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# Investigating freight corridors towards low carbon economy: evidence from the UK

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**Abstract**

The objective of this study is to gain a better understanding of whether a freight corridor concept, as promoted by the EU TEN-T initiative, is feasible and sound and can be promoted to reduce the environmental (greenhouse gas) impact of long distance freight operation. Research has been conducted to investigate the characteristics of freight corridors across the European Union. This paper reports the analysis of freight corridor links from the UK and Ireland to Duisburg, Germany. This analysis is based on desktop research and interviews with UK freight operators. The findings suggest that the corridor is relatively green and, by its use, has the potential to attract greener freight flow. The key barriers are capacity bottlenecks on road and rail. We found that key improvement opportunities to promote the use of the green corridors are: the uptake of Channel Tunnel surplus capacity; released capacity on rail due to the planned high speed lines; better train management systems and the development of cleaner road transport.



*Keywords:* transport policy; $CO_2$ emissions; transport technologies; freight

## 1. Introduction

The concept of 'Green freight transport corridors' was launched as European Commission (EC) policy in the Freight Transport Logistics Action Plan of 2007, with the intention of concentrating freight traffic between major hubs and over relatively long distances and with a view to developing sustainable and competitive co-modal freight services (EC, 2007). The concept has been developed further within the SuperGreen project, which was tasked by the EC to explore and investigate the feasibility of various possible corridors within the Trans-European Transport Networks (TEN-T) policy-setting Green Paper (EC, 2009) and is also epitomised by the recent 2011 White Paper on Transport. This aims to shift road

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freight, carried over 300km, to more environmentally sustainable modes such as rail or waterborne transport - 30% by 2030 and 50% by 2050 - in order to achieve an overall 60% greenhouse gas (GHG) emission reduction (EC, 2011).

The SuperGreen project used the TEN-T structure to investigate priority freight corridors and this paper focuses in on the authors' work to address the concept in the United Kingdom (UK) and Ireland, from the Channel Tunnel to Glasgow with Liverpool–Dublin links, here named the 'Cloverleaf Corridor.' Fig. 1 demonstrates how the UK, as an island, has a higher proportion of domestic road freight operations than the EU average for internal trade: 67% versus 46%. A significant proportion of this is Irish freight traffic transiting through England. A large proportion of the higher value trade between Ireland and Europe (approximately 1.5million tonnes of imports and a little lower volume for exports) passes overland by lorry through Great Britain, mainly down to the ports of Southeast England and the Channel Tunnel (Inter Trade Ireland, 2008).

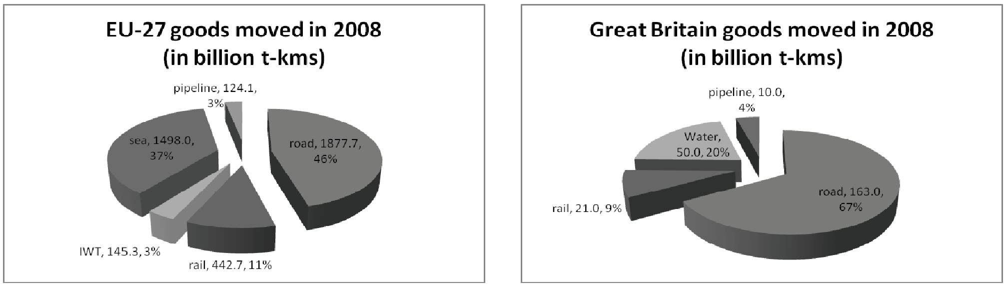


Fig. 1 Comparison freight volume and mode choice between EU and GB data (source: EC, 2010; DfT, 2009)

The paper is structured as follows: Section 2 discusses the UK freight profile and the current practices. Section 3 discusses the SuperGreen project methodology, with focus on the Cloverleaf Corridor. Section 4 presents the interview with UK freight operators about the feasibility of the green corridor concept. Section 5 contains the conclusions of the UK green corridor concept exercise, addressing the UK agenda of the future low carbon economy.

## 2. UK Freight profile - making the case for added value 'green' corridors: a literature review

A UK government funded study reported that domestic freight transport in the UK generated 33.7 million tonnes of $CO_2$ in 2004: roughly 21% of emissions from the transport sector and 6% of total emissions from all sectors (McKinnon, 2007). UK Road transport alone accounted for 92% of these freight-related emissions, but the $CO_2$ freight emission estimation varies, depending on contested underlying assumptions. The latest UK guideline to industry on the $CO_2$ estimation can be seen in Table.1.

