LIFTING THE SPIRIT – ENVIRONMENTAL BENEFIT ANALYSIS

Submitted to

HITRANS
THE HIGHLANDS AND ISLANDS TRANSPORT PARTNERSHIP

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Executive Summary

1. The aim of this report is to analyse the environmental benefits of moving whisky spirit by rail from Elgin to Grangemouth.
2. It describes the trial mode switch from road to rail which took place between September and November of 2013 and which involved 4 distillers and 7 distilleries plus a potato grower in the HITRANS area of Scotland.
3. The trial involved the use of specialised inter-modal containers filled at the various distilleries, taken by road to Elgin, transferred onto a train and taken to Grangemouth where they are off-loaded onto lorries to be transported to their final destination in the central belt of Scotland.
4. The methodology used was the Department for Transport's (2009) Mode Shift Benefit analysis which is used for assessing mode shift grant schemes in the UK. It is designed to assess the net social benefit of transferring freight from road to rail (or water).
5. This methodology takes into consideration the costs of congestion, accidents, noise, climate change, air pollution, infrastructure and other costs. The net social benefit (NSB) of transferring freight from road to rail (or water) is made up of 'the net benefit of reducing the amount of freight traffic on road and the net cost of increasing the amount of freight traffic on other modes' (DfT, 2009). The mode shift benefits thus reflect the NET effect of transferring goods from road to other modes. Although very general, this methodology is probably the best available at the time of writing and for the scope of this report.
6. The analysis in the report also accounts for the additional road legs at either end of the rail trip.
7. Using data provided, marginal social benefits were calculated. The conclusions are quite clear that there are substantial benefits from this modal switch, both in terms of pure environmental benefits in the reduction of CO_2 and the wider social benefits.
8. The report concludes that for each round trip lorry load displaced by rail, approximately half a tonne of CO_2 is saved and approximately £200 of marginal social benefits accrue.
9. For each train laden with 20 containers, this amounts to 10 tonnes of CO_2 saved and £4000 of marginal social benefits to society. Over a year, the benefits would amount to 520 tonnes of CO_2 saved and £208,000 of marginal social benefits accruing to society.

Aim

To analyse the environmental benefits of moving whisky spirit by rail from Elgin to Grangemouth.

Introduction

The Highlands and Islands area of Scotland contains the majority of the malt whisky distillers in Scotland. Around 85% of all scotch malt whisky is produced at the 77 malt distilleries which lie within the area. Currently, most of the spirit which is produced at the distilleries is taken by 44 tonne articulated road tanker from each of the separate distilleries to bottling or storage areas in the Central Belt of Scotland, mainly on the A95, the A96 and the A9 roads. As the tankers are very specialised, they return empty, using the same routes. The MVA (2011) study estimated that around 138,000 goods vehicle trips per year are made on the A95/A941 Speyside corridor and 50,000 longer-distance vehicle trips per annum use the A9 for whisky related movements.

Between September and November 2013, a trial took place to transfer some of these journeys onto rail at Elgin. Each freight train could carry between 16 and 20 (maximum 32) tankers from Elgin to the railhead in Grangemouth, via Aberdeen. Although only a single train per week actually ran, the plan is for 2 trains per week in the future.

The trains returned, sometimes empty, sometimes carrying products required by the distilling industry (such as casks) and sometimes with loads for other industries based in the North of Scotland.

As well as the whisky tankers, other containers used the service. Indeed, included in this analysis is a company which used the train for transporting potatoes from Elgin to Grangemouth in containers of various sizes (20ft, 40 ft and 45ft).

For the whisky, specialised lorries, leased from DB Schenker for the period of the trial, were required to take the inter-modal skeletal trailers (skellies) containing the tanks from the participating distilleries to the railhead at Elgin. Using a mobile lifting device (a reach-stacker), hired in specifically by JG Russell for the trial, the skellies were lifted onto the train (see Figure 1). At the other end of the journey, they were lifted off the train and on to specialised lorries again for the final leg of the journey.

Each tanker contained malt whisky spirit from a single distiller (i.e. no mixing of product is allowed). There was no need for the tanks to be washed between trips so long as they carried the same spirit on the following trip.

This report will analyse the environmental and social impacts of this mode switch trial. The methodology used will be the Department for Transport's (2009) Mode Shift Benefit analysis which is used for assessing mode shift grant schemes in the UK.

The methodology is described below in more detail, but in summary, it is designed to assess the net social benefit of transferring freight from road to rail (or water). It takes into consideration the costs of congestion, accidents, noise, climate change, air pollution, infrastructure and other costs of both road vehicles (trucks) and other modes (rail and water). It then subtracts the costs of the latter from the costs of the former to give one **net** value. Although very general, this methodology is probably the best available at the time of writing and for the scope of this report. The analysis uses before and after (i.e. during the trial) data, supplied by an independent consultant, on road and rail mileages travelled and routes taken by each participating distiller from the origin distillery to the destination warehouse/storage facility in the central belt. It compares the marginal social benefits of using a combination of road and rail against the road only option. The conclusions are quite clear that there are substantial benefits from this modal switch, both in terms of pure environmental benefits in the reduction of CO_2 and the wider social benefits.

