploratory data analysis was performed to produce summaries of the data reported below and in Appendix C.

This project is considering medium and long term investments in transport infrastructure, where the benefits are going to be available in the years ahead. There are many uncertainties that will influence trade levels including the ongoing impacts of the COVID-19 pandemic, Brexit, new shipping routes and ships with higher capacities, and changes as transport businesses progressively decarbonise. We do not know how far these factors will drive changes in demand.

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[8] Commonwealth Handling Equipment Pool.

[9] This analysis of HMRC data by Lancaster University and University of Nottingham, Prof Peter Neal.

[10] This analysis of HMRC data by Lancaster University and University of Nottingham, Prof Peter Neal.

[11] This work by LHOFT consortium member PRB Associates.

[12] Standard International Trade Classification.

But what can the recent trade data tell us about likely need for demand for transport over coming years?

Time series analyses of trends in the data were performed using the forecasting app developed at Lancaster University as part of the LHOFT project. The forecast shown in Figures 4 and 5 covers exports and imports between the North West of England and Central, Northern and Eastern Europe countries described in section 4.7 below. The data is displayed in thousands of tonnes, by quarter, showing observed data from the first quarter of 2013. Observed exports and imports are shown as black dots. Forecast exports and imports by red dots. 95% confidence intervals for forecasts are shown as dashed magenta lines. Further information is provided in Appendix C.

Figure 4: Exports: North West of England to Central, Northern and Eastern Europe (SITC 1, 5-8)

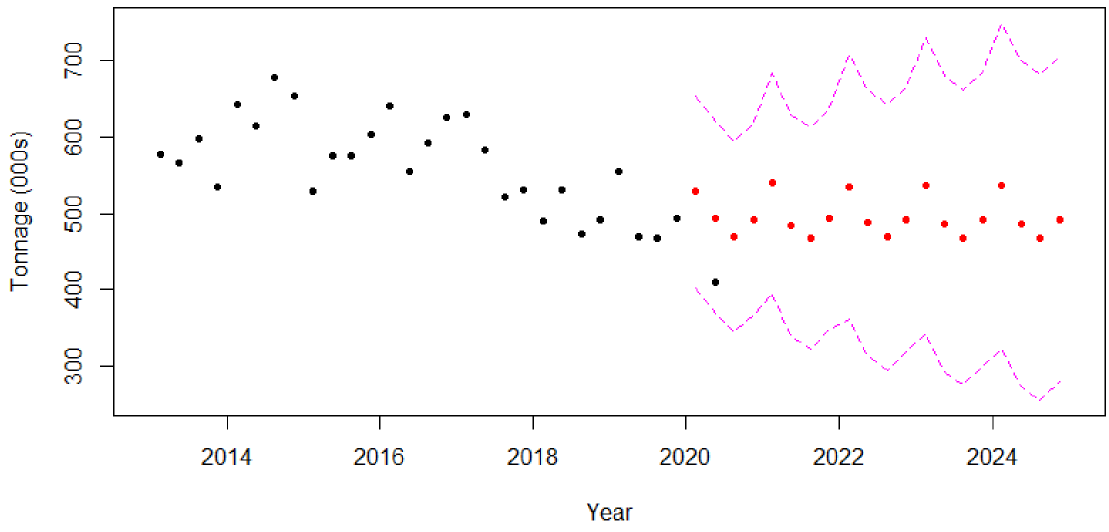
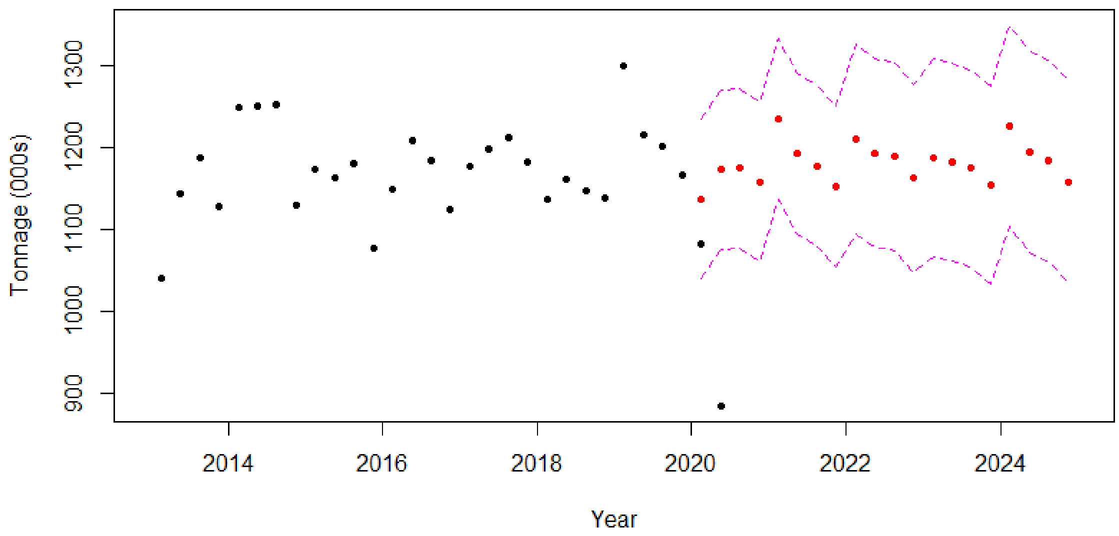


Figure 5: Imports: North West of England to Central, Northern and Eastern Europe (SITC 1, 5-8)



The charts show the seasonal variations in traffic levels, and the forecasts indicate steady levels of demand over the next five years. Import tonnages continue at a much larger level than exports, by a ratio of over 2:1.

4.7 Countries served via east coast ports

Our focus is on increasing use of rail in Northern England, particularly via the Humber ports. So we identified a subset of European and nearby countries that could find a route via the Humber to be logical and efficient for a significant proportion of trade. A share of this traffic may therefore be available to be moved by rail across Northern England. We have used this subset in the forecasts described in section 4.6 above.

Major flows of freight are transported to and from the North West from France, Spain and Portugal. But these are most likely to use south coast ports and Liverpool. Some of this container traffic may already use rail to Manchester, for example from Southampton. But the rest will be road hauled. It will need innovations in shipping to change the balance of road and rail on these corridors including, for example, routes between northern French ports and the Humber. Another way would be growth in through freight trains via the Channel Tunnel.

The current, and most likely future, countries served through east coast ports will be those who can be reached from continental ports in the eastern Channel and North Sea. These ports are principally in Belgium, the Netherlands, Germany and Scandinavia. The major European overland freight routes from these ports serve countries linked by the north-south Rhine corridor (from the Channel and North Sea to Switzerland and Italy) and then in an anti-clockwise sweep through central, eastern and northern Europe. It is freight flows with these countries that we see to be priority candidates for switch to rail in Northern England.

Table 1: North West England Exports and Imports 2019 for a selection of countries ('000s tonnes)

Country	Exports	Imports
Germany	569.01	1459.21
Belgium	239.87	726.07
Netherlands	347.29	719.06
Italy	118.03	382.11
Turkey	83.48	309.10
Norway	25.13	265.61
Poland	120.80	198.27
Sweden	81.74	161.22
Russia	33.92	102.48
Finland	57.62	96.55
Denmark	48.96	89.76
Czech Republic	28.48	67.66
Austria	25.69	61.00
Slovakia	23.99	46.47

Source: Lancaster University and University of Nottingham, Prof Peter Neal, analysis of HMRC data

Table 1 shows the leading role of trade with Germany, Belgium, the Netherlands and Italy with North West England. In each case, import tonnages are much higher than exports, supporting the approach that for transport network planning capacity needs to be scaled to handle the larger flow of imports. Turkey is included in Table 1. But we should note the range of routings taken by this traffic. For example, we have seen white goods in unaccompanied road trailers, after a sea journey across the Mediterranean to the south of France, transferred to piggyback rail to be hauled to Calais where they will travel by ferry across to the UK and be road hauled across England.

Appendix C Table 10 provides our full list of European and nearby countries, and the selection we have made based on our assessment of the likelihood of their traffic using east coast ports. The data covers merchandise typically carried in containers, containerised tanks and road trailers. It excludes bulk products that would typically be moved, for example, by tanker ship and pipeline from the port.

4.8 Choice of route and port

In the absence of North West England regional data available at a port level, the LHOFT team had to create a further step in the analysis, to provide a more representative data set for short sea unit load freight traffic flows.

We took HMRC trade data on the quantities of 41 countries' import freight to North West England in tonnes. These countries are in mainland Europe and nearby - Scandinavia and to the east - shown in Appendix C Table 10. We converted this data into unit loads for transport based on our assessment of an average 17 tonnes[13] of product in each load. The data was then processed to create an allocation to ports. The UK port of entry for EU commodity trade, was assessed based on:

- The European country of origin.
- The likely mode of transport used for different commodities, taking account of the speed of transport, temperature control, security, loading / discharge and payload requirements.
- The respective Short Sea Freight RoRo and LoLo shipping capacity available on different routes. [14]

The results from this exercise are summarised in Table 2. This shows traffic flows for North West England's imports in terms of unit load characteristics by port. The Humberside ports, the focus for our investigation, together with unit load totals for a geographical grouping of ports, are highlighted.

***Table 2: European Imports to North West England by Port of Entry** (number of unit loads)*

Port	Trailers		Containers		Ports totals		NW's share of traffic at each port
	Accompanied	Unaccompanied	Box	Tank	Each port	Port group	
Blyth	0	0	333	375	708	708	
Tyne	0	0	327	368	695	695	5.6%
Teesport	75	495	8,746	6,543	15,860	15,860	9.7%
Hull	1,454	9,302	6,750	7,097	24,603	24,603	14.1%
Killingholme	1,155	45,382	2,523	2,840	51,900	109,480	20.8%
Immingham	1,515	34,448	8,061	13,556	57,580		
Felixstowe	206	18,936	14,574	1,991	35,707	35,707	8.8%
Harwich	2,466	27,471	2,066	2,325	34,328	34,328	19.1%
London Gateway	0	0	34	26	59	31,108	6.4%
Tilbury	8	16,828	8,271	5,043	30,151		
Purfleet	15	757	107	19	898		
Dover	32,718	0	0	0	32,718	32,718	2.7%
Eurotunnel	19,120	0	0	0	19,120	19,120	2.4%
Newhaven	603	12,450	0	0	13,052	13,052	59.4%
Portsmouth	3,404	11,807	0	0	15,210	15,210	15.7%
Southampton	0	0	1,389	2,039	3,428	3,428	5.4%
Poole	0	7,795	214	37	8,046	8,046	43.4%
Plymouth	0	158	0	0	158	158	6.2%
Bristol	0	0	5,868	1,675	7,543	7,543	37.7%
Liverpool	0	0	8,928	3,566	12,494	12,494	10.5%
TOTALS	**62,738**	**185,829**	**68,190**	**47,500**	**364,257**	**364,257**	
Sub-totals of all trailers and all containers	*248,567 (68%)*		*115,690 (32%)*		*364,257 (100%)*		

Source: PRB Associates analysis based on HMRC, PRB Associates Capacity Analysis and DfT data. Note: "NW's share of traffic at each port" is the percentage of each port group's total traffic that is destined for NW England.