Table.1 Modal Carbon Emissions Comparison (Source: adapted from AEA, 2010)

| Mode of transport | Type | gram $CO_2$ per net tonne km |
|---|---|---|
| Road Freight | HGV (average) | 124.70 |
| Rail Freight | Diesel/Electric | 28.50 |
| Shipping | Various Vessels (exclude Large RoPax) | 2.00 – 50.00 |

The gap between road freight and any other mode, in terms of emissions and volume, has led to a series of studies to explore freight modal shift in the UK. Several of these studies have suggested that rail and water freight should be promoted, to achieve modal shift away from road and movement to rail was seen as a good policy move towards achieving a greener transport system (Santos et al., 2010 and UoW, 2010). Rail has dominated the coal haulage market and the growing intermodal markets, particularly port-based intermodal, domestic intermodal and Channel Tunnel flows, are the areas of potential growth (UoW, 2010). For water transport, unitised and biomass cargoes are envisaged to offer considerable growth. At a regional level, a study conducted by AECOM and ITS Leeds (AECOM, 2011a and 2011b) proposed a number of alternative freight flows that favour rail and/ or water transport in order to achieve modal shift. This micro level study used a model that assumed road freight costs at £16 per tonne lifted, for an 120km journey (low fixed costs but fairly high movement costs), whilst rail and water freight were estimated at £12 per tonne (but with high fixed cost component and relatively low movement costs).

To have a better picture of the UK freight profile, transport network and technologies, the next sub-sections discuss each of the transport modes separately.

### *2.1. Rail freight network and technology in the UK*

Much of the 21,000 miles of UK rail network has mixed traffic (freight and passenger) capability, with a small number of sections designated as freight-only routes and others where freight is restricted or excluded (DfT, 2010b). Forecasts show that the daily volume of freight trains (both directions) will continue to increase from 2007 to 2030, with the West Coast Main Line (WCML) experiencing the most traffic (MDS Transmodal, 2009). In 2007 it was estimated that most of the rail freight-capable tracks carried between 10 and 100 freight trains per day, but the segment between the West Midlands and Liverpool, on the WCML, reported up to 200 trains per day. By 2030, most of the segments, especially the links from Channel Tunnel to London and then to the WCML, are estimated to achieve more than 250 freight trains a day.

In the UK there were 278,496 freight train movements in 2009/2010 moving 19.1 billion tonne kilometers; thus rail freight accounts for 8% of the domestic freight market (Clarke et al, 2011). There are approximately 600 freight locomotives, operated by 5 primary operators. Over 400 Class 66 locomotives (first introduced in the UK in 1998) are in operation and represent around 80% of the diesel locomotive market. The Class 66, which has life expectancy of 40 years (and thus is expected to be in operation within the UK rail freight network up until 2040's), is a six axle diesel-electric freight locomotive, developed in part from the British Rail Class 59 and manufactured by Electro Motive Diesel (EMD); there have been various modifications made to the Class 66 in operation across Europe, including France, Scandinavia and Spain.

AECOM (2011b) examined some manually collected data from the 34 UK Class 66 rail freight operations run by two UK freight operating companies and concluded that the fuel consumption and emissions of the locomotive is affected by numerous factors. These include: driver style; route; number of stops; train weight; signal spacing; length of passing loops; unloading time and facilities and congestion on the rail network. Regarding the emissions standard, the Class 66 locos with 2420kW engines are still within the legal limit of Stage IIIA for EU Non-Road Mobile Machinery Directive. When the new emission standard (Stage IIIB) is introduced in January 2012, in-engine improvements may be no longer sufficient and after-treatments technologies and hybridisation of diesel traction are the future research direction, to reduce the already outstanding emission levels from rail. The UK Department for Transport (DfT) reported the rail carbon emissions rate for company reporting as 28.5 g $CO_2$/t-km (for both diesel and electric), while a variety of other studies suggest actual rates between 15 and 37 g $CO_2$/t-km. It is reported that there has been less motivation to reduce fuel consumption in the rail freight sector, compared to the road freight sector, because fuel accounts for only 15% of costs for rail, compared to 30% for road; but fuel price rises since 2008 have prompted action (Clarke et al., 2011).