Scope and boundaries of the report.

Setting the boundaries in any assessment of impacts is always difficult. In this study, the boundaries are very tight. The study considers only the impacts of the operations between the distillery and the ultimate central belt destination. It does not consider any impacts further than this, for instance on the export or retailing side. Additionally, it considers only the distribution of the malt spirit. It ignores the inputs to the process (e.g. the malt) and the by-products (e.g. the draff) produced. It is confined to a very small element of the total logistics chain. It also ignores all upstream impacts, for instance, the construction of the vehicles, tankers, rail lines etc. It takes all these as givens. It also ignores the financial impact on the distillers and the operational requirements of the mode switch, as these are the subject of a different report.

In measuring the environmental effects of logistics it is important to distinguish between different levels of impacts. The International Green House Gas Protocol Initiative has developed the following categorisation:

SCOPE 1 emissions – direct GHG emissions from sources owned or controlled by the entity, e.g. emissions from fossil fuels burned on site, in vehicles etc.

SCOPE 2 emissions – indirect GHG emissions resulting from the generation of electricity, heating or cooling or steam generated off-site but purchased by the entity and the transmission and distribution losses associated with some purchased utlilities (e.g chilled water, steam)

SCOPE 3 emissions – indirect GHG emissions from sources not owned or directly controlled by the entity but related to the entity's activities (e.g. travel and commuting by employees, solid waste disposal.

In this report, we will focus solely on SCOPE 1 emissions from logistics operations, which could also be termed ‘first order’ impacts.

Brief introduction to the domestic logistics of the malt whisky industry.

This is a brief introduction. Much more detail of the whole logistics of the whisky industry can be found in the MVA (2011) report, from which some of what follows is taken.

Scotland currently has 99 registered malt whisky distilleries, 77 of which are in the HITRANS area. These are concentrated in the Speyside area. There are several large companies (such as Diageo, Pernod Ricard, Bacardi and Edrington) who own multiple distilleries as well as many independent distillers. Diageo and Pernod-Ricard between them own around 40% of the distilleries and account for around 40% of the whisky produced in Scotland. Scottish whisky producers directly employ around 10000 people in Scotland and support around 35000 jobs and, obviously, are a very important part of the Scottish economy. It is a very competitive industry, which is currently thriving.

Currently, all bulk whisky spirit is moved by road from the distillers to warehouses and bottling halls across the central belt of Scotland. It is transported using 44 tonne articulated tankers, each of which carry approximately 30,000 litres of liquid. Each distillery organises its own transport, using some of the major logistics companies in Scotland (such as Malcolm Logistics, Mundells, McPhersons and Carntyne). Very many lorries per week make the journey to the central belt and they all return empty because of the specialist nature of the vehicles. Most of the vehicles use the busy A9 at some part of their journey. Many also use the A95 from Speyside to Keith, which becomes the A96 to Aberdeen. It has been calculated that around 50% of the HGV traffic on the A95 is associated with the whisky industry.

The rail trial involved the use of multi-modal containers. Each 20 foot ISO standard container has a capacity of 26,000 litres and carries 24,000 litres of spirit. Some distilleries use non-ISO standard containers with 33,000 litre capacity and which contain 31,000 litres of spirit. The containers were leased for the trial by JG Russell. The containers were filled at the plant and were taken to the railhead at Elgin by truck, where they were lifted directly onto the train by a ‘reach-stacker’ which was also leased for this trial.