[13] See Appendix C, section C.4.

[14] PRB Associates UK Short Sea Freight RoRo and LoLo Capacity Analysis.

Table 2 shows the role played by south Humberside ports, with over 109,000 import loads destined for North West England in 2019, making up more than 20% of the ports' import traffic. We have checked this assessment with those made by the port operator and leading road hauliers. Their view is that more than 20% of the south Humberside ports' traffic is likely to be destined for North West England, maybe as high as a third. We are therefore taking the 109,000 South Humberside estimate as being conservative and so sufficient for our work on rail traffic potential.

4.9 Potential market for containers by rail

We see the potential for the start of movement of trains of containers across the Pennines between Manchester and the Humber ports. After implementation of the TRU[15], with its direct gauge cleared route across the Pennines, there may be early potential for three container trains a day.

Table 2 shows that, taking Hull, Killingholme and Immingham together, more than 40,000 box containers and tanks were imported in 2019, destined for North West England.

We expect a direct rail route across the Pennines that is gauge cleared for the conveyance of high cube 45 foot long containers will become available in the TRU. From our discussions with shipping lines DFDS and A2B during the LHOFT project, we believe around 14,000 high cube containers a year are available now to be moved by rail if the cost and service specification are satisfactory. This traffic, along with the existing smaller (lower height and narrower) containers that can already be carried on trains by the gauge-constrained trans-Pennine routes, would provide the load for potentially three intermodal trains per day from a combination of Hull and Immingham to the North West.

Later in section 5 we discuss the cost trends facing road and rail haulage, which appear to be moving in favour of rail. More detailed investigation of the origins and destinations of this traffic in relation to the location and capacity of the road-rail transfer terminals in North West England will be necessary to understand how much is switchable to rail.

Finally, it is worth noting the significant number of containers coming in to Teesport, Felixstowe, and Tilbury. As these ports are already served by container trains, we expect some of this traffic will already be carried by rail, in trains conveying a mix of European and deep sea traffic.

4.10 Potential market for road trailers by rail

Road trailers outnumber containers by 2:1 in North West England's European import market, but Britain's national rail network cannot carry them.

Table 2 shows that containers only have a minority share (32%) of the import market. 68% is carried in road trailers, which cannot be accommodated by rail in the North of England. This section explores the size of the potential market if a railway between the Humber ports and North West England could handle road trailers as happens in continental Europe.

Piggyback rail is an operating technology where articulated lorries are moved by rail on special wagons, see Figure 6. Sometimes trains operate with a mix of piggyback road trailers and containers. Appendix B contains a description of piggyback rail in Europe.

If piggyback rail was available between the Humber and North West England, what would be the demand[16]?

[15] TRU - Network Rail's Transpennine Route Upgrade

[16] Of interest, Network Rail's "Railfreight forecasts: Scenarios for 2033/34 & 2043/44" published August 2020 included a forecast of demand on an indicative concept national "European gauge" network for Britain.

The trade data in Table 2 suggests that a new rail freight service capable of carrying piggyback traffic will have its best potential market in moving trailers and containers from the adjacent ports of Immingham and Killingholme.

4.11 Medium term view, with a piggyback rail route across Northern England

A radically improved freight railway across the Pennines would offer rail a series of opportunities to improve its service to businesses, in addition to gauge clearance for piggyback. These include:

- More capacity - both timetable paths on the network and longer trains.
- More flexibility in timing of journeys to meet business requirements.
- Shorter journey times.
- Decarbonisation, through electric haulage.
- Cost efficiency, from all the above plus a very high level of resource efficiency.

Figure 6: Piggyback rail in Europe - wagons being discharged at Le Boulou terminal, south of France

Meanwhile, road haulage faces great uncertainties, and Brexit will cause changes in export/import flows that are hard to forecast. Faced with this, we have prepared a series of options for the medium term, 10 to 15 years ahead, when a new piggyback rail service could be in place. We combine container and road trailer demand, recognising that there may be changes in the balance of use between them. We assume that the total traffic through the Humber ports will be at the same level as 2019 or higher. We have tested rail demand with port throughputs at 2019, 2019 +50% and 2019 + 100% levels, and a rail market share of 65%.

In the concept railway we outline in section 6 and Appendix A, we show how the traffic could be accommodated. An hourly path would be available in each direction, up to a maximum of 18 a day. We assume that services will operate 5 days[17] a week for 51 weeks a year, with an average load factor of 80%, and trains formed with either 30 or 40 platforms.

South Humberside ports - Manchester

Immingham and Killingholme have large flows of containers, tanks and road trailers destined for North West England. Three options for demand are shown in the Table 3.

[17] The railway would be open 7 days a week for passenger services. Freight trains could operate at weekends if there is a need.

Table 3: Potential Rail Demand from Immingham/ Killingholme to Manchester, for Road Trailers, Containers andTtanks			
	2019 Demand Level	**2019 +50%**	**2019 +100%**
No. of unit loads per annum through ports	109,480	164,220	218,960
Potential rail demand at 65% share	71,162	106,743	142,324
Demand, units per day	279	419	558
Rail capacity required @ 80% load factor	349	524	698
Trains per day @ 30 units per train	12	18	N/A
Trains per day @ 40 units per train	9	13	18

Source: ORS analysis for LHOFT.

The option analysis suggests that between nine and 18 trains a day could be needed to move a combination of road trailer and container traffic between Immingham and North West England. In section 6, we have assumed 12 trains of 30 platforms operate each weekday.

Hull - Manchester

Hull's role as a gateway for North West England imports is for containers, tanks and road trailers. But the number of trailers handled is much lower than at Immingham and Killingholme. We therefore see the priority for rail at Hull in hauling containers and tanks. Three options for demand are shown in Table 4.

Table 4: Potential Rail Demand from Hull to Manchester, for Containers and Tanks			
	2019 Demand Level	**2019 +50%**	**2019 +100%**
No. of unit loads per annum through port	13,847	20,771	27,694
Potential rail demand at 65% share	9,001	13,501	18,001
Demand, units per day	35	53	71
Rail capacity required @ 80% load factor	44	66	88
Trains per day @ 30 units per train	1-2	2-3	3
Trains per day @ 40 units per train	1	2	2-3

Source: ORS analysis for LHOFT.

Table 4 suggests that between two and three trains a day could be needed to move container traffic between Hull and North West England. There are a range of routes that could be taken by Hull to Manchester trains, including the TRU route via Huddersfield or potentially via a new freight route to Manchester that also serves South Humberside.

4.12 Discussion

Our analysis indicates the scale of the potential for train load quantities of containers via the Humber ports to be transferred from road to rail following the completion of the TRU.

We also identify the substantial scale of the potential demand for rail if continental road trailers could be accommodated on a specially cleared east-west route across the north of England.

At the time of writing, only the earliest stages of the impact of Brexit on UK trade with the EU have been seen. Changes in trade volumes, transport costs, mode and routing seem likely. The forecasts can be adjusted as the situation stabilises.

Clearly such factors as the rail service's characteristics, inland terminal locations and cost, together with changes in the quality and cost of the competitor road haulage, will be fundamental in determining rail's share of the market. The issue of costs will be discussed further in section 5.

The major rail technical challenges to accommodate piggyback wagons on parts of the UK rail network are discussed in section 6 and Appendix A.

Will the Humber ports maintain and grow traffic?

In the absence of a clear view of the impact of Brexit on European trade, our medium term forecasts show a continuing steady volume of exports and imports.

Given the need for very significant investment to develop a piggyback rail route from Immingham to the North West of England, it is important to take a very long term view of the flow of traffic through the Humber ports. Would such investment be wasted by commercial factors or technology change?

The analysis described here only considers within-the-route transfers of mode, from road to rail. However, we would expect there to be changes in type of unit and route. This may follow, for example, the introduction of new ferry routes and a switch away from south coast ports. The shipping lines are investing in new and larger ships to serve the Humber ports. Actions in continental Europe to make more use of rail to ports to reduce HGV journeys and emissions, and the expansion of the continental piggyback rail network, will favour ports capable of handling large numbers of unaccompanied trailers.

Conclusions

It is the trailers and containers to and from ferries at Immingham and Killingholme, and the containers and tanks at Hull, that offer the largest scope for impact through switching from road haulage to rail.

5 Trends

While road haulage on the trans-Pennine corridor will face increasing costs in future years, rail will benefit from reduced mileage-driven costs and the efficiency of electric haulage.

In this section we consider some trends, and seek to answer the question: "Will rail be cost competitive with road haulage?"

5.1 Possible trend away from use of south coast ports and the Channel Tunnel

We have been told by transport operators and businesses that they expect a growth of traffic through east coast ports, as part of a shift away from the south coast ports of Dover and the Channel Tunnel. A combination of factors may drive this trend.

In the short term, with the end of the Brexit transition and an increased risk of delay in road freight via the Channel Tunnel and Dover, many in the transport industry expect that both imports and exports to continental Western Europe through the Humber will increase. This would be a reversal of the decline of European movements via the Humber, and growth through short sea routes, that occurred after the signing of the Maastricht Treaty. It would be a continuation of a trend already evident in recent years.

Driver shortages may encourage a change from long distance accompanied trailer moves via the short sea routes and Channel Tunnel to containers or unaccompanied trailers via the Humber.

In the medium term, actions to decarbonise road freight transport are likely to reduce the attractiveness of the long road haul via Dover and the Channel Tunnel and favour shorter road trips or rail haulage.

5.2 Costs

Road

Road haulage costs are increasing at nearly 2% per annum[18]. The sector faces uncertainty on its future costs. In addition to the cost of mitigating the problems of driver availability and an unclear trend in the price of fuel, there are the costs of meeting tighter vehicle environmental regulations, possible "emissions taxes", and of further road and port congestion. We have consulted with senior managers in the road haulage industry and their expectation is that costs will continue to rise in real terms at between 1.5% and 2% a year.

The additional administrative complexities of UK-EU freight movement following the end of the Brexit transition period have further increased haulier's costs.