### *2.2. Road freight network and technology in the UK*

Unlike rail freight, mainly served by a particular locomotive (Class 66), road freight is characterised by a number of different goods vehicles. These road vehicles moved 163 billion tonne kilometres of goods in 2008 (DfT, 2009) and served 67% of the freight market. The latest UK DfT study, carried out by The Society of Motor Manufacturers and Traders Limited (SMMT), identified eight different types of truck to suit different scales and applications in an area (SMMT, 2010). However, in terms of capacity, there are only two main vehicle categories in the road freight sector: heavy goods vehicles (HGV) (both articulated and rigid) above 3.5t gross vehicle weight (GVW) and light goods vehicles, at 3.5t GVW and below (LGV), also referred to as vans (UoW, 2010, Baker et al., 2010). In other parts of Europe, LGVs are also called Light Delivery Vehicles (LDV). These are associated with urban and short distance freight movements and also the provision of services. They often have a dual role, both as goods vehicles during the day and as passenger vehicles in the evening. LGVs are a growing area of freight and have become significant in urban areas and for courier services, not least because they do not require a special driving qualification above the norm. The maximum permissible GVW for road goods in the UK is 44 tonnes, which allows a payload of 28 – 30 tonnes of goods, after allowing for the weight of the vehicle itself. HGVs are able to travel at up to 90 km per hour (56 mph), on British motorways, but they can be affected by speed limits, weight limits and height limits for other road categories; especially where congestion, bridges etc. occur and in or near urban areas.

A DfT funded study divided HGVs type into Medium Duty and Heavy duty (Ricardo, 2010). The medium duty vehicle is most common in the UK: a 7.5t two-axle rigid with a box van type body, while the heavy-duty vehicle is typically an articulated vehicle, comprising a tractor and trailer with a GVW of > 32.5 tonnes utilising a three axle configuration. The typical heavy-duty operation is long-distance motorway journeys, at speed, with little urban driving. In 2007 there were about 434,000 HGVs above 7.5 tonnes, registered in Britain, and Euro IV/V rated engines are the most common. Euro VI standards will be required from January 2013.

The highest road congestion in the UK is mainly concentrated around the M25 (the Greater London orbital road) and the segment between the West Midlands (Birmingham) and Liverpool, with reported levels at 14,000 hours per mile or over (DfT, 2010b). These are the areas upon which the DfT wishes to focus modal shift, rather than rural motorways with low congestion.

Whilst passenger cars dominate the UK $CO_2$ emissions with 64% share, HGVs contribute 24% of the road freight emissions and vans contribute 12% (NAEI, 2009). HGV traffic represented only 5.2% of vehicle kilometres run within Britain in 2009 (DfT, 2010b). HGV emissions are influenced by many factors including: weight; volume; length and age of the vehicle. For guidance, using the AEA standard of measuring $CO_2$ emissions, the average for HGV emissions in Britain is 124.70g $CO_2$/t-km.

### *2.3. Water freight network and technology in the UK*

Since the UK is an island, the coastal shipping network is effectively without limits. Coastal and Short-Sea Shipping (SSS) consists of services from the UK to the European continent and UK-UK services. The UK water freight network consists of 2,000 miles of rivers, estuaries and canals and 11,072 miles of coastline, connecting to 300 ports. Water freight was 20% of the domestic freight market in 2008 (see Fig. 1.) It was suggested that container feeder vessels receive lower priority at the deep-sea ports, compared to the main deep-sea vessels but, at many ports, management is increasingly appreciating the importance of coastal feeder trade and rail for the onward transport of containers inland (DfT, 2010b). The interchange points between different modes have been supported by intermodal terminal handling equipment, such as gantry cranes, to optimise co-modality; indeed there are more port based intermodal facilities than rail based (DfT, 2010a).

A DfT study to benchmark UK water freight transport, carried out by AECOM (2011a), found that shipments between UK ports are commonly transported by general cargo ‘coaster’ vessels capable of reaching small inland ports and wharves. The size of these vessels does vary, but is normally only 3,500dwcc (dead weight cargo capacity) and this provides an acceptable level of cost-efficient performance for operators.

The emissions of water freight can vary, depending on a variety of factors, including vessel design; age; fuel use; weather conditions etc. The AEA (2010) Guidance for UK Shipping Industry estimates that the emissions from water freight vessels can vary between 2.00–50.00g $CO_2$/t-km. However, it should be noted that the sheer scale of international trade and shipping results in high aggregate emissions across the sector and this leads the UK-based Chamber of Shipping to propose a series of emissions rules for land-based industry (AECOM, 2011a).