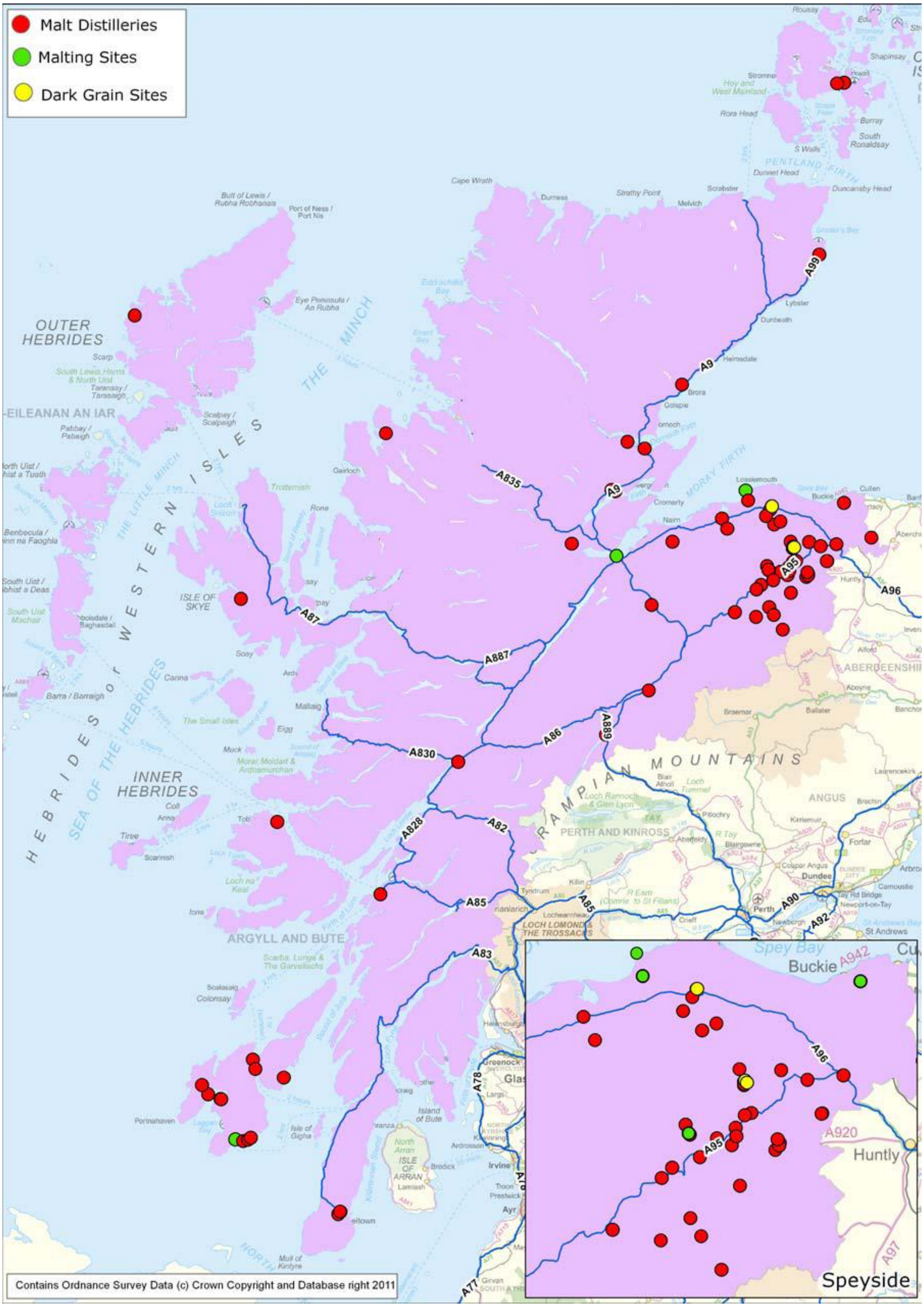
Figure 1. Containers at various stages of being loaded onto a train at Elgin

The train, which started from the railhead in Elgin, was a standard Class 66 type operated by DB Schenker. The train could take up to 32 containers and travelled to the port of Grangemouth, where the containers were lifted onto waiting vehicles and taken to their final destination. In some cases, Grangemouth was their final destination. The plan was for 2 trains per week to make the journey, each taking between 16 and 20 containers. However, because of contractual and liability issues, only 1 journey per week was made. The freight trains travelled at up to 75 mph, approximately the same speed as some passenger trains, although as Elgin to Aberdeen is single track, they had to wait at Aberdeen for 30 minutes.

The trial involved 4 major distillers and 7 distilleries plus a potato grower.

A map of the distilleries, taken from the MVA (2011 report) is shown in Figure 2.

Figure 2. Geographic distribution of distilleries in the HITRANS area (Source: MVA, 2011)



The environmental impacts of HGVs.

Emissions

Emissions from freight transport largely depend on the amount and type of fuel used. The main fuel used by trucks as well as conventional rail locomotives and ships continues to be diesel. Trucks emit pollution mainly because the combustion process in their engines is incomplete (see Figure 3). Diesel and petrol contain both hydrogen and carbon. If it were possible to achieve perfect combustion, 100% of the hydrogen would be converted to water and all the carbon into CO_2. However, because combustion is not complete, tailpipe emissions of pollutants such as hydrocarbons, carbon monoxide and nitrogen oxides result.