Rail

The current circuitous routing of container trains between the Humber ports and Manchester tips the cost balance against rail. With no direct gauge-cleared route for high cube containers across the Pennines, trains currently have to run via the Midlands. This increases mileage-driven costs and reduces resource utilisation because locomotives, wagons and crews are occupied for longer than if a direct route across the Pennines could be used.

We expect the TRU will provide a direct route, via Huddersfield, reducing mileage and improving resource utilisation. Later, with national network electrification, the efficiency of electrically hauled freight trains will further reduce costs.

We have no cost benchmarks for a UK piggyback service. Compared with current freight trains, faster journeys will reduce costs by allowing improved locomotive, vehicle and crew productivity.

[18] Road Haulage Association/ Menzies LLP assessment of road haulage costs for the period 1st October 2018 to 30th September 2019, shows an increase in road transport costs of 1.88%.

For the notional piggyback route that we have developed as a case study, we have used a sample of British intermodal rail service costs per loaded tonne km for our modelling on the OFT Platform.

Shipping

Shipping costs vary significantly between routes and customers, and a volume commitment by the customer is a key part of the rate. Individual agreements between freight forwarders and shipping lines are the norm in the short sea shipping industry, so published rates do not give a good guide to the costs actually incurred for individual consignments.

To obtain economies of scale, ferry operators are investing in larger vessels to maintain a margin in the face of fierce competition and rate pressures.

We are unclear how costs will trend in the future as the industry takes on the changes associated with new trading flows and the technology for decarbonisation. Options will need to be regularly reviewed on how this affects business's choice of mode and route for Anglo-European traffic.

5.3 Will there be a trend from road trailers to containers?

Containers can be accommodated on Britain's railways, so a trend away from road trailers to containers may reduce the benefits of investment in piggyback rail.

However, we have seen no evidence of a trend away from road trailers towards containers for European traffic. While containers offer a well proven means of achieving modal change from road to rail, they have a series of disadvantages compared with road trailers. These include pay load weight penalties, and lack of flexibility in loading and unloading compared with the access provided by curtain sided trailers, see section 4.4.

5.4 CO_2

Road

Decarbonisation of road transport is a key commitment from government. The route to decarbonisation is not clear, with a range of alternatives being investigated. In the absence of an immediate cost effective technological solution, we expect that limited steps will be taken in the medium term to reduce CO_2 emissions. We expect this will be expensive and so increase costs.

Rail

The route to decarbonisation is clear, with much of the change through well-established technologies.

Shipping

The shipping industry is taking steps to reduce carbon emissions but the route to full decarbonisation is unclear. The trend is for larger capacity ships on ferry routes. These reduce CO_2 emissions for each tonne of cargo, so are cost-effective for cargo owners. But it is unclear how far these changes can achieve the necessary level of CO_2 reduction and then elimination. In the meantime, shipowners and operators are investigating alternative fuel types and engine configurations for new vessels, considering converting to LPG, battery power, hydrogen and even wind power.

We have examined some of the issues through the OFT Platform. It is clear that the impact of CO_2 emissions from the ship leg makes a very significant impact on the overall emissions of a particular route option. Under current UK government assumptions on CO_2 emissions by mode, it is electric rail that beats ferry per tonne mile.

Forecasts

In section 7 we report on our use of the OFT Platform to visualise the CO_2 impacts of different routing options. In this exercise we use the current UK assumptions on the generation of emissions by different transport modes. A next stage could be to use the OFT Platform to visualise the impact of technical innovations over the medium term, and consider how they would influence route and mode choice.

5.5 Discussion

Overall, we expect rail to have a cost advantage over road for a substantial portion of market between the Humber ports and North West England.

The Scenario 1 and 2 work has identified that the cost of transport by rail in England for containers is now very close to that of using road throughout, including port handling, lift on/lift off and road tripping to/from the customer's premises.

From a 2020 base where the costs of rail and road haulage of containers between North West England and the Humber ports are very close, there is evidence that road costs are expected to increase, while rail will benefit from efficiencies arising from major investment in the TRU and electrification. We expect rail to gain a cost advantage over road.

6 Rail Infrastructure and Services

The TRU will provide solutions for the movement of containers, but not piggyback road trailers.

In this section we seek to answer the question: "How can the traffic be accommodated on the rail network?"

6.1 Approach

The Market review in section 4 has described the physical characteristics of European freight currently carried by road across Northern England, and an indication of the potential additional traffic for rail. Carrying the two main types of unit – containers and road trailers – by rail present very different practical challenges. In this section we consider potential major enhancements to the rail network and terminals to enable movement of large quantities of European import/export freight in the UK by rail.

The key issues obstructing greater use of rail on the central trans-Pennine routes are cost competitiveness, route capacity and loading gauge. In developing rail solutions, the LHOFT team has considered two major rail freight infrastructure upgrades:

- TRU via Huddersfield, providing clearance for high cube containers.
- Notional new trans-Pennine route with gauge clearance for freight up to and including piggyback road trailers.

In the case of the Network Rail's TRU, we have made assumptions about the capability to accommodate high cube containers on the principal trans-Pennine route on completion of the enhancement work.

However, no project is underway examining options for rail to be able to accommodate road trailers on the highly constrained loading gauge UK routes. The LHOFT team has identified some possible solutions that could be considered, and developed an illustrative trans-Pennine piggyback concept that includes route and terminals. The aim of this workstream in the LHOFT project has been to support the development and testing of the OFT Platform, and to share the analysis and insights gained. It has not been to develop engineering designs and business cases for particular infrastructure schemes. We have therefore used the Platform to calculate train mileage run, operating costs, train capacities, and journey times for freight traffic.

The OFT Platform has a function that allows new land and sea routes to be modelled. We have used the trans-Pennine piggyback concept route to calculate the key inputs to the model. This has allowed us to compare rail and road and in terms of cost, journey time and CO_2. We describe the results in section 7.

6.2 Route for trains carrying containers

Gauge and Route Capacity

In a recent development, Network Rail has cleared the principal trans-Pennine route via Huddersfield for the conveyance of high cube containers on 'super low' wagons[19]. There is only a limited fleet of these wagons available in the UK.

We expect the step change improvement in gauge clearance for high cube containers on standard 1m high platform rail wagons[20] over the Pennines should come with implementation of the TRU. At the time of writing, we are told by rail industry contacts they are hopeful that government funding will be made available for the TRU, but nothing is confirmed.

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[19] Wagons classified IDA and FLA.

[20] This is described as W12 loading gauge.

In addition, following work by (among others) Transport for the North, Rail Freight Group, Logistics UK and the Chartered Institute of Transport, it is also possible that additional track and signalling will be provided so that an hourly freight path in both directions will be available from the upgrade. In the short term, this could provide capacity to meet the demand for three trains a day of containers from a combination of south and north Humberside to North West England.

We expect the TRU will provide capacity to handle these trains on the central section via Huddersfield. However, there are capacity pinch-points in various places, including east and west of the Pennines, but particularly acutely in Manchester.

We are unclear about the potential for longer freight trains to operate following implementation of the TRU. On many parts of the network, train length is very constrained. Long freight trains, potentially up to 750m, can be very efficient both in reduced operating costs and making good use of paths on the network.

Implementation of the TRU works will take some years to complete. Announcements on programme are due in 2021. It may be a reasonable planning assumption that within five to ten years, gauge and freight train paths will be available to enable train loads of containers to operate between Manchester and the Humber ports via Huddersfield.

In addition to gauge clearance and additional train paths, the TRU is expected to allow faster terminal to terminal transits for freight trains across the Pennines. This will not only improve service transit times but, as resource utilisation improves, could improve efficiency by allowing locomotives and wagons to make two round trips between the Humber and North West in 24 hours.

Manchester pinch point

Manchester's suburban rail network is already busy with passenger and freight trains. We are unclear about the capability of the new freight train paths across the Pennines created through the TRU to reach terminals in the North West. In addition, while the existing container terminals in the Manchester area have spare capacity at the time of writing, they will not be able to accommodate a significant increase in trains without expansion.

Electric haulage

Electrification of the trans-Pennine route via Huddersfield under the TRU will only be usable by freight trains if they are hauled by bi-mode locomotives, or there is an electric to diesel locomotive change on route, or there is more electrification of routes used either side of the trans-Pennine core by freight trains.

6.3 Route for trains carrying piggyback road trailers as well as containers

UK experience

We introduced the concept of piggyback rail in section 4. It is proven technology in daily service across countries in Europe.

The UK has experimented with piggyback systems in the past, but none have been particularly successful, principally because the loading gauge of UK railways is too restrictive to accommodate standard continental road trailers on piggyback wagons. European road trailers could be conveyed on rail routes with a GB1/P400 gauge. This gauge is the largest available in the UK, on HS1. A lift on/lift off piggyback trial using a pocket wagon[21], with a well into which the trailer's wheels can be slotted, took place between Antwerp and Barking in May 2012.

[21] For an example see https://www.vtg.com/wagon-hire/our-fleet/t72104da/

Gauge and Route capacity

In the medium term, with some growth in total throughput at the ports and gauge clearance for piggyback trains, Immingham and Killingholme could be sending between nine and 18 trains a day to a Manchester terminal. For our planning we have assumed 12 trains a day. The trains could carry both road trailers and containers.

In addition, three container trains a day, requiring the high cube W12 gauge, would run from Hull.

The creation of piggyback gauge clearance on existing busy railways in England would require major works to provide the necessary height and width. This would be very complex and costly. Moreover, the works would be very disruptive to existing users of the network. It is inconceivable that such enhancements could be made on any of the existing trans-Pennine routes or through central Manchester.

We therefore have developed an outline concept for a new trans-Pennine route with gauge clearance for road trailers on piggyback rail wagons.

Route

The piggyback concept route runs for 100 miles, between a road-rail transfer terminal west of Manchester via Sheffield to a rail-ship terminal that would serve the ports at Immingham and Killingholme. The route follows a mix of less intensively used passenger and freight railways, reopened sections of closed railways, and new construction. We have assumed the railway is principally formed of double track with some single line sections. Additional tracks to allow overtaking could be installed over some sections to provide more capacity. The notional route does not conflict with the TRU, and could be implemented at the same time as the electrification of mainlines proposed in Network Rail's Traction Decarbonisation Network Strategy.

The concept is not for a ‘high speed’ railway, but a conventional (60-100mph) route, with the capacity to operate a range of passenger and freight trains. For example, new electric South Humberside and Lincoln to Sheffield and Manchester passenger services could provide extensive benefits to users.

A route mainly for freight has been developed in the Netherlands where a dedicated freight railway linking Rotterdam to the German border has been constructed. The line, known as the Betuweroute, is 99 miles long so is comparable in length to our concept piggyback rail route.