## 3. SuperGreen Cloverleaf Corridor

### *3.1. SuperGreen Methodology*

The project methodology followed the TEN-T framework to select core freight corridors and then used other criteria - including length of corridor; population; existing recognised bottlenecks; transport volumes; types of goods and multimodality; geographical pre-conditions; transport and information technologies in use; supply chain management and specific transport clients - to map targeted green freight corridors. In addition to the aforementioned criteria, a Delphi survey was used, exploiting the SuperGreen project partners' specific knowledge, to finally select the chosen transport network links (Salanne et al, 2010).

The next step taken to measure the greenness of freight corridors was to choose Key Performance Indicators (KPIs). Following an extensive literature study, validated by a series of regional SuperGreen workshops, the five KPIs chosen to observe the selected corridors were: efficiency (costs), service quality (including: reliability, frequency, security and safety), environmental sustainability (GHG), infrastructural sufficiency (congestion and bottlenecks) and social issues (land-use and noise). Benchmarking, policy analysis and bottleneck analysis were also carried out within the selected corridor. At the time of writing, the project is to examine how technologies and ICTs can be used to improve the corridors. At a later stage, it is intended that policy and future research and development recommendation be formulated to address the EU agenda of Logistics Action Plan goals. Further details can be found at the SuperGreen project website.

The formation of the KPIs leads to the data collection phase of the selected corridors, to measure how current practice looks and whether there are any feasible opportunities to benchmark the corridor. The next sections demonstrate how the Cloverleaf Corridor has been examined through literature review and semi-structured interviews.

### *3.2. Examination of Cloverleaf Corridor*

The Cloverleaf Corridor connects links from Glasgow (A) to Duisburg (G) through Carlisle (B), Liverpool (C), London (D), Dover (E) and Calais (F); a link to Dublin in Ireland is connected via Liverpool (C) (Fig. 2). The distance of the corridor between Glasgow and Duisburg is 1280km by train

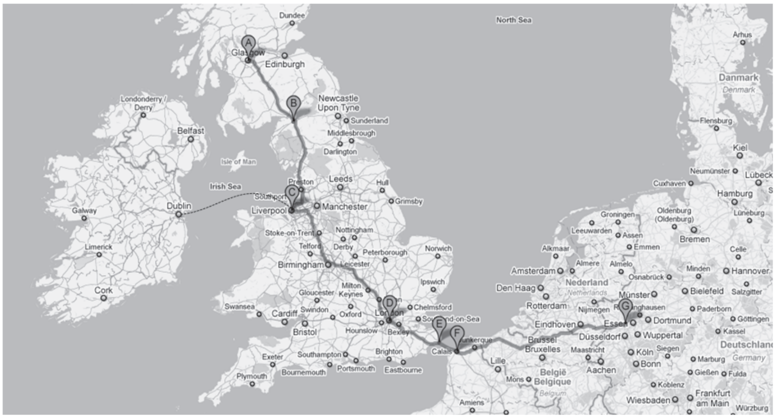


Fig. 2 Cloverleaf Corridor on actual transport network link (Source: Google Map)

network, of which 772km (60%) of the rail network is located within Britain. The distance by road network is 1203km, of which 785km (65%) is within Britain. The main interchange point is in the West Midlands area – be it Rugby or Distribution Centre (DC) Daventry. In terms of network capacity, the segment between the West Midlands and Liverpool is the most crucial, as a DfT study (2010b) has reported there is growing congestion. The distance link between Liverpool and Dublin is 237km by sea (covering 228km port to port distance) with a 5km road ride from the logistics centre to the port, in both Liverpool and Dublin.

The DfT (2010b) freight modal choice study identified numerous corridors and it is both viable and useful to use the data for comparison. Corridor 1 (Dover to London), Corridor 5 (M25 – Greater London ring road) and Corridor 8 (London – Glasgow) exist both in the Cloverleaf Corridor and in the DfT studies (See Fig. 3). The link between London and Glasgow via the West Midlands and Liverpool (representing the WCML) as highlighted by Corridor 8 and Corridor 5 (almost 100,000 tonnes freight daily) has potential commodities flows for modal shift as demonstrated in Table. 2. The SuperGreen Cloverleaf Corridor can be seen as consisting of Corridors 1, 5 and 8. This main segment of the SuperGreen Cloverleaf Corridor comprises more than 40% of the overall estimated potential freight flow (70% of which is Ro-Ro traffic). This figure suggests that the selection of the Cloverleaf Corridor by the SuperGreen project corresponds well with the UK Government's freight transport agenda. However, there are operational and infrastructure issues, within the UK rail network, that may weaken the promotion of the green corridor concept, including gauge; train haulage and length; journey times and capability gaps. The DfT study also reported that all rail is not competitive with road due to lack of loading gauge that would allow continental gauge wagons or HGVs to be carried on low rail wagons from Europe. Furthermore, the WCML and the line around the London ring road, cannot handle the standard, 775m long, intermodal services from Thames/Haven Ports to the Midlands, the North West and Scotland. Moreover, no freight movement is allowed on the WCML near London, during peak hours.