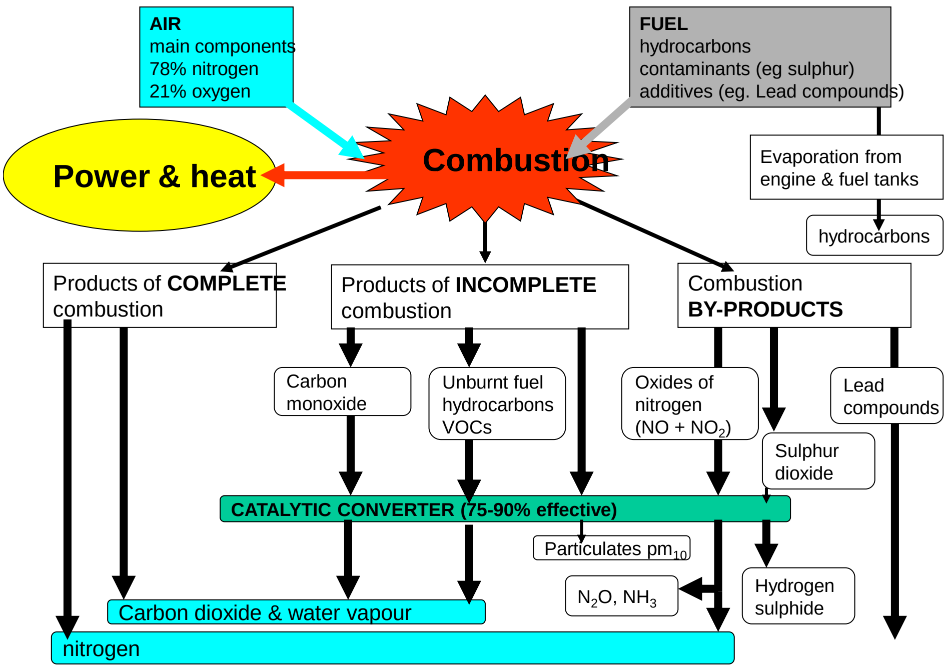


Figure 3. Emissions and the combustion of fuel

According to the Inter-governmental Panel on Climate Change (IPCC, 2007) scientific evidence that human activity is the main cause of global warming is now 'unequivocal'. It explains that "greenhouse gases are the gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds" The greenhouse effect arises because GHGs and some particles in the atmosphere allow more sunlight energy to filter through to the surface of the planet relative to the amount of radiant energy that they allow to escape back up to space. The IPCC (1996) lists 27 greenhouse gases. These are combined into 6 categories in the Kyoto Protocol agreed in December 1997, namely:

- Carbon dioxide (CO_2)
- Methane (MH_4)
- Nitrous Oxides (NOx)
- Hydrofluorocarbons (HFC)
- Perfluorocarbons (PFC)
- Sulphur Hexafluoride (SF6)

Table 1 shows the emission factors of the main modes of freight transport.

Table 1: Average emission factors for freight transport modes within Europe

		Energy Consumption (kj/tkm)	**CO_2 (g/tkm)**	**NOX (mg/t km)**	**SO_2 (mg/tkm)**
Aircraft		9,876	656	3253	864
Truck >34-40-t	Euro 1	1,086	72	683	
	Euro 2	1,044	69	755	
	Euro 3	1,082	72	553	90
	Euro 4	1,050	70	353	
	Euro 5	996	66	205	
Train	Diesel	530	35	549	44
	Electric	456	18	32	64
Waterway	Upstream	727	49	839	82
	Downstream	438	29	506	49

Source: IFEU (2008)

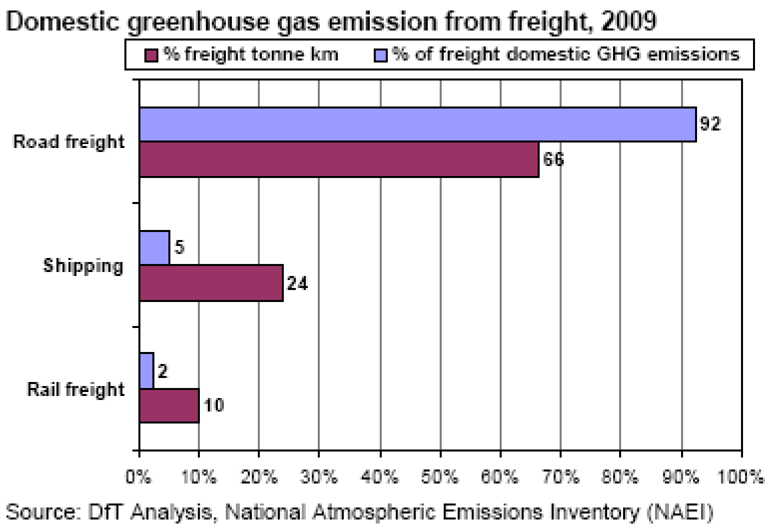
Caution must be exercised, however, in interpreting comparative environmental data for freight transport modes (McKinnon, 2008). The relative environmental performance of a particular mode can be affected by:

- Differing assumptions about the utilisation of vehicle capacity
- Use of tonne-kms as the denominator, misrepresenting modes specialising in the movement of lower-density cargos
- Extrapolation of emissions data from one country to another with different transport and energy systems
- Allocation of emissions between freight and passenger traffic sharing the same vehicles (such as aircraft and ferries)
- Neglect of emissions associated with the construction and maintenance of infrastructure
- Restriction of the analysis to emissions at source rather than ‘well-to-wheel’ data

Carbon dioxide accounts for by far the largest proportion of GHGs in the atmosphere (approximately 85%), which is why there is so much attention focused on this particular gas.

In the UK, transport accounts for 27% of total domestic GHG emissions, and freight transport is responsible for around 5% (DfT, 2013a). At a global level, the movement of freight accounts for roughly a third of all the energy consumed by transport (IPCC, 2007). In the UK in 2009 all modes of freight transport emitted a total of 122.2 million tonnes of CO_2 equivalent ($MtCO_2e$[1]). Road freight transport accounted for 92% of this total. HGVs accounted for 17.2% of UK domestic GHG emissions, with rail accounting for 1.8% and domestic shipping 1.3% (DfT, 2013a). Figure 4 shows the proportions of work done and the GHG emitted by the main freight modes in the UK.

Figure 4.



Source: DfT (2013b)

Since the early 1990s, emissions from diesel-engined-HGVs have been strictly controlled by EU legislation. New HGVs have been the subject of progressively tightening environmental standards, known as EURO emission standards. Emissions of nitrogen oxides and particulate matter have been particularly targeted and will be almost negligible after 2013, as can be seen in Table 2 and Figure 5.