Manchester pinch point

The central Manchester pinch point would prove a fundamental obstacle to the introduction of the piggyback train service. The notional route includes an assumed bypass link around Manchester, to reach a rail-road transfer terminal west of the city. This could also link into Liverpool, providing a west-east bypass of central Manchester. We have not considered whether the link west of Manchester to Liverpool could be of piggyback gauge.

Train Length and Capacity

Our view of the train service needed to carry import freight is provided in section 4.11 above. In our assessment we have assumed that trains could carry 30 or 40 unit loads, and be up to 750m long.

Further information

The notional route and services are described in Appendix A.

7 Visualising Change

The OFT Platform allows visualisation of complex freight routing decisions, allowing cargo owners, transport planners and government to model and visualise alternative routing strategies.

In this section we seek to answer the question: "How can the different mode and route options be visualised to businesses, transport operators and government, informing them and enabling them to take decisions?"

7.1 Optimising of Freight Transport

Businesses and their logistics providers face complex decisions on the choice of routes mode of transport for freight movements. The route taken by a consignment, and the UK port used, will depend on a range of factors including the country of origin / destination, the urgency of the movement, the availability of suitable sea freight capacity, and cost.

The OFT Platform illuminates this decision process, allowing cargo owners to test alternative routing strategies. These options can include use of rail across the Pennines and shipping via the Humber ports.

The Platform enables shippers to identify collaboration opportunities for long term transport plans, discover new intermodal routes and structure their transport plan accordingly. It enables logistics service providers to give visibility to their services, understand freight flows, determine the potential for new services and develop better transport plans with fewer empty miles. The visibility of aggregated transport data - including CO_2 emissions arising from different strategies - allows government and local authorities to design better policies and prioritise investment in infrastructure. Taken together, the results will be seen in reduced overall logistics costs and emissions.

The OFT Platform is designed to be deployed flexibly in any country. However, its roots of development and testing are in the North of England, during which the LHOFT team has collected and analysed freight transport data to gain a greater understanding of the market and generate ideas on how the routing of traffic could be improved.

7.2 Method

The OFT Platform was used to calculate journey time, cost and CO_2 for a Hanover to Manchester journey by routes with five characteristics, shown in Table 5 and Figure 7. We assumed transport of a single 45' container, with contents weighing 18.2 tonnes.

Table 5: Modes of transport for five route options from Hanover to Manchester

Option	Crossing	Mode of transport		
		Hanover to port	**Sea crossing**	**UK port to Manchester**
1	Rotterdam - Felixstowe	Road	Ship	Rail
2	Calais - Folkestone	Road	Channel Tunnel (electric rail)	Road
3	Rotterdam - Immingham	Road	Ship	Road
4	Rotterdam - Immingham	Road	Ship	Diesel Rail
5	Rotterdam - Immingham	Road	Ship	Electric Rail (TRU or Piggyback)

Source: Logistics Institute, University of Hull

Note: For Options 1,4 and 5, we assume local road delivery from the rail terminal to NW England destination.

Figure 7: Map to show routes from Hanover to Manchester

Source: Logistics Institute, University of Hull

In Option 1, the sea crossing is via Rotterdam-Felixstowe (blue route). The journey characteristics are road transport from Hanover to Rotterdam, unaccompanied crossing to Felixstowe, followed by rail from Felixstowe to Manchester Trafford Park, and local delivery by road.

In Option 2, the Channel Tunnel is used between Calais-Folkestone (pink route). The journey is otherwise by road transport throughout to Manchester.

In Option 3, the sea crossing is via Rotterdam-Immingham (green route). The journey characteristics are road transport from Hanover to Rotterdam, unaccompanied crossing to Immingham followed by road transport to Manchester.

In Option 4, the sea crossing is via Rotterdam-Immingham (green route). The journey characteristics are road transport from Hanover to Rotterdam, unaccompanied crossing to Immingham followed by diesel traction rail to Manchester Trafford Park, and local delivery by road.

Option 5 is the same as Option 4, except that electric rail haulage is used between Immingham and Manchester. In the visualisation exercise, we have only modelled the CO_2 impacts.

The OFT Platform allows users to input their preferred parameters for the visualisation. For this exercise we have used set of parameters described in Table 6 below.

Table 6: Source of inputs for each mode of transport			
Mode	**Source of the inputs for the Visualisation**		
	Journey time (km/h)	**Cost (£ per 45' container)**	CO_2 **(kg per tonne km)**
Rail	Average speed of intermodal trains between Norton Bridge and Winsford (Freight Network Study, April 2017)	Formula derived through regression analysis from a variety of indicative service costs. Fixed costs includes lift-on/off charges and inherent service initiation costs.	DEFRA 2020 with split between diesel and electric traction based on work done by Logistics Institute, University of Hull
Road	Dep for Transport. Vehicle Speed Compliance Statistics, Great Britain: 2018	Formula derived through regression analysis done by Logistics Institute, based on statistics of actual UK distribution loads for a large retail manufacturer.	DEFRA 2020, Average laden articulated HGV >33 tonnes
Short Sea	Various literature and scheduled time/distance calculations	Indicative costs obtained for individual services, with extrapolation based on distance for services we did not have indicative costs.	DEFRA 2020, LoLo: 0-999TEU, RoRo: 2000+ lane metres

Source: Logistics Institute, University of Hull

7.3 Results

The results of the exercise are shown in Table 7.

Table 7: Results						
Option	**Crossing**	**Transport mode UK port to Manchester**	**Result of the Visualisation**			
			Sum of distance km	**Sum of time h**	**Cost £**	**Sum of** CO_2 **eq(L)**
1	Rotterdam – Felixstowe (Ship)	Rail	1,062	25	1,479	967
2	Calais – Folkestone (Channel Tunnel)	Road	1,146	19	1,475	1,376
3	Rotterdam – Immingham (Ship)	Road	972	23	1,233	1,128
4	Rotterdam – Immingham (Ship)	Diesel Rail	987	25	1,280	1,011
5	Rotterdam – Immingham (Ship)	Electric Rail (TRU or Piggyback)	987	25	1,280	970

Source: Logistics Institute, University of Hull

Note: We have not yet included in our model a cost for UK piggyback train operation per mile with electric haulage, and have used the diesel haulage rate instead in this table.

From the results in Table 7, the following conclusions can be drawn:

- **Journey time:** The Channel Tunnel and road route provides the shortest journey time.
- **Cost:** Routing via Immingham offers significantly lower cost than via Calais. At 2020 price levels, road and rail between Immingham and Manchester have very similar costs. The visualisation does not yet include the cost efficiencies from the TRU, electric rail haulage and piggyback.
- **CO_2**: The rail haulage options have the best outcomes even before electrification. There are interesting trade-offs between shorter sea crossings/ longer rail haul (e.g., Felixstowe) and longer sea crossing / shorter rail haul (e.g. Immingham). Routing via Calais with road haulage significantly increases CO_2 above the other options tested.

8 Findings

The report shows the potential for train load quantities of containers between continental Europe and Manchester via the Humber ports to be transferred from road to rail, following the completion of the TRU. The report also identifies the much higher scale of the potential demand for rail if traffic in continental-height road trailers could be accommodated on a specially cleared east-west piggyback route across the north of England. In a case study we have made suggestions on how this might be achieved.

8.1 Questions

The report started with four questions:

1. What is the size of the market for rail, and is it sufficient to allow efficient train loads of traffic to be assembled?
2. Will rail be cost competitive with road haulage?
3. How can the traffic be accommodated on the rail network?
4. How can the different mode and route options be visualised to businesses, transport operators and government, informing them and enabling them to take decisions?

8.2 Size of the market for rail

A priority for this workstream has been to identify the potential market size for switching from road to rail, to give confidence in the potential for train loads of traffic.

HMRC's EU trade statistics do not include any information relating to the UK port of entry or departure. This constrained our analysis. It would have been easier and more accurate if HMRC and DfT Ports data sets were joined up, to provide a record of the route taken by loads from origin to destination.

We therefore made a detailed assessment of commodities, quantities and countries of origin in order to assign the most likely mode of transport and UK ports of entry. Potential train loads of traffic transferable from road to rail have been identified. The results are reported in section 4 and additional detail of the process followed is provided in Appendix C.

On the route between North West England and the Humber ports, the early potential for three train loads of freight traffic each day has been identified.

In the medium term, on the Hull to Manchester route we see the opportunity for three trains carrying containers each day. Between Immingham and North West England, the analysis suggests that between nine and 18 trains a day could be needed to move a combination of road trailer and container traffic. For our planning we have assumed 12 trains a day.

We have not included freight traffic moving between the EU and Ireland, chiefly through Holyhead, Liverpool and Heysham: if some of this could be switched to rail between the Humber ports and North West England, then this would provide the potential for additional traffic.

8.3 Cost of road and rail transport

The routing and transport mode of most freight movements are decided by cargo owners, principally on the basis of the door to door price, the speed and quality of transit. Increasingly, reductions in CO_2 and progress to decarbonisation are becoming factors. We have considered the likely trends in transport costs for road and rail, reported in section 5.

Road freight faces cost challenges, including those arising from driver shortages, road and port congestion, the need to reduce CO_2 and other emissions, and eventually – with technology not yet clear – to decarbonise completely. The technology to decarbonise HGVs and the future possibility of "emissions taxes" may increase haulage costs.

Rail freight faces general cost pressures too but counterbalancing these are some major cost efficiency initiatives which are currently underway. The route to decarbonisation is becoming clear, principally with electric haulage, which should offer lower costs than with the current diesel traction.

These trends will change the balance of decisions facing businesses on whether to use road or rail haulage. Our work provides evidence that, in the medium term, rail could be able to offer business lower costs than road on trans-Pennine hauls. As a further benefit, rail could be a cost effective means to decarbonise freight transport.

8.4 Rail network capacity and capability

Rail faces problems of constrained route capacity and limited flexibility in loading gauge. Where investments in new capabilities are necessary, we have identified possible solutions.

More rail routes will be gauge cleared to allow the international standard high cube containers to be carried in long, efficient train loads. Additional network capacity will provide more paths for freight trains to run at the times that customers need them, and with high levels of resource efficiency. We expect the route between Liverpool, Manchester and the east coast ports to be gauge cleared for high cube container trains in parallel with the TRU, but this has not been confirmed by Government.

However, capacity “pinch points” are likely to remain either side of the Pennines, particularly where routes have to pass through the major urban areas where high frequency passenger services operate. The problem is particularly acute in Manchester.

The most significant opportunity to switch traffic from road to rail will come if a rail route could be available to allow road trailers to be carried on rail wagons. In addition to the high gauge, the route could be optimised for freight transport, ensuring short journey times and very productive use of resources. Faster journeys will reduce costs by allowing improved locomotive, vehicle and crew productivity. We have developed a notional route to allow the train service and capacity options to be considered, and to provide input to the visualisation exercise carried out using the OFT Platform.

