Britain without Double-deck Lorries

An Assessment of the Effects on Traffic Levels, Road Haulage Costs, Fuel Consumption and CO$_2$ Emissions.

Prof Alan McKinnon
Logistics Research Centre
Heriot-Watt University
EDINBURGH

a.c.mckinnon@hw.ac.uk
http://www.sml.hw.ac.uk/logistics
http://www.greenlogistics.org

October 2010
Executive Summary

In developing a new system of Whole Vehicle Type Approval for lorries the European Commission is proposing to standardise the maximum height of trailers at 4 metres. Twenty of the EU25 countries currently impose a 4 metre height limit on trucks. The UK, however, currently has no legal height limit and most of its road network can accommodate lorries up to 4.9 metres high. This has permitted the double-decking of trailers and consolidation of lower density loads in a smaller number of freight deliveries. It is estimated that there are around 7000 of these double-deck trailers in use in the UK, significantly cutting road haulage costs, traffic levels, fuel consumption and exhaust emissions. If implemented, the proposal to limit trailer height to 4 metres would significantly increase the economic and environmental costs of road freight transport in this country.

An attempt has been made to quantify the additional economic and environmental costs that would result from the implementation of this measure. The analysis is based primarily on data from the government’s Continuing Survey of Road Goods Transport but also includes information from manufacturers and operators of double-deck trailers. The figures relate to 2008. Because of statistical limitations, the values of several key parameters have had to be estimated.

The analysis suggests that the removal of double-deck trailers from UK roads and their replacement by standard height trailers would increase the distance travelled by UK-registered articulated lorries by around 4.5%. Annual road haulage costs would rise by roughly £305 million. Switching from double-deck to standard trailers would increase fuel consumption and CO$_2$ emissions by a mid-range estimate of 64%. In terms of its impact on CO$_2$ emissions, this would be equivalent to adding 151,000 new cars to Britain’s roads.
1. Introduction

Tall trucks, up to 4.9 metres high, are now a common sight on Britain’s roads. They are almost unique to the UK. Few, if any, countries have road infrastructures that can accommodate these vehicles. Partly because we have double-deck buses in this country, height clearances at bridges and tunnels are relatively high. Indeed, there is actually no legal limit on the height of a truck in the UK, though by ‘custom and practice’ 4.9 metres has been adopted as the maximum height of a trailer. This has enabled many British businesses to double-deck their lorries, gaining extra cubic capacity vertically. Companies transporting lower density products can almost double the amount of freight they move in a single vehicle while staying within the legal weight limit. This load consolidation dramatically cuts lorry-kms, fuel consumption and exhaust emissions per tonne of product delivered. Both economic and environmental costs are substantially reduced and the higher capital costs of the double-deck trailer quite quickly recouped. All in all, the double-deck lorry has been a great logistical success for this country.

Companies, such as John Lewis, Tesco, B&Q and Boots, operate large fleets of double-deck vehicles. Many have put the double-deck vehicle at the heart of their plans to cut carbon emissions and improve the general environmental sustainability of their distribution systems. In addition to acquiring double-deck trailers, some businesses have invested and are investing in new handling systems at factories, distribution centres and shops to facilitate the loading and unloading of these vehicles. So strong is the business case, in economic and environmental terms, for operating double-deck trailers that they are being used much more extensively across UK supply chains. Between 2004 and 2008 there was a 57% increase in the amount of freight movement in double-deck trailers (measured in tonne-kms)\(^1\). The longer term future of the double-deck vehicle may, however, be in jeopardy, if a new European Commission proposal is adopted.

The European Commission is proposing to introduce, under its system of Whole Vehicle Type Approval, a 4 metre height limit on new trailers purchased within the EU\(^2\). This would effectively bring the UK into line with twenty of the EU25 countries which currently impose a 4 metre height limit on trucks. If the proposal is implemented and the UK is not granted an exemption, the current double-deck fleet would gradually be phased out and this country denied the economic and environmental benefits it offers. It is possible to operate double-deck vehicles within a 4 metre limit, but this is only applicable to particular types of freight and offers much less benefit. The vast majority of double-deck trailers on UK roads are substantially taller than 4 metres and would thus be affected by the new European ruling if it were to come into force.

The analysis reported in this paper has attempted to quantify the likely economic, traffic and environmental effects of this ruling in the UK. It is essentially a ‘counter-factual’ calculation, hypothesising what would happen if a particular type of freight vehicle was removed from the UK road network. A similar analysis has been conducted in Sweden\(^3\) to assess the effects of eliminating longer and heavier freight vehicles.

---

1. Unpublished data from the Department of Transport’s Continuing Survey of Road Goods Transport
vehicles (up to 25.25 metres long and 60 tonnes gross weight) and applying the 18.75 metre / 40 tonne limits prevalent across much of the EU.

It should be noted that not all tall trucks are double-decked\textsuperscript{4}. Some companies move low density products that can be stacked to heights of 3 metres or more on a single deck. The 'high-cube' vehicles that they use can be just as high as double-deck lorries, but as they are not classified as 'double-deck' they are excluded from the statistics and from the calculations reported in this paper. Including these high-cube vehicles would significantly increase the estimated economic and environmental costs to the UK of imposing a 4m trailer height limit.