[1] Some gases have a greater impact on global warming potential than an equivalent amount of others, so GHG emissions are expressed in terms of the equivalent million tonnes of CO2 (MtCO2e).

Table 2. Emission Standards for Heavy Duty Diesel Engines (g/kWh)

Tier	Date of implementation	CO	HC	NOx	PM
Euro 1	1992 (>85kw)	4.5	1.1	8.0	**0.36**
Euro 11	1998	4.0	1.1	7.0	**0.15**
Euro 111	2000	2.1	0.66	5.0	**0.10**
Euro 1V	2005	1.5	0.46	3.5	**0.02**
Euro V	2008	1.5	0.46	2.0	**0.02**
Euro V1	**2013**	**1.5**	**0.13**	**0.4**	**0.01**

Source: www.nao.org.uk

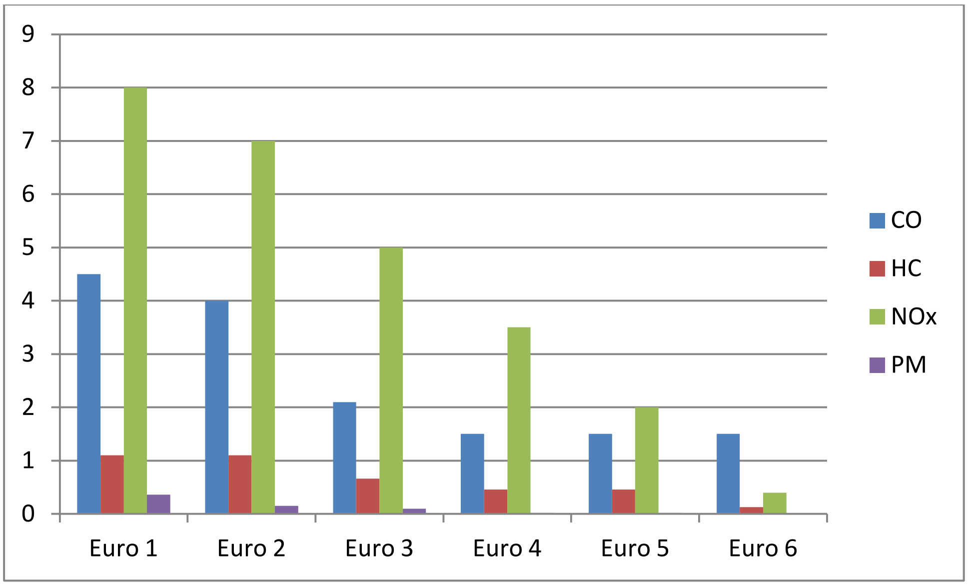


Figure 5. Euro Emissions standards for trucks, g/kWh

Source: unece.org (2012)

Rail transport has also become considerably less environmentally damaging over the past couple of decades. In the UK, since privatisation took place, rail freight operators have invested heavily in Class 66 locomotives which are far more fuel efficient than their predecessors. According to Freightliner (2006), emissions of carbon monoxide are 95% lower, hydrocarbons 89% lower and nitrous oxides 38% lower. Generally, however, because pressure on the rail industry has been less than on the road freight industry, environmental improvements have been slower to be introduced.

Noise pollution

Road traffic is the main cause of environmental noise at the local level. The immediate adverse effects of noise disturbance include annoyance, communication difficulties, loss of sleep and impaired cognitive functioning resulting in loss of work productivity. Longer-term, physiological and psychological health issues may also arise. Currently, around 30 per cent of the European Union's population is exposed to road traffic noise and 10 per cent to rail noise levels above 55 dB(A).

In the UK, 90 per cent of people hear road traffic noise while at home and 10 per cent of these regard this noise source as highly annoying (Watts et al. 2006).

Trucks generate road noise from three sources:

- Propulsion noise (power train / engine sources) which dominates at low speeds (less than 50kmph);
- Tyre / road contact noise, which is the main cause of noise at speeds above 50kmph; and
- Aerodynamic noise, which increases as the vehicle accelerates.

European vehicle noise standards for individual vehicles were introduced in the early 1970s (Directive 70/157/EEC), when the permitted noise emissions for trucks were set at 80dB(A). Noise standards have been tightened several times since then. Significant reductions in noise levels have been achieved by technical advances in engine design, tyres and the aerodynamic profiling of vehicles. Nevertheless, overall noise levels have not improved, as the growth and spread of traffic in space and time has largely offset both technological improvements and other abatement measures. The trend towards heavier and more powerful goods vehicles and the use of wider tyres has further exacerbated the problem.

In 2001 the European Union launched regulations that limited the levels of noise generated by vehicle tyres (Directive 2001/43/EC). Tyre noise was targeted specifically for two reasons. First, tyre rolling noise is generally the main source of noise from trucks at medium and high speeds and second, as tyres are replaced more frequently than vehicles, implementing tyre noise standards was considered to be one of the fastest ways to achieve road noise reductions.