The route would provide additional capacity and gauge clearance for road trailers on trains but avoids many of the complexities associated with an attempt to adapt very busy mainlines on the existing rail network. The notional route described in this paper will involve large capital expenditure but appears to have the potential to build in many benefits for other freight traffic, aside from that serving the Humber ports, and for passengers. Additional detail is provided in Appendix A. More information on piggyback rail on the Continent is provided in Appendix B.

8.5 Enabling business, operators and government to make choices

We have used the results from our analysis and train service development to create illustrative route and service options. These have been modelled through the OFT Platform, and the results visualised to make clear the key factors that inform choices.

The modelling we have carried out to drive the visualisations covers cost, journey time and CO_2. The visualisations show the trade-offs when decisions are made about ports, ferry routes, distance and mode of overland haulage. They use 2019 data for their inputs.

The OFT Platform is designed to be flexible, allowing users to specify the value of inputs. A next step could be model and visualise future year changes in these input factors so that the impact on route and mode choice can be made clear. Examples of the application could include changes in rail and road infrastructure, port and sea ferry routes, shipping costs and emissions.

9 Recommendations

Our recommendations are in six areas:

1. Investigate and develop options for a range of potential future year changes in the key factors that drive choice in freight load routing and mode for Northern England's European imports and exports. The potential changes should include new port infrastructure and sea ferry routes, greater port and shipping service utilisation, additional capacity and schedule intensification on existing ferry routes, technology for decarbonisation of rail, road and sea transport, and provision of rail infrastructure to allow continental road trailers to be carried on trains between the Humber and North West England.

2. Identify options for additional road-rail intermodal terminal capacity to the west of Manchester, with road links to the city, M62 and M6. This would enable switch of freight from road to rail, and position terminal capacity to support the use of decarbonised road transfers for short distances to and from business premises.

3. Consider whether a Manchester by-pass railway, avoiding conflict with routes intensively used by passenger trains, could allow more freight trains to avoid the city centre and access road-rail transfer terminal sites. This would provide route capacity for additional freight trains to operate. It could also improve the cost efficiency of rail freight by allowing more productive use of locomotives, crews and wagons – a benefit that can be shared with businesses through lower transport costs.

4. Improve data availability for study of mode choice and routing of the UK's European imports and exports, by including port of entry and departure in HMRC Trade data. Consider how to join up the HMRC Trade and DfT Ports data, alongside the PRB Associates Short Sea Freight RoRo and LoLo Capacity Analysis. This would enable robust analysis of trade flows, identification of opportunities for route and mode change and improved forecasts. Data on full origin to destination freight journeys is key to this analysis.

5. Continue development of tools like the OFT Platform, allowing visualisation of choices for businesses, transport operators, infrastructure planners and government. This will enable them to test and understand the dynamics of options for decisions on mode and route.

6. Use the approach to analysis and visualisation through the OFT Platform described in this report, to consider options for infrastructure enhancement. This will provide clear explanation of the choices that need to be made that meet the twin priorities of higher business efficiency and decarbonisation.

Appendix A: Trans-Pennine Piggyback Rail Illustrative Concept

This Appendix describes a concept for a west to east rail route, around Manchester and across Northern England. It would have a piggyback gauge to accommodate road trailers on rail wagons. The route would also be able to carry passenger and conventional British-gauge freight trains.

A.1 Introduction

The concept route runs from a road-rail transfer terminal west of Manchester to the south Humberside ports of Immingham and Killingholme. To assess the journey times we used in our visualisation and modelling work, we envisage a substantial upgrade to mainline status of the existing lines used. New construction would principally be on the route of former passenger and freight railways.

To achieve a very efficient piggyback freight operation, well designed terminals that allow fast on and off loading of trailers, short journey times and high levels of punctuality will be essential. The concept is intended to show what might be achieved.

A.2 Terminals

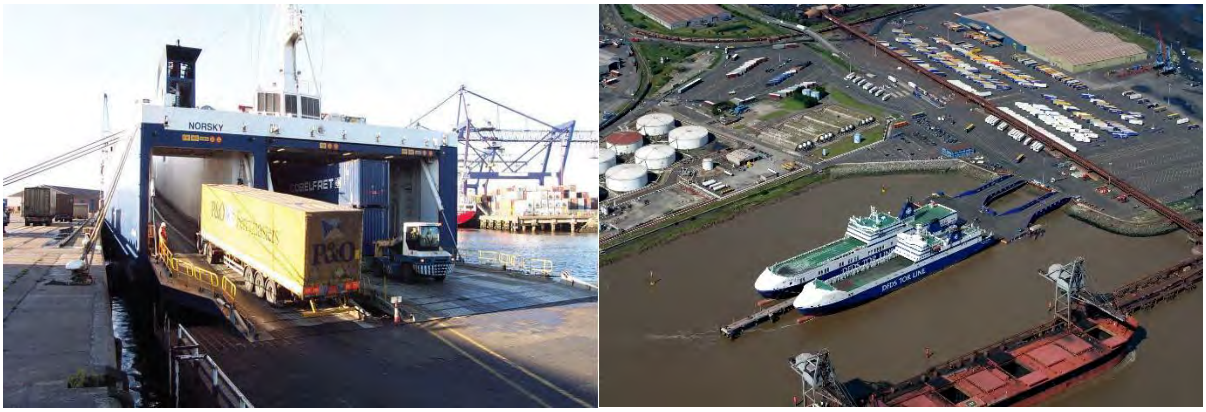
Manchester

We discussed the outline specification for the location of a road-rail transfer terminal to serve North West England with road hauliers and Highways England. Both stated a preference for a terminal west of Manchester, with road access to the city as well as the M6 and M62. We therefore assumed a west of Manchester terminal location for the route.

Immingham

There are two ports where road trailers are loaded to and from ships on the south side of the Humber - Killingholme and Immingham (Figure 8).

Figure 8: Loading and unloading unaccompanied trailers



Tugs would haul trailers between ferries and trains. There is an extensive rail network in the Immingham area along with large areas of level land. We assume that a suitable terminal site could be identified in a future study.

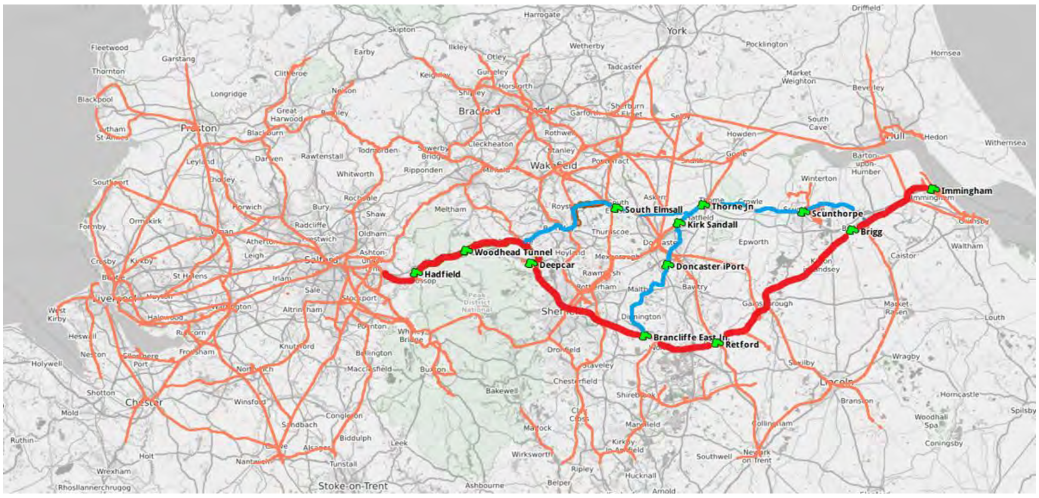
A.3 Route

Three potential Manchester to Immingham corridor options were initially identified, and one selected for the concept exercise based on:

- **Use, where practical,** of sections of existing and former railways.
- **Avoidance** of busy sections of the current rail network, and construction of new railway alignments through and near urban areas.
- **Minimisation** of rail distance and freight train journey times.

The concept route would run from Manchester to Immingham via Guide Bridge, Hadfield, Woodhead, Penistone, Deepcar, Sheffield, Retford and Brigg. It is shown in red in Figure 9. The other corridor options, not pursued for the exercise, are shown in blue.

Figure 9: Illustrative concept route between Manchester and Immingham, shown in red



Source: Logistics Institute, University of Hull

MANCHESTER BY-PASS RAILWAY AND ACCESS TO THE NORTH WEST ENGLAND ROAD-RAIL TRANSFER TERMINAL

A possible terminal location in the Manchester area depends on both good rail and road access. The Manchester rail network is congested, with very limited capacity for additional freight trains in the central area and on most radial routes. Moreover, the complex and disruptive works necessary to provide gauge clearance for piggyback trains on these lines would just not be feasible.

We therefore assumed the terminal would be reached by a Manchester-bypass freight railway made up of lightly used sections of the national rail network, reopening of closed sections of railway and limited new construction. We assume that the eastern end of the Manchester-bypass freight railway would join the Manchester Piccadilly-Hadfield (then to Sheffield and Immingham) line at Guide Bridge.

GUIDE BRIDGE TO HADFIELD AND DEEPCAR TO SHEFFIELD AND IMMINGHAM

These existing railways would be upgraded, within the existing railway land, with additional tracks to increase capacity over some sections and gauge clearance for piggyback trains. Station platforms, where these need to be against the track used by the piggyback trains, will need to be rebuilt to allow clearance.

Many significant structures are likely to require major work to make them suitable for electrification, the gauge and weight of freight trains, higher levels of service and higher speeds. We assume some short sections of single line will be used. For example, the single line over Dinting viaduct could remain and short sections of single line may assist in achieving gauge clearance in tunnels. In the case of Dinting, this would pose a capacity problem, especially in the commuter peaks, which could be solved by timetabling freight trains outside the high peak period. Bi-directional signalling on double track between Guide Bridge and Hadfield would be an advantage. The Gainsborough Central to Barnetby (Wrawby Junction) route is not currently intensively used. Evaluation of loading gauge enhancement on this route could result in some short sections of single track to lower costs for the upgrade.

The route from Deepcar to Woodburn Junction (Sheffield) is a former double track line that is now single track and only normally used by one freight train per day. This would be doubled.

Parts of the route are busy, for example between Wrawby Junction and Immingham. Here, the opportunity for some sections to have an additional track could be explored.