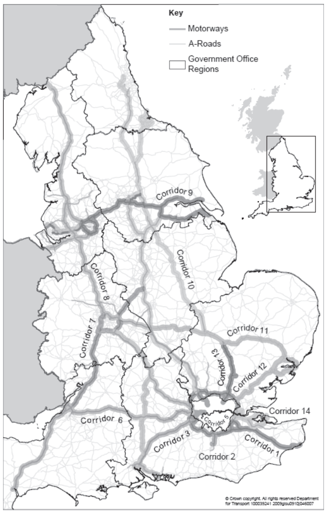


Fig. 3 UK strategic freight corridors (DfT, 2010b)

Table. 2 Estimated daily tonnages for potential flows on the UK strategic corridors (DfT, 2010b)

| Commodity | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agricultural Products | 810 | | | | 1,080 | 280 | | 800 | 1,000 | | 800 | 1,760 | 960 | |
| Automotive | | | 160 | | 160 | | 430 | 1,300 | 660 | 2,230 | 970 | | 520 | |
| Beverages | | | | | | | | 4,690 | | 2,730 | 2,730 | 600 | 1,950 | |
| Construction Materials | | | | 1,670 | 4,600 | 2,840 | 3,750 | 8,350 | 10,330 | 18,520 | 5,850 | | 1,260 | 4,600 |
| Food | 830 | | 1,060 | | 420 | 1,060 | | 6,220 | 1,170 | 15,520 | 6,370 | 4,810 | 8,740 | 420 |
| Forest Products | | | | | | | | 2,120 | 520 | 520 | | | | |
| Lo Lo | 1,560 | | 3,370 | 1,040 | 3,950 | 1,250 | | 2,010 | 2,580 | 5,530 | 5,480 | 9,600 | | 5,130 |
| Manufactured Goods | 940 | | | 860 | 1,730 | 860 | 860 | 2,770 | 1,520 | 6,930 | 3,920 | 1,270 | 2,560 | 1,730 |
| Metals | 500 | | | | 500 | 1,270 | 5,000 | 3,250 | 3,440 | 4,310 | | | | |
| Ro Ro | 61,390 | | 6,230 | | 22,520 | 1,910 | | 32,290 | 12,510 | 10,140 | 12,360 | 17,850 | 9,860 | |

For a water-based strategic corridor, Liverpool to Dublin is the only link of concern to the Cloverleaf Corridor. The IEA (2009) reported that BG Freight Line was strongly critical of the UK and Irish Light Dues regime - port fees for lighthouse maintenance. This barrier is also echoed in the DfT freight modal choice study that noted the cost of additional handling in ports (DfT, 2010b). Recent increases would mean that each 366 TEU vessel operating into UK or Irish waters would pay € 7716.78 per annum in Light Dues, a cost that is not levied elsewhere in Europe (IEA, 2009). The lower frequency services operated by each Lift on – Lift off (Lo-Lo) vessel compared to a Roll on – Roll off (Ro-Ro) vessel meant that such costs were greater per cargo unit. The regime was also a dis-incentive for deep-sea vessels to come to UK or Irish ports, encouraging the feeding of those markets via continental Ports (ibid).

### *3.3. Channel Tunnel*

The Channel Tunnel is one of the main critical segments in the Cloverleaf Corridor and is described separately here, based mainly on the Walker and Crosslands Study (2011.) Around the year 2000, there were three different types of freight train used in the Channel Tunnel: intermodal trains (made up of wagons carrying containers and swap bodies); conventional trains, carrying palletised goods, automotive components and bulk loads in either enclosed wagons or in adapted wagons (tankers, platforms, etc.); and trains with specialised wagons for transporting new cars. Today only the intermodal trains are still in operation; the operation of conventional trains, carrying palletised goods and of trains transporting new cars, has ceased. Some of the reasons identified for this downturn are: reorganization of national railways that has led to the closure of freight forwarding and rail aggregation; general recessions across Europe; illegal immigrants getting into cargo or trying to walk the route (which led to very stringent security presence and checks, making the operations very difficult and time consuming); decline in performance of long distance rail; re-routing of services to short sea and fire in the Channel Tunnel.