Accidents

Accidents cause personal injury and death for those involved, and general inconvenience for other road users. Overall, accidents involving HGVs by distance travelled are fewer than for cars, although there is a higher likelihood of an HGV being involved in a fatal accident. This is partly a reflection of the greater momentum of HGVs, and partly because of the relatively high proportion of time that they are driven on faster roads.

Table 3. Casualties in reported accidents in Great Britain, involving HGVs, 2012

	Built-up roads	Non built-up roads	Motorways	A roads	B roads
Killed	81	144	46	175	22
Killed or seriously injured	511	641	196	800	137
All severities	3427	3322	1949	4722	718

Source: Department for Transport, 2013

Putting an economic value on road casualties is notoriously difficult. The values associated with the prevention of a casualty include the following elements of cost (DfT, 2013c, p2):

- Loss of output due to injury i.e. the present value of the expected loss of earnings, plus non-wage payments made by employers
- Ambulance costs and the costs of hospital treatment
- The human costs of casualties, based on a ‘willingness to pay’ to avoid pain grief and suffering to the casualty, relatives and friends as well as intrinsic loss of enjoyment of life in the case of fatalities.

The average value of prevention per reported casualty in GB is currently:

- Fatal - £1,703,822
- Serious – £191,462
- Slight - £14,760
- Average for all severities - £50,698

Of course, in an accident, there is likely to be more than one casualty, so the cost of an accident is higher than that of a casualty and also reflects the additional costs of

- Damage to vehicles and property
- Police and administrative costs of accident insurance.

The average value of preventing an accident is thus:

- Fatal - £1,917,766
- Serious - £219,043
- Slight – 23,336
- Average for all severities - £72,739

Congestion

Congestion imposes many costs on society, mostly in terms of time wasted. When a HGV enters the traffic, it often slows the traffic, increasing the time it takes all road users to get to their destination. Additionally, slower speeds can lead to increased operating costs for other users and increased emissions, particularly in stop-start conditions. On top of these obvious costs, congestion leads to increased journey time variability for all road users and road users must put aside more time for their journey than would be the case without congestion. In conditions where the speed limit for lorries on a particular stretch of road is lower than for other vehicles, particularly on single-carriageways where overtaking is difficult, the congestion costs will be higher.

Congestion costs are calculated on a 'value of time' basis. Each second wasted by every person affected by the congestion has an opportunity cost. Such costs are grossed up and multiplied by a standard 'value of time' calculated by the DfT. This explains why in the marginal social benefit (MSB) analysis, congestion costs account for such a high proportion of total marginal benefits.

Land-Take and visual intrusion

Logistics activities take up a substantial amount of land – whether this is for roads or warehouses/depots. McKinnon (2009) estimated that warehousing sites occupied 23,500 hectares of land in the UK alone, representing around 1% of non-agricultural and forestry land. On the urban fringes of most major cities can often be found several kilometres of warehousing and distribution facilities. This land take contributes to the degradation of eco-systems as well as causing considerable visual intrusion.

Resource sustainability

Fossil fuels such as diesel are by definition unsustainable, i.e. their availability is finite. In addition, many of the oil-producing countries are politically unstable and some use their power as oil producers in politically/economically dubious ways. The future of oil supplies is inherently unstable. As a consequence, the price of fuel is also subject to considerable fluctuation and this is likely to be exacerbated in the future. Although alternative sources of fuel are being sought, none are yet as universally available as diesel.

Mode Shift Benefit Analysis.

Mode shift benefit (MSB) analysis is a method used by the Department for Transport in the allocation of mode shift grants. It looks at the benefit of removing 1 lorry[2] mile of freight from road and transferring it to rail (or water). The costs included are congestion costs, accident costs, noise cost, climate change cost, air pollution cost, infrastructure costs and other costs. These costs, which are not direct financial costs borne by the operator, are termed external costs, or externalities.

The economic detail incorporated within MSB analysis is quite complicated. MSB analysis does not look at the total external costs imposed on society by road freight, rather it looks at the costs *additional* to those that are already covered by taxation

[2] In the DfT document, 'lorry' refers to an average articulated vehicle over 7.5T

(and which are therefore termed, internalised). In essence, it accepts that the costs imposed on society by lorries are higher than those covered by taxation and that therefore, there is a benefit to society if lorry miles are reduced and transferred to other, less damaging modes.

Thus, the net social benefit of transferring freight from road to rail consists of the difference between the net benefit of reducing the amount of freight on the road and the net cost of increasing the amount of freight on rail.

So:

$NSB = (MEC_{ro} – MT_{ro}) – (MEC_{ra} – MT_{ra})$

Where:

NSB = net social benefit of moving marginal amounts of freight from road to rail

MEC_{ro} = Marginal external cost of road freight

MT_{ro} = Marginal tax on road freight

MEC_{ra} = marginal external cost of rail freight

MT_{ra} = Marginal tax on rail freight

The net costs of road freight ($MEC_{ro} – MT_{ro}$)

The MEC_{ro} comprise the sum of the MEC of each of the individual elements of cost. Thus, *MEC – C* is the marginal external cost of congestion. This includes incident related and journey time variability as well as day-to-day variability. It includes the costs to other road users. MEC – C is the largest single component of MSB, accounting for over 60% of the total MSBs.