Hadfield - Woodhead - Penistone - Deepcar

A new railway would be constructed on this section. In the illustrative concept, it would largely make use of the route of the former line between Manchester and Sheffield that ran via Woodhead and closed in 1981. The Woodhead railway was one of the shortest routes across the Pennines. Its major engineering feature was a comparatively modern tunnel which was officially opened in June 1954.

After the route was closed, the tunnel was acquired by the National Grid, who have installed cables through it. We have assumed that the tunnel can be reopened to rail traffic, with National Grid high voltage infrastructure transferred to a new cable tunnel. The whole route could then be made available again as a trans-Pennine railway.

A double track route is the ideal requirement for a new freight railway. A freight route with single line sections is restrictive. But there may be cost saving benefits to be achieved in delivering piggyback rail by using a centrally placed single line through the constraint of major structures with limited clearance. Woodhead Tunnel is the main example on this route.

The disused track bed on either side of the tunnel is used by cyclists and walkers between Hadfield and Penistone, with a detour over the summit rather than through the tunnel. In our concept, a cycle and walking route would continue to run alongside the railway, either side of the central tunnel section.

Electrification

The whole route would be electrified with 25Kv overhead power supply. This would provide the traction power necessary to haul long freight trains over the route in between passenger services. Importantly, electric haulage by rail also provides savings in cost and CO_2 that we have used in our modelling of the benefits of rail haulage compared with HGVs.

A.3 Train Services

Freight

The infrastructure concept we have described is designed to support a minimum of two freight trains per hour, in each direction. Notionally, one would be a piggyback train, the other a piggyback, container or bulk freight train.

However on its own, the level of freight traffic we have identified is unlikely to be sufficient to justify the large capital investment required to create the route. We have therefore considered how further train services could be added to provide additional benefits.

Passenger

The characteristics of this railway, as a modern electrically operated 'conventional' mainline, opens up the opportunity for new passenger train services.

Any British conventional train would be able to run over the route. However, we have assumed that passenger trains that call at a station with a platform against a track cleared for piggyback gauge trains would need to be formed of rolling stock designed for the route. These vehicles would be designed to be able to operate safely, and call at station platforms, both on the new route and the conventional network. They would be electrically powered and equipped with access doors suited to use at both the platforms on the piggyback gauge cleared lines and standard national rail platforms.

The concept route would bring mainline electrification eastwards across the Pennines from Hadfield to Sheffield and on through Lincolnshire. New electric passenger services could operate from Manchester to Sheffield, Retford, Gainsborough, Grimsby, Cleethorpes and Lincoln.

There could be three groups of passenger services:

- Manchester Piccadilly to Glossop and Hadfield. Local services calling at all stations as now but equipped with new trains.
- Manchester Piccadilly each half hour fast to Hadfield then Penistone, Sheffield and extended onwards into Lincolnshire. These could run hourly to each of Lincoln and Cleethorpes.

- Sheffield local services, which could be equipped with new electric trains and potentially forming a new local service from Penistone into Sheffield.

Because of line speed limitations, we do not see the notional route as providing the principal service between Sheffield and Manchester, which would continue to be via the Hope Valley line and Stockport. The reopened route could offer a semi fast service, allowing passenger and freight trains to be timetabled together and providing a Sheffield to Manchester journey time of under an hour, every half hour.

The passenger services would also provide benefits for local people affected by the construction and operation of the new railway. Penistone station could gain platforms on the new railway. A new city centre station near the site of the former Sheffield Victoria could be reopened, potentially together with two local stations up the Don Valley from Sheffield, perhaps at Wadsley Bridge Stocksbridge. We have outlined a potential passenger train service that fits with the number of freight trains we have identified, and the freight train journey times that we have modelled through the OFT Platform.

A possible standard hour timetable between Manchester Piccadilly and Sheffield is shown below in Table 8. It has been developed using similar timings and a 60mph line speed over the route before its closure. With track and signalling in a modern form, 75mph or higher speeds may be possible. Taken together with provision of a separate local train from Penistone for the two possible new intermediate stations into Sheffield, a reduced Manchester-Sheffield timing of 50 minutes may be possible, with intermediate stops only at Hadfield and Penistone. This type of inter-urban service would be more suitable in the event of the trains extending eastwards to and from Lincoln and Grimsby / Cleethorpes.

Table 8: Example standard hour timetable between Manchester Piccadilly and Sheffield Victoria

Passenger service eastbound		
Manchester Piccadilly	10.22	10.52
Hadfield	10.42	11.12
Woodhead tunnel pass	*10/51*	*11/20*
Penistone	11.03	11.32
Stocksbridge	yes	yes
Wadsley Bridge	yes	yes
Sheffield Victoria	11.21	11.51
Continues to:	Cleethorpes	Lincoln
Passenger service westbound		
Arrives from:	Cleethorpes	Lincoln
Sheffield Victoria	10.05	10.35
Wadsley Bridge	yes	yes
Stocksbridge	yes	yes
Penistone	10.25	10.55
Woodhead tunnel pass	*10/37½*	*11/07½*
Hadfield	10.46	11.16
Manchester Piccadilly	11.04	11.34

Source: Developed by ORS for LHOFT.

Route capacity

The infrastructure concept and service pattern we have described would support two freight and two passenger trains each hour in both directions operating over the route through Woodhead.

With further enhancements to infrastructure, additional passenger and freight services could be operated. Instead of the alternating-by-direction timetable pattern through the Woodhead tunnel we have assumed, trains could be 'flighted' (follow each other at close headways) through the single-track section, so increasing throughput. However, potentially very expensive additional infrastructure may be needed on the approaches to the tunnel and on constrained sections such as the Dinting viaduct, to handle the bunching of services.

Additional passenger trains would provide the benefit of increased service frequency. Additional freight trains could open the possibility for more piggyback services for domestic rather than international flows.

A.4 Freight train transit times

An input to the modelling of the piggyback service has been to consider the journey time of trains between Manchester and Immingham. We have access to the schedules used by British Rail on the railway through Woodhead before its closure, but are conscious that piggyback trains will have very different characteristics – they will be long, heavy, and hauled by modern 25kv electric locomotives.

We have therefore taken the operational details of the Worgl-Brenner piggyback rail route in Austria (see Appendix B) and have used them as a benchmark for describing how a similar operation may work on the Manchester to Immingham route. This is based on the assumption that if piggyback freight trains with two modern electric locomotives can travel at a certain speed over the extreme gradients of 1 in 40 and very tight curves (248m radius) of the Worgl-Brenner route, similar or better timings should be achievable over the Immingham-Manchester route.

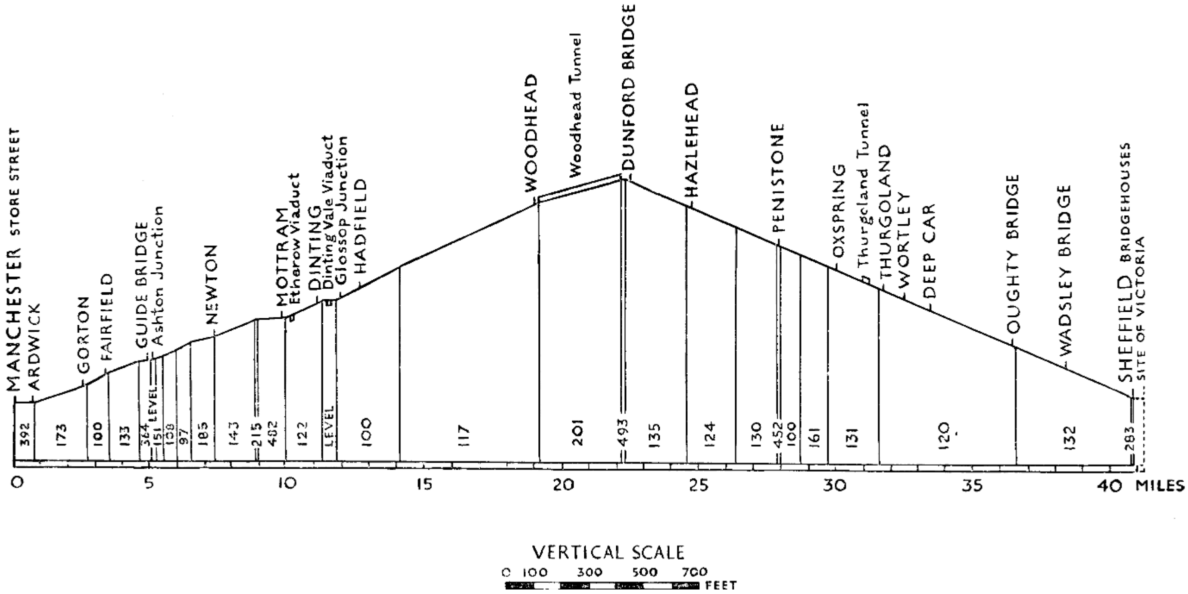
Worgl to Brenner is a distance of 61.5 miles (99km), with piggyback trains traversing this route in a southerly direction (uphill) in 2h20mins, giving an average speed of 26.5mph.

Immingham port to Manchester via Sheffield and Woodhead is 100 miles (160km) with 20 miles of near-continuous climbing on both sides of the Pennines, shown in Figure 10. Applying the average speed given by the piggyback service on the Worgl-Brenner route would give a transit time between Immingham and Manchester of 3h45. However, given that the Woodhead route has gradients nowhere near as steep as the Austrian route, higher average speeds should be attainable:

- Average speed of 35mph   Transit time - 2h50
- Average speed of 40mph   Transit time - 2h30

Given the favourable speed profile of the route, potentially allowing sections of 60-70 mph running, and with modern traffic control systems, we have chosen a terminal to terminal time of just under 3 hours for our plan. By comparison, a loaded HGV would travel by road between the same points in 3h00 to 3h30.

Figure 10: Sheffield-Manchester via Woodhead route gradient



A.5 Freight service programme and capacity

If rail's costs are to be competitive with road, it is vital that a highly efficient operation is put in place. We have developed a train service and resource programme that would meet the likely demand and has flexibility to handle growth.

In our concept, between nine and 18 trains would operate the Manchester to Immingham piggyback and container service, in each direction on Mondays to Fridays. We have assumed 12, but the actual number would depend on demand, the trade-offs between the length of train operated and the frequency of service.

In comparison, on the benchmark Worgl-Brenner route, trains run at regular hourly intervals, 18 times a day on weekdays, and less frequently at weekends.

With each train formed of 30 platforms, 12 trains a day would give a daily capacity of 360 trailers and containers in each direction. With the addition of a less frequent weekend programme, an annual capacity of more than 100,000 units in each direction is achievable.

Additional capacity could be provided either by increasing the number of services or introducing longer trains of 40 platforms.

Appendix B: Piggyback Rail in Europe

Piggyback rail enables road trailers to be loaded on to rail wagons. There is a growing network of piggyback trains in Europe, many of which extend to the Channel ports.