The only intermodal forwarder still in operation is Transfesa, a shared ownership between a family run business (49%), RENFE (20%.) and others. The Transfesa operation has been supported by either EPCH (Europorte Channel) or Deutsche Bahn Schenker (DBS) who are the only operators licensed to move freight in the Tunnel. EPCH and DBS have to apply to Euro Tunnel (ET), the Channel Tunnel authority, for train path allocation and must follow their agreed operational procedures.

In 2007, EPCH embraced a new strategy to stimulate the rail freight operation through the Channel Tunnel with three core policies: the development of free access for all goods train operators; dealing effectively with border restrictions and a simplified and competitive pricing policy. In spite of the recession that began in 2008, freight volumes have since held fairly steady (see Fig. 4) against a background of circa 30% reductions in European intermodal rail traffic. The Channel Tunnel has capacity for 10 million tonnes per annum, yet usage peaked in 1998 at 3.14mt. Over time, ET aims to return to 3mt p.a. then build up to 6mt. In 2010, the volume through Tunnel was only 1.05mt, though it is reported that the volume in 2011 was 15% higher than 2010.

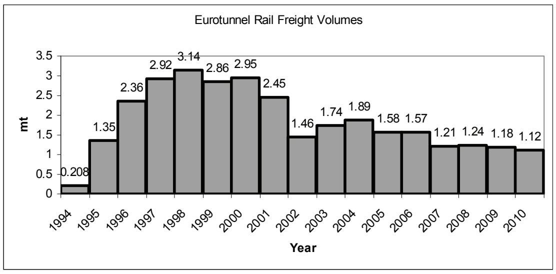


Fig. 4 Channel Tunnel rail freight volumes (source: EPCH, 2010 – cited from Walker and Crosslands, 2011)

EPCH noted that there is an alarming decline in freight traffic across Europe (>30%.) The annual tonnage transported through the Tunnel is less than 2% of the potential market between Continental Europe and the UK. There is an issue of complexity in setting up cross border rail transport in Europe, despite the successive reorganisation of operating structures for cross-Channel freight in the UK. There is also a lack of competitiveness of rail versus road transport (due in particular to the fixed cost of border infrastructures) and moreover, financial difficulties of rail freight in France.

EPCH are optimistic about the effects of extended training of drivers; the announcement of DB setting up a European container network; and SNCF (French national rail) freight working to develop its own European network. Additionally, higher fuel prices, changes in the Supply Chain to Eastern Europe; new projects for rail; lorries on rail; new gauge wagons; Marco Polo funding; companies seeking ‘Green Solutions’ and an improved longer distance offering by DBS/EP are all evidence to support this optimism.

It should be noted that, despite 80% of freight locomotives operating in Britain being Class 66s, for the Channel Tunnel, only the Class 92 loco can be used. This has implications, not only for the use of the Channel Tunnel itself, but also for the connecting High Speed 1 line, which has the potential to reduce the journey time between London and the Channel Tunnel from 4 hours to 70 minutes (Clinnick, 2012).

## 4. Interview with freight operators

With the KPIs discussed in section 3.1, a semi structured interview plan was developed to facilitate data collection from a number of potential respondents. The interview card consisted of three parts: part 1 comprised general information about the company and the nature of its activity; part 2 comprised information about cargo and the selection of transport chains to be examined, including critical corridor segments; cargo flows along a critical segment; typical cargo selected; transport chain card (TC) (that asks for information about a specific segment within the targeted corridor) and characteristics of typical vehicles used. The TC was designed to capture data to benchmark the KPIs quantitatively, collecting data regarding transport chain description; origin-destination; cargo type; typical consignment size; loading unit and annual cargo volume. Part 3 of the interview card consisted of the evaluation of selected indicators including: relative unit cost; transport time; reliability; frequency; Information and Communication Technology (ICT) applications; cargo security and safety; traffic safety; congestion and bottlenecks.

Twelve companies who use the Cloverleaf Corridor in their freight operation were invited to complete the survey. Six responded to a follow up call, but only four companies completed the phone interviews, achieving a 33% response rate. One of the respondents answered two segments of the corridor, enabling five segments of transport chain in total to be examined. The interviewees consisted of four Transport Service Providers (three of whom were Third Party Logistics (3PL) companies), three interviewees offered rail based services and one interviewee was a single mode road freight operator. The rail freight operators were delivering generally food, drink and tobacco type of freight, but with some chemical products and miscellaneous products including paper, glass and bottles. The road freight operator was mainly delivering retail goods and beverages within the London – Glasgow segment and biomass and waste paper for the Duisburg – London segment.