MEC – CC is the marginal external cost, climate change. In order to calculate this parameter, standard relationships are used. The impact on climate change is based on CO_2 output. Diesel has a specific carbon content (696.23 g per litre of diesel). The mass of carbon emitted can be translated into the mass of CO_2 by multiplying by 3.67 (equivalent to 44/12, the relative mass of carbon to CO_2). This means that one litre of diesel burns completely to produce 696g or 2.63 kg of CO_2. Thus by calculating the amount of fuel consumed by a lorry and then multiplying this by the carbon content of fuel, you arrive at an amount of carbon in grams and an amount of CO_2 produced. This is then multiplied by Defra's (2007) shadow price of carbon, which in 2010 was £29.47 per tonne of CO_2 equivalent.

The DfT has calculated that an average articulated lorry emits 935g of CO_2 per km. This is equivalent to an average fuel consumption of 7.7 mpg (which is about correct for our whisky lorries). Thus, using the train rather than a lorry for the trip between Speyside and Grangemouth (a round trip of approximately 500km) saves around 467,000g or approximately half a tonne of CO_2. A 44 tonne articulated lorry travelling

60,000 miles a year emits nearly 100 tonnes of CO_2. If it travels 80,000 miles per year it emits around 130 tonnes of CO_2.

MEC – N is the marginal external cost of noise. This accounts for approximately 4% of the total marginal external costs of HGVs.

MEC – A is the marginal external cost of accidents. Some of the cost of accidents is covered by insurance, so this element is not included. MEC – A covers the change in accident costs that is 'caused by the additional traffic but that is not factored into the operators decision to send freight by road.' Accident costs account for 3% of total marginal external costs of HGVs.

MEC – I is the marginal external cost of infrastructure. It accounts for 10% of total marginal external costs of HGVs.

MEC – P is the marginal external cost of pollution (e.g. NO_x, PM_{10}, VOCs, CO and SO_2). These are again calculated based on the emissions per tonne of fuel consumed combined with the damage cost values given by Defra.

MEC - O is the marginal external cost of other things. These include:

- Up and downstream processes
- Soil and water pollution
- Nature and landscape
- Driver frustration/stress
- Fear of accidents
- Community severance (restrictions on cycling and walking)
- Visual intrusion

The net costs of rail (MECra – MTra)

This element considers the marginal external cost of increasing the amount of freight transported by rail by 1 lorry load.

This is calculated at being around £13 per 1000 tonne km. It is assumed that the fuel consumption of an inter-modal freight train is 4.8 litres per km. The DfT calculates that the carbon emissions of rail freight are equal to around 25% - 30% of the average road freight. Calculated using the same basis as for the road parameters, the resulting net costs of rail freight by component (pence per lorry mile) are shown in table 4.

Table 4. Net costs of rail freight by component (pence per lorry mile)

Component	Cost
Noise	2.6
Pollution	2.2
Climate change	1.3
Other	1.2
Taxation	-1.7
Total	**5.7**

Source: DfT, 2009

The resulting MSB values (that is, the NET benefit of transferring goods from road to rail taking into account the costs of the additional rail trips) are shown in table 5.

Table 5. MSB values by road type and component (pence per lorry mile)

	Motorway high[3]	Motorway low	A roads	Other roads	Weighted average[4]
Congestion	100.2	24.1	75.9	85.2	52.4
Accidents	0.5	0.5	5.7	5.6	2.8
Noise	8.6	6.0	7.2	9.1	7.0
Pollution	1.9	1.8	3.3	3.8	2.5
Climate change	3.6	3.6	4.2	4.2	3.8
Infrastructure	4.7	4.7	10.8	68.7	9.0
Other	6.4	6.4	6.4	6.4	6.4
Taxation	-34.4	-34.5	-33.6	-34.8	-34.1
Rail costs	-5.7	-5.7	-5.7	-5.7	-5.7
Total	**86**	**7**	**74**	**143**	**44**

Source: DfT, 2009

The final weighted average MSB values to be used in the calculations are shown in table 6.

Table 6. MSB values (pence per lorry mile)

Motorways	High value	86
	Standard	7
All A roads		74
Other roads		143
Weighted average[5]		**44**

Source: DfT, 2009

[3] The 'high' value refers to a few motorways where the volume of traffic is very high. The only parts of the Scottish motorway network to be allocated a 'high' level are junctions 8 and 19 of the A8/M73
[4] Weighted by articulated goods vehicle kms and their use of the road network
[5] Weighted by the proportions of articulated traffic kms in each category

The calculations.

A simple illustrative example.

Assume the road trip from distillery to the origin railhead = 20 miles on A roads

Assume the number of road miles displaced by the train is 200

Assume there is no onward trip from the destination railhead.

Assume further that the road trip that rail displaces is 100 miles on Motorway and 100 miles on A roads.

Then, the MSB of the rail trip =

(100 x 0.07) + (100 x 0.74) = £81

The MSB of the road leg =

(20 x 0.74) = £14.80

The net social benefit of using rail = £81 - £14.80

= £66.20 each way per container or £132.40 per return trip.