B.1 Introduction

Piggyback rail has long been used in North America. It is being developed and deployed increasingly in Europe, including in Germany, Austria, France, Italy and Switzerland. The operational benefit of this system is that loads do not need to be trans-shipped between road and rail, as the trailer is driven or placed directly onto the wagon.

In some cases, the road tractors are also carried, with the drivers in passenger coaches attached to the train. This applies in the Austria-Italy ROLA service operated by Rail Cargo Group, between Worgl and Brenner. The route takes lorries and drivers across the Alps. There are 18 trains a day in each direction, providing an hourly service.

Another piggyback rail service relevant to UK traffic is the VIIA network. Centered on France, VIIA reaches the port area of Calais, where road trailers to the UK must be transferred to ferries then road hauled from the UK port to destination.

B.2 Technology

Key to the development of piggyback rail has been the wagon technology, allowing for very fast and efficient loading and unloading at specially equipped terminals.

Four types of rail wagon are in service on piggyback operations in Europe. Loading and unloading at terminals is quick and efficient. In addition to the wagons used by VIIA, with platforms that swivel to allow the trailers to be hauled on and off by tugs, some require cranage to physically lift road trailers on to the train, while others involve a 'metal platform' being moved with the trailer on to a rail vehicle.

Piggyback trains in Europe use four types of wagons:

- **A lift on/lift off wagon** where a road trailer is physically lifted onto/off a rail wagon. In the UK, the last builds of this type of wagon were the Thrall (KDA Eurospine bogie wagon) and the Babcock mega 3 wagon (KAA). Both had limited success due to the UK gauge restrictions, and requiring trailers specially adapted to be lifted by cranes.
- **An end loading wagon** where road tractors and trailers can drive on to/off a wagon. These wagons are used in the Worgl-Brenner case study, see section B.3 below.
- **Using a sliding steel platform.** The Cargo Beamer type wagon uses a steel platform that is placed parallel to a rail siding. A trailer is driven on to the steel platform and, upon the arrival of the train, the platform is side shifted onto the rail wagon.
- **Using a rotating wagon platform.** The LOHR type wagon is used by VIIA, where trailers are parked at an angle next to the rail siding. When the train arrives, part of the wagon body pivots out by around 45 degrees. The trailer is moved onto the wagon which then rotates back into place.

B.3 Case study: Austrian Worgl-Brenner RoRo route

The gradients experienced in mountainous parts of Europe are far more severe than in the UK, so heavy freight traffic is actively encouraged off the road and on to piggyback rail.

Figure 11: Piggyback rail on the Worgl-Brenner route

The Austrian transalpine piggyback system moves road freight by rail across mountainous and environmentally sensitive areas, such as Worgl to Brenner (Figure 11). Traffic then continues either by road or rail down the somewhat gentler slopes towards the Austrian/Italian border.

Austrian railways (ÖBB) operate 18 trains a day now, and plan to increase the number of daily piggyback trains and capacity on the Brenner corridor from 200,000 lorries a year to around 450,000 in a bid to switch more traffic from road to rail. This is one element of a 10-point plan to reduce the environmental impact of lorry traffic on the Brenner Autobahn through Austria.

B.4 Case study: VIIA Network

VIIA is a French based system with an extensive network. VIIA is planning new routes, and additional capacity, and expects to see growth in market share.

Figure 12: VIIA network

The VIIA network of piggyback services started in 2003 with the Alpine Rail Highway and has since grown to seven routes (Figure 12 and Table 9). The services have been a success with 100,000 units per year transported on the network.

TECHNOLOGY

Each wagon has two road trailer carrying platforms. Ground based electric motors swivel the platforms through approximately 45 degrees to allow loading/unloading (see Figure 13). The network is particularly flexible as standard European road trailers can be conveyed. They do not need special fitments for lifting (it is estimated that only around 10% of European trailers have this special fitment). Rolling stock is intensively used. Some mixed trains operate, carrying road trailers and containers.

Terminals and Routes

Transfer sidings have loading areas on both sides of the track, at the same level as the carrying platforms on the wagons so that trailers can be hauled on and off by tugs or tractor units.

At Le Boulou (Figure 6), trains can be assembled in two or three segments, depending on length. A train consisting of 10 wagons with 20 trailers can be discharged and re-loaded in as little as 90 minutes. The present terminal utilisation is 10 wagon segments 10 times in 24 hours, providing capacity for 200 trailers a day. However, VIIA plan to increase productivity to 16 wagon segments in 24 hours, allowing capacity for 320 trailers in a day.

Figure 13: Wagon platforms can swivel to allow loading/unloading

The Calais terminal was completed in 2015 and cost €7m. It is on an old hover port so had an existing surfaced platform. It enables transfer of unaccompanied trailers from the train directly to ferries to connect to the UK.

The new Bettembourg-Dudelange terminal in Luxembourg is designed to transfer 600,000 semi-trailers and containers between road and rail per year.

Table 9: VIIA Routes

Route		Start of operation	Frequency	Capacity	Journey time	Distance of road travel avoided
Aiton–Orbassano	Connects France and Italy across the Alps	2003	Up to 5 round trips per day, 6 days per week	Up to 40 trailers per train	3 hours	175 Km
Le Boulou-Bettembourg	Connects Spain with Luxembourg, Eastern and Northern Europe	2007	3 round trips per day, 7 days per week	48 trailers per train	15 hours	1,054 Km
Le Boulou-Calais	Connects Spain and the UK	2016	Up to 2 round trips per day, 6/7 days a week	Up to 40 trailers per train	22 hours	1,200 km
Orbassano-Calais	Connects Italy and the UK	2018	Up to 5 round trips per week	Up to 40 trailers per train	18 hours	1,069 km
Barcelona-Bettembourg	Connects Spain with the low countries	2019	6 round trips per week		22 hours	1,152 km
Macon- Calais	Connects the Rhônes-Alpes region to the UK	2019	1 round trip 5 days a week on each line	Up to 40 trailers per train		680 km
Macon- Le Boulou	Connects the Rhônes-Alpes region to Spain	2019	5 round trips per week on each line	Up to 40 trailers per train		541 km

Source: ORS analysis for LHOFT.

VIIA claims that most routes save c.1 tonne of CO_2 per trailer per trip, with a 90% reduction in greenhouse gases compared to road transport.

Appendix C: Export and Import Freight Data

The HMRC regional trade data provides a high-level, but limited, picture of UK trade with Europe. For trade with EU countries, there is no identification of the UK port of discharge and loading for imports and exports.

By utilising expert knowledge of UK port movements, allied to a detailed understanding of the deployment of short sea freight RoRo and LoLo shipping and Channel Tunnel freight capacity, a more detailed mapping of freight flows by UK port has been possible.

C.1 Approach

Analysis of HMRC data has provided the base matrix of trade information for import and export flows between North West England and 41 European countries, across 66 different commodities (SITC 2-digit level). Attention was then focussed on 32 countries in Central, Northern and Eastern Europe that are more relevant in this rail study. Forecasts of exports and imports were produced for the next five years. The likely UK ports of entry for each country-commodity combination were assessed.

C.2 Use of HMRC data to understand current freight flows

The data on current freight flows were extracted from the HMRC trade data website which allows the user to select a bespoke data set. Given the interest in regional freight flows, and in particular freight flows to and from the North West of England, we focussed on regional data. This allowed us to extract for each UK region (nine English regions along with Scotland, Wales and Northern Ireland) quarterly data on the total tonnage of imports and exports to foreign countries broken down by SITC code to SITC level 2. This enables an in depth investigation of regional trade.

The raw HMRC data was manipulated into data arrays to enable straightforward data visualisation of tonnage by region, country, product and time for both imports and exports. Exploratory data analysis was performed to produce summaries of the data reported below. Time series analysis of trends in the data were performed using the forecasting app[22] developed at Lancaster University as part of the LHOFT project.

Table 10 below shows the country-by-country results, for exports and imports, together with a flag to indicate whether each country is among in the 32 countries included in the further forecasting exercise.

[22] https://aaronplowther.shinyapps.io/host-hmrc/

Table 10: North West England Exports and Imports 2019 ('000s tonnes), showing whether included in the countries selected for trade forecasts								
Country	**Included?**	**Exports**	**Imports**		**Country**	**Included?**	**Exports**	**Imports**
Austria	Yes	25.69	61.00		Portugal	No	80.84	265.45
Belgium	Yes	239.87	726.07		Romania	Yes	26.17	26.79
Bulgaria	Yes	4.26	7.46		Slovakia	Yes	23.99	46.47
Croatia	Yes	2.56	0.96		Slovenia	Yes	5.91	10.16
Cyprus	No	6.06	0.27		Spain	No	197.40	412.50
Czech Republic	Yes	28.48	67.66		Sweden	Yes	81.74	161.22
Denmark	Yes	48.96	89.76		Azerbaijan	Yes	1.21	0.02
Estonia	Yes	12.26	5.37		North Macedonia	Yes	0.56	2.13
Finland	Yes	57.62	96.55		Georgia	Yes	0.45	6.72
France	No	266.49	412.72		Kazakhstan	Yes	1.78	0.02
Germany	Yes	569.01	1459.21		Other Eastern Europe	Yes	3.29	12.99
Greece	Yes	11.89	5.10		Russia	Yes	33.92	102.48
Hungary	Yes	15.24	22.63		Serbia	Yes	2.65	2.59
Irish Republic	No	529.90	273.11		Ukraine	Yes	5.30	3.53
Italy	Yes	118.03	382.11		Gibraltar	No	1.86	0.04
Latvia	Yes	5.48	15.62		Iceland	Yes	7.37	0.95
Lithuania	Yes	17.48	40.12		Norway	Yes	25.13	265.61
Luxembourg	Yes	7.83	19.37		Other Western Europe	No	0.21	0.01
Malta	No	5.81	0.18		Switzerland	Yes	48.21	16.78
Netherlands	Yes	347.29	719.06		Turkey	Yes	83.48	309.10
Poland	Yes	120.80	198.27					
Source: Analysis of HMRC data by Lancaster University and University of Nottingham, Prof Peter Neal.								

C.3 Trade Forecasts

The forecasts presented in this paper were obtained using a seasonal ARIMA model which allows the incorporation of quarterly effects into a time series model for imports and exports. They cover the 32 countries in Central, Northern and Eastern Europe that are most relevant in this rail study, where we are considering the scope for rail to have a greater role in handling traffic at the Humber ports.