### *4.1. Carbon emissions*

The collected data on the transport chain can be seen in Tab. 3. Emissions figures were derived using EcoTransIT® e-tool, an emissions measurements database based on the data provided by DB Schenker and large shippers. For rail freight, comparing the UK benchmark figure (28.5 g $CO_2$/t-km – see section 2) with the Cloverleaf Corridor data (13.14-18.46 g $CO_2$/t-km), the corridor seems to be already relatively ‘green,’ in contrast with some of the more congested areas in continental Europe. For road freight, the comparison of the Cloverleaf Corridor’s 68.1 g $CO_2$/t-km with the UK national guidelines of 124.7 g $CO_2$/t-km, makes current practice along the corridor acceptably green.

### *4.2. Bottlenecks*

For rail freight operations, the main bottlenecks are in places where there is only one track – an infrastructure problem. One rail freight operator interviewee, who reported low bottleneck problems, noted that the ‘anticipated’ future bottlenecks included: (1) Stafford (Midlands); (2) Carlisle (North West); (3) an area near Glasgow (Scotland). The issue is with shared track/routes where passenger trains have priority and scheduled maintenance delays are frequent (infrastructural and operational constraints). It was also reported that changing locomotives and drivers when crossing the borders, including Germany and France, adds an extra hour to the voyage for each change (operational and regulatory constraints). Also two rail sections: Warrington, near Liverpool and Motherwell, near Glasgow are reportedly often congested, as the capacity of the infrastructure is insufficient, with only two tracks in place instead of the four required.

Table. 3 Cloverleaf interview results by transport chain (TC) (Source: this study)

| TC no | | | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|
| Origin – Destination | | | | Rugby-Carlisle | Midlands -Glasgow | Duisburg-Midlands | Midlands -Glasgow | Dusiburg -London | London-Glasgow |
| Mode | | | | Rail | Rail | Rail | Rail | Road | Road |
| Annual volume (t) | | | | 194000 | 78000 | 68000 | 480000 | 112350 | n/a |
| KPIs | Cost | €/tkm | | n/a | 0.05 | 0.095 | n/a | 0.057358 | n/a |
| | Delivery time (h) | | | 8 | 10 | 20 | 8 | 10 | 12 |
| | Emissions (Annual) | (g/tkm) | $CO_2eq$ | 18.456 | 18.457 | 13.142 | 18.462 | 68.814 | n/a |
| | | | NOx | 0.0157 | 0.0157 | 0.0166 | 0.0157 | 0.5053 | n/a |
| | | | SOx | 0.0136 | 0.0136 | 0.0210 | 0.0136 | 0.0907 | n/a |
| | | | PM | 0.0014 | 0.0014 | 0.0018 | 0.0014 | 0.0153 | n/a |
| | Reliability | | | 97% | 98% | 90% | 98% | 80% | 90% |
| | Frequency | p.a. | | 312 | 156 | 156 | 364 | 4680 | n/a |
| | ICT applications | | | 0 | 0 | 0 | own | own | own |
| | Cargo Security | | | 0.0% | 0.0% | 0.0% | 0.0% | 3.0% | 1.0% |
| | Cargo Safety | | | 0.0% | 0.0% | 0.0% | 0.0% | 1-2% | 1.0% |
| | Congestion | | | 37.5% | 5.0% | 20.0% | 40.0% | 20-25% | 20-25% |
| | Bottlenecks | | | 3 | 0 | 1 | 2 | 3 | 4 |

For the road operation, the problem is in and around cities and within urban areas. Road freight operator respondents reported that between London and Glasgow, the main bottlenecks are on the M25, frequent road works around the Milton Keynes area and Birmingham toll roads and around Warrington. For the segment between London – Duisburg, the main bottleneck reported is at Kennedy Tunnel in Antwerp (the most congested section of the Glasgow to Duisburg corridor); the Channel Tunnel; and any major ring roads, especially the ones near Venlo in the Netherlands, where one of the largest European logistics centre is located.