If each train carries 30 containers per week, the MSB =

30 x 132.40 = £3972 per week or £206,544 per year

The distillery example

As stated in the introduction, 4 major distillers took part in the trial, each based in the HITRANS area. In addition, an agricultural products producer, E, also put containers on the train. Distillers A and D used the trial rail service for just 1 of their distilleries and distillers B and C used the trial rail service for multiple distilleries. For confidentiality purposes, their names have been anonymised in the information which follows. The details of their journeys are shown in table 7. Thus, for distiller A, based near Elgin and transporting spirit to the Stirling area, their normal road trip involves 157 miles on A roads (with no motorway mileage). Using rail, the trip involves a 7 miles road leg to Elgin railhead, the train trip to Grangemouth and then a further 13 miles by lorry on A roads from Grangemouth to its final destination near Stirling.

Table 7. Trip details of the trial companies

Company	Origin	Destination	A road miles	M/way miles	Total road miles	Miles to Elgin	Final leg A road miles	Final leg M/way miles
A	Roseisle	Cambus	157	0	157	7	13	0
B	Glenburgie	Dalmuir	153	31	184	8	8	27
	Keith	Dalmuir	165	31	196	17	8	27
	Longmorn	Dalmuir	162	31	193	4	8	27
C	Royal Brackla	Glasgow	145	29	174	29	2	25
	Craigellachie	Glasgow	147	29	176	13	2	25
D	Rothes	G'mouth	150	15	165	10	1	0
E	Alves	G'mouth	157	15	172	4	1	0

Taking as an example, distillery A, where each container travelled 157 miles by A road from Roseisle to Cambus. During the trial, it travels a total of 20 miles by A road (comprising 7 miles from Roseisle to Elgin and 13 miles from Grangemouth to Cambus) and the rest by rail. The calculated MSB for the trip based on the above table and categorised by cost type, yields the total MSB of £101.64 each way, as shown in table 8. Table 8, also illustrates that, as described in the earlier text, a very high proportion of the benefits arise as a result of the decrease in 'congestion', with infrastructure benefits being the second largest benefit category and pollution and climate change between them accounting for a very small percentage.

Table 8. MSB per cost category, distiller A, (£) per one way trip

Cost type	cost per mile (pence)	Benefits from road miles displaced (157)	Costs from new road miles (20)	Net MSB
Congestion	75.9	119.16	15.18	103.98
Accidents	5.7	8.94	1.14	7.8
Noise	7.2	11.3	1.44	9.86
Pollution	3.3	5.18	0.66	4.52
Climate Change	4.2	6.59	0.84	5.75
Infrastructure	10.8	16.96	2.16	14.8
Other	6.4	10.05	1.28	8.77
Taxation	-33.6	-52.75	-6.72	-46.03
Rail costs	-5.7	-8.95	-1.14	-7.81
Total				**101.64**

Calculating the benefits for each distillery (plus the potato producer) based on the data presented in table 7 yields the following results, shown in table 9.

Table 9. MSB for the various companies

Company	Origin	Destination	MSB (£) one way	MSB (£) return
A	Roseisle	Cambus	101.4	202.8
B	Alves	Grangemouth	114.3	228.6
C	Glenburgie	Dalmuir	101.7	203.3
	Keith	Dalmuir	103.9	207.8
	Longmorn	Dalmuir	111.3	222.6
D	Royal Brackla	Glasgow	84.6	169.3
	Craigellachie	Glasgow	98.0	196.0
E	Rothes	Grangemouth	104.7	209.3
Average			**102.5**	**205**

From this table, it can be calculated that the average MSB for all the distilleries taking part in the trial, plus the potato producer, is £205 per container per round trip. If the average train takes, say 20 containers, the saving per train is £4100. For the trial period of 2 months (or 8 weeks), this amounts to £32,800. If the train was fully loaded with 32 containers, the MSB would be £6560 per train or £52,480 for the trial period. Grossing this up to an annual benefit, the MSB would be £213,200 for a 20 container train and £311,120 for a fully laden train. Of course, if the planned 2 trains per week were to operate, the benefits would be double the above figures.

Summary and Conclusions

This report has sought to analyse the environmental and social impact of the trial currently underway to move the transport of bulk malt whisky spirit from road to rail in the HITRANS area. It has outlined some of the environmental issues, described the methodology used by the Department for Transport to calculate the benefits of modal switch from road to rail in general and then used this methodology to actually calculate the marginal social benefits to society.

The conclusions are quite clear that there are substantial benefits from this modal switch, both in terms of pure environmental benefits in the reduction of CO_2 and the wider social benefits. The headline figures are that for each round trip lorry load displaced by rail, approximately half a tonne of CO_2 is saved and approximately £200 of marginal social benefits accrue. For each train laden with 20 containers, this amounts to 10 tonnes of CO_2 saved and £4000 of marginal social benefits to society. Thus, over a year, this would amount to 520 tonnes of CO_2 and £208,000 of marginal social benefits.

It is a tribute to the organisers of this trial that they have persuaded several major distillers to take part, as the administrative problems of re-organising their logistics processes must have been considerable. It seems likely that the longer the train service operates and the more positive publicity it receives, the greater the likelihood that both other distillers and producers of other products will shift to rail, particularly if there are financial incentives to so do.

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