The quarterly data from the first quarter 2013 to the last quarter 2019 (28 quarters) were used to fit the model. We choose to start modelling the data from the first quarter 2013 since that was the first quarter where the HMRC's current methodology of estimating regional imports and exports was introduced, see HMRC (2018) Regional Trade Statistics Methodology Paper[23]. For both imports and exports, the most appropriate seasonal ARIMA model was selected using Akaike Information Criterion, which balances model fit with the number of model parameters. Forecasts are generated for five years starting with the first quarter 2020 with point estimates given alongside 95% confidence intervals to give a measure of the uncertainty in the forecasts. For the first two quarters of 2020 we can compare the forecasts with actual imports and exports. However, due to the effects of Covid-19, the observed imports are considerably lower than the forecasts with exports less affected.

The forecasts are shown in section 4 and are repeated here for convenience (Figures 14 and 15).

Figure 14: Exports: North West of England to Central, Northern and Eastern Europe (SITC 1, 5-8)

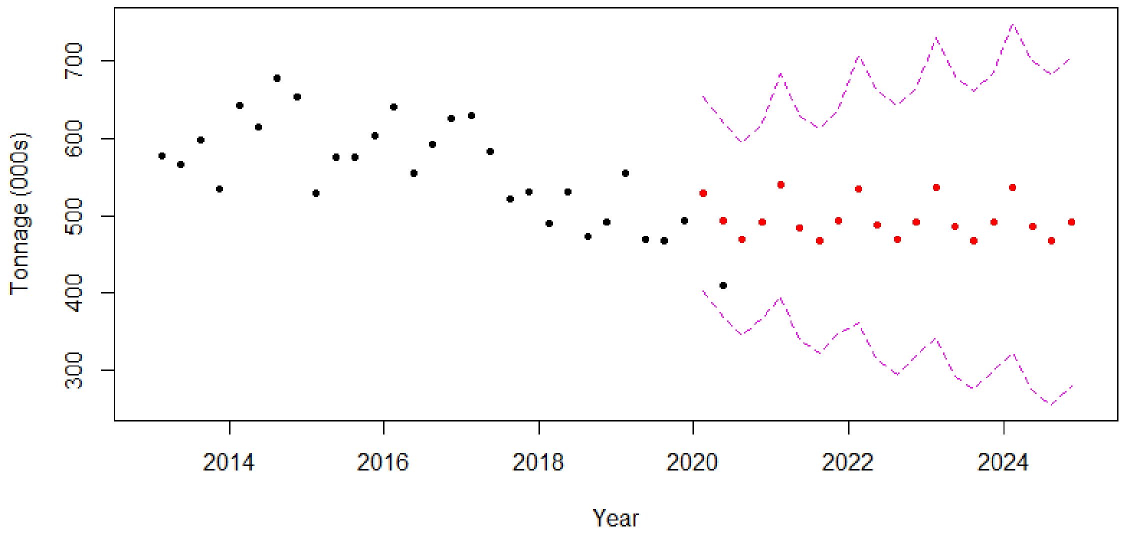


Figure 14: SITC Level 1: Products 1 (Beverages & Tobacco), 5 (Chemicals & related products), 6 (Manufactured goods classified chiefly by material), 7 (Machinery & transport equipment), 8 (Miscellaneous manufactured articles) exports from the North West of England Europe (32 countries + Other Eastern European) in 1000 Tonnes by quarter from the first quarter of 2013. Observed exports – black dots; Forecasted exports – red dots; 95% confidence interval for forecasts dashed magenta lines. Source: Lancaster University and University of Nottingham, Prof Peter Neal, analysis of HMRC data.

[23] HMRC (2018) Regional Trade Statistics Methodology Paper - March 2018. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697012/RTS_Methodology_Revision.pdf

Figure 15: Imports: North West of England to Central, Northern and Eastern Europe (SITC 1, 5-8)

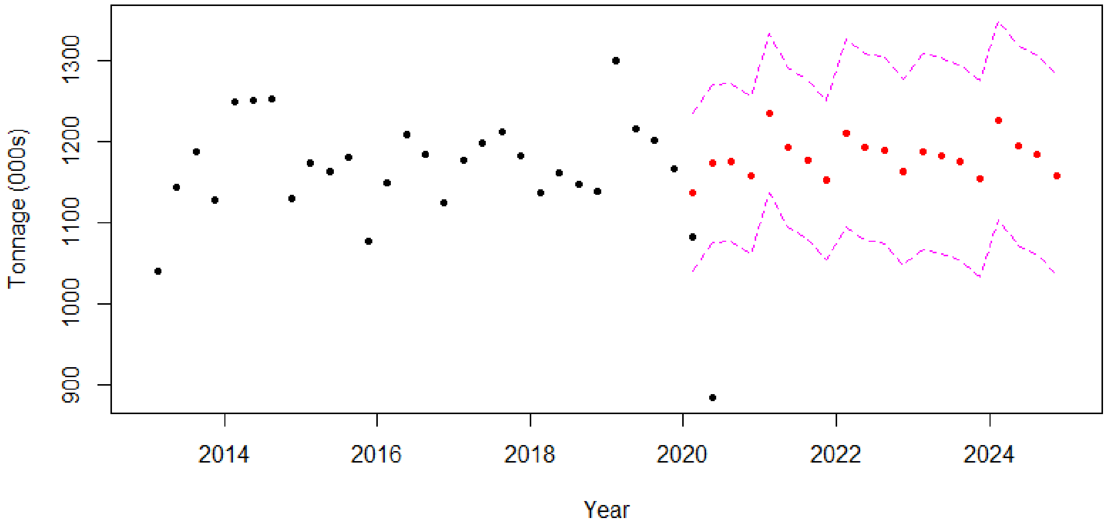


Figure 15: SITC Level 1: Products 1 (Beverages & Tobacco), 5 (Chemicals & related products), 6 (Manufactured goods classified chiefly by material), 7 (Machinery & transport equipment), 8 (Miscellaneous manufactured articles) imports to the North West of England from Central, Northern and Eastern Europe (32 countries + Other Eastern European) in 1000 Tonnes by quarter from the first quarter of 2013. Observed exports – black dots; Forecasted exports – red dots; 95% confidence interval for forecasts dashed magenta lines. Source: Lancaster University and University of Nottingham, Prof Peter Neal, analysis of HMRC data.

C.4 Conversion of Tonnages to Unit Loads

The next step in the analysis was to convert the import tonnages from every country shown in Table 10, for each qualifying mode (i.e. non-bulk), into an equivalent number of unit load movements using average payload estimates ranging from 16 tonnes for trailers up to 18 tonnes for containers and 24 tonnes for tank containers. This resulted in a worksheet, with each country / commodity combination linked to a specific mode of transport, giving an estimated number of loads for the year.

C.5 Allocation of flows to English Ports

Evaluating the mode of unit load mode of transport for each country-commodity combination (41 x 66 = 2,706 combinations) was the first process required to evaluate the potential port of entry.

The possible modes of transport are:

- Accompanied trailer
- Accompanied or Unaccompanied trailer
- Unaccompanied trailer
- Unaccompanied trailer or Container
- Container
- Tank container
- Bulk or container
- Bulk or Accompanied trailer (sugars)
- Bulk or Tank container
- Bulk or Unaccompanied trailer

In addition to those commodities that will be transported by unit load mode, there are those among the 66 commodities that may be transported *either* as bulk *or* in unit load mode, *and* there are those that will be shipped as bulk in conventional vessels.

Where the country-commodity combination is considered likely to be carried by one or other of two unit load modes, the model incorporates a percentage split that can be changed and reflected in the output results.

For the current version of the model, the unaccompanied trailer mode is considered to dominate (95%) the mix when it is considered against the accompanied trailer and container modes. Where commodities could be either shipped as bulk or carried in unit load mode, the balance is currently considered to be 50/50.

The final step in the process was to spread each of the derived number of estimated unit load flows for each country across the routes and UK ports of entry most likely to be used for particular unit types coming from individual countries. The Excel file contains a worksheet for each country in which the unit load flows, identified by mode, allocated to UK ports of entry most likely to serve the country and mode in question. For example, a load of office equipment moving from the Netherlands to Irlam is most likely to be conveyed in an unaccompanied trailer via Immingham.

This allocation to ports was carried out by using the UK Short Sea Freight RoRo and LoLo Capacity Analysis and Report[24] findings that provide an evaluation of the unit load capacity serving all routes between the UK and continental Europe, Scandinavia, the Baltic and Ireland.

By way of example, for routes serving links between the Near Continent and Northern Europe and the UK for unaccompanied trailers, the split of service capacity serving the market is shown in Table 11 below. It reflects the short sea maritime capacity available on RoRo and LoLo links between the Near Continent and North European countries (not including Scandinavia and Baltic States) for unaccompanied trailers to the UK and specifically for the North West of England.

Table 11: Split of service capacity for unaccompanied trailers

Port	Percentage of Traffic Assumed by Port of Entry	
	Destined for all UK	Destined for NW England
Tyne	0.69%	0.00%
Teesport	6.07%	0.00%
Hull	4.72%	6.52%
Killingholme	23.19%	32.04%
Immingham	12.40%	17.13%
Felixstowe	9.68%	13.37%
Harwich	14.01%	19.37%
Tilbury	8.37%	11.56%
Purfleet	17.30%	0.00%
Dagenham	3.58%	0.00%

Source: PRB Associates analysis from HMRC and DfT data. Note: Specified intermodal loads only

There are a total of 16 different routing option ranges defined, including the one above, according to country of origin and mode of transport. The resulting analysis for each country is summarised into one worksheet within the file, breaking down the number of different unit types (accompanied trailer, unaccompanied trailer, container and tank container) destined for North West England handled through each appropriate UK port.

C.6 Summary of European imports to North West England by port of entry

Table 2 in section 4.8 shows the results of the exercise to assign traffic to ports of entry.

In 2019, we estimate that 364,257 import freight units arrived by sea in the UK from European countries and were then moved overland to destinations in North West England. Of this total, 109,480 of the import unit loads from European countries were estimated to enter the UK via either

[24] http://www.prbassociates.co.uk/rorololo.php

Immingham or Killingholme ports. Thus, Immingham and Killingholme handle 30.0% of the total number of import units destined for the North West of England.

In addition, a further quantity of European unit load import traffic ultimately destined to the North West of England will first be routed from the ports to national and regional distribution centres, which are mostly located in the 'heart' of England, the 'Golden Triangle' around the M1 / M6 junction in Northamptonshire.

To set this in context, this means that of the 527,490 units moved through Immingham and Killingholme for any destination (DfT Maritime statistics 2019), 20.8% are destined to the North West of England.

Among other inbound traffics entering the UK through Killingholme and Immingham, there will be traffic destined to North Wales, Northern Ireland and the Republic of Ireland, all possible traffic for the trans-Pennine rail service.

Appendix D: Contacts

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