### *4.3. Other qualitative remarks*

One interviewee commented that rail costs 20% more than road, contradicting the DfT study (2010b) estimate, though this can vary by route and other factors. All of the operators interviewed had a desire to move by rail but rail may not work for everyone, as a certain scale of cargo throughput needs to be achieved. According to one interviewee, over the last 10 years the UK has witnessed a shift toward rail freight by many major retailers, for example ASDA (part of the giant Wal-Mart supermarket chain) whose rail share is now at about 11% with the expectation of reaching 20% by 2025. Another interviewee welcomed the green initiatives and pointed the importance of just one - the modernisation of the truck fleet from Euro II, III, IV through to Euro V.

Most rail freight operators are not using GPS, or similar systems, to track their freight operations, though this is common for road hauliers. For the rail operators, the main emphasis is on the loading data from the terminals and signaling systems along the journey, to provide the necessary monitoring of a trip.

## 5. Conclusion and recommendation

The current study finds that the SuperGreen Cloverleaf Corridor (Glasgow-Duisburg) corresponds well to the British strategic freight transport agenda and therefore recommends that the Cloverleaf Corridor is feasible to be promoted as a green corridor. The typical cargoes along the corridor are manufactured goods and foodstuffs, along retailers' supply chains, with the road based Ro-Ro market having the biggest potential to be shifted to rail. Whilst, in terms of emissions, the reported existing practice is within the accepted 'green' limit, the main challenges for modal shift towards greener corridors are the cost of operations by rail; congestion; infrastructure bottlenecks and regulatory matters. Within the Cloverleaf Corridor, the Channel Tunnel does not represent a bottleneck in terms of operation but shippers can - and often do - prefer to use alternative routes by SSS, calling at ports such as Hull, to bypass expensive Channel Tunnel charges and the congested South East of England.

It should be noted that, despite the small number of interviews, the interviewees are responsible annually for over 1 million tonnes of freight operation (80% of which derived from rail freight operation) within the Cloverleaf Corridor alone. Comparing this figure with the DfT strategic corridor figure as reported in Table. 2 for Corridor 8 (London to Glasgow segment), the interviewees are responsible for about 5% of the total potential freight volume flow.

Rail is primarily congested on the WCML. The Channel Tunnel has significant unutilised capacity. The WCML is envisaged to benefit from the release of capacity from the proposed High Speed rail line between London and Glasgow (HS2), and implementation of European Rail Traffic Management Systems (ERTMS) in the long term. In Britain, 40% of the track has been electrified, with 2/3 of that track equipped with overhead lines and the remainder being 'third rail' systems: these electrified lines carry a little under half of the passenger train miles operated and around 5% of the freight (Network Rail, 2009). The Cloverleaf Corridor is mostly electrified but freight is hauled by Class 66 diesel locos that have 20-30 years of working life remaining. Although electric locos potentially emit 20 to 30% less $CO_2$ than diesel, the UK has a high proportion of electricity generated from hydrocarbons, and the energy invested in the current fleet makes their replacement unsustainable. ICT use is low, and its potential for sustainability largely unexplored.

Road freight is congested in the South East of England on the M25, and between Liverpool and the Midlands. Satellite navigation and route planning, now increasingly with overlays friendly to freight vehicles, are thought to help optimise, and thereby reduce, emissions. UK HGVs represent 24% and LGVs 12% of the total domestic greenhouse gases and, on the corridor, this is where the greatest potential for reduction in GHG emissions lies. There is no evidence of HGVs cleaner than EURO IV on the Cloverleaf Corridor, but a recent study on HGV low carbon technology pointed to three potential themes to be investigated further, including vehicle, powertrain and fuel (Ricardo, 2010). The European Road Transport Research Advisory Council (ERTRAC) has a clear roadmap for the development of diesel-electric hybrid commercial vehicles for road transport and a 50% more efficient road transport system by 2030 (ETRAC, 2011) and initiatives such as the Hybrid Commercial Vehicle (HCV) (please see: http://www.hcv-project.eu/) show progress towards more sustainable long haul road freight.

The Cloverleaf Corridor is relatively green and can be promoted to absorb freight flow, making it more efficient and 'green,' thus boosting economic opportunities via the green corridor concept. The key barriers to further sustainability are: lack of capacity on both the road and rail networks and the high hydrocarbon content of the dominant road mode. Its key opportunities are: first, the freeing up of capacity on rail on the WCML by HS2, plus ERTMS, which would allow the Channel Tunnel to be used and so create modal shift to the cleaner rail option; and secondly, the clean-up of road freight transport with the development and deployment of diesel-electric hybrid vehicles. Plans are in place for both.

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