Given the limited amounts of published data available on double-deck operations, the calculation is inevitably quite crude, but does provide a rough indication of the adverse effects of imposing a 4 metre trailer height limit. The next section outlines the statistics that have been used.

2. Available Data

As companies do not have to register trailers in the UK there is no central data base with information on trailer numbers and types. Since 2004 double-deck trailers have been separately identified in the Continuing Survey of Road Goods Transport (CSRGT), the main government survey of road haulage operations. It is mainly unpublished data from this source that has been used to assess the consequences of eliminating double-deck trailers from the UK lorry fleet. This indicates, for articulated lorries with double-deck trailers, the weight carried, the distance travelled, the percentage of kms travelled empty and the proportion of loads constrained by weight and/or volume. The figure for the total distance travelled can be used to estimate the size of the UK double-deck fleet. In 2008, double-deck lorries travelled a total of 491 million kms. In 2008, tractor units hauling semi-trailers travelled an annual average distance of 90,000 km\textsuperscript{5}. The number of trailers significantly exceeds the number of tractor units. Across a sample of 91 lorry fleets transporting food surveyed in 2007 the so-called 'articulation ratio' was 1.77 (i.e. 1.77 trailers for every tractor)\textsuperscript{6}. It is likely however that this ratio will be much lower for double-deck vehicles given their higher capital cost and application to specific types of delivery operation. If it were in the region of 1.2-1.4, the average double-deck trailer would travel around 65-75,000 kms annually, suggesting that there are 6500-7500 double-decks operating in the UK. This figure is broadly in line with estimates obtained from trailer manufacturers\textsuperscript{7}.

No data is available on the average proportion of space in these trailers (or any lorries for that matter) actually filled with freight. In the absence of this information, assumptions have to be made about the number of standard height trailers that


\textsuperscript{6} Department for Transport (2007) 'Key Performance Indicators for Food and Drink Supply Chains' Freight Best Practice Programme, London.

would be required to carry the freight displaced from double-deck vehicles. Nor is there any general information available on the dimensions and internal configuration of double-deck trailers. There has been a proliferation of double-deck trailer designs over the past decade to match particular companies’ logistical requirements, but no survey has yet been done to determine the proportions of trailers in different design and size categories. The ratio of the carrying capacity of a double-deck to a standard trailer can vary from around 1.5 to 1 to 1.95 to 1. A case study based on the Focus DIY chain and published by the government’s Freight Best Practice programme compared delivery operations employing double-deck and single-deck vehicles. The double-deck trailer was 4.8 metres high and could carry 87 roll-cage equivalents (RCEs) while the single-decks could only accommodate 45 RCEs, representing a carrying capacity ratio of 1.93 to 1. To deliver the same quantity of goods to the same destinations the two single-deck vehicles ran 1.93 times more kilometres than the double-deck vehicles. Other double-trailers will have heights less 4.8 metres and hence significantly lower carrying capacity ratios. Another constraint on this ratio is the vehicle weight limit, currently 44 tonnes for a 6-axle articulated vehicle and 40 tonnes for a 5-axle lorry. In 2008 double-deck vehicles ‘weighed out’ before they ‘cubed out’ on 12% of the distance that they travelled loaded. In other words, because of the density of the product, the vehicle weight limit was reached before all the space (or floor-space) in the trailer was used. Following consultation with industry experts on the use of double deck vehicles, an average ratio of 1.65 to 1 has been applied in this calculation. In a subsequent sensitivity analysis the ratio has been varied to assess the effect on fuel and CO₂ estimates.

Assumptions have also had to be made about the fuel efficiency of the road haulage operations. The CSRGT collects information on the fuel consumed by trucks in the survey. On this basis it was estimated that in 2008 the average articulated lorry in the UK had a fuel efficiency of 7.6 mpg (or 2.7 kms per litre). No separate figure is available for tractor units hauling double-deck trailers. The CSRGT monitors the activities of tractor units over the period of a week but does not enquire about the amounts of fuel they consume when hauling particular types of trailer. Some allowance must, nevertheless, be made in the calculation for differences in fuel efficiency between standard and double-deck trailers. As double-decks can be up to a metre taller they experience greater wind resistance and thus, other things being equal, consume more fuel per km. One study estimated that the increase in the ‘drag coefficient’ resulting from raising the trailer height from 4 to 4.48 metres reduced fuel efficiency by 5-6%. Many of the new double-deck trailers commissioned in recent years, however, have sloping fronts which help to streamline airflow and minimise the fuel penalty. The supermarket chain Somerfield, for example, found that aerodynamically profiling double-deck trailers reduced their fuel consumption by an average of 7%. We do not know, however, what proportion of double-deck trailers are aerodynamically profiled and thus the average magnitude of the fuel penalty across the double-deck fleet.

---

In comparing the average fuel efficiency of double-deck and standard height vehicles two other factors need to be considered.

1. The tare (i.e. empty) weight of the double-deck trailer will be greater because of its larger frame, the extra deck and, in the case of powered-deck trailers, the hydraulic equipment. This can add 4-5 tonnes to the weight of a double-deck trailer. On the other hand, curtain-sided double-decks and an increasing number of box double-decks have fixed decks which carrying a much lower weight penalty.

2. Double-deck vehicles cater mainly for lower density products and, as a consequence, their average payload weight is significantly lower than that of the average articulated lorry. In 2008, it was 12.4 tonnes as opposed to 15.2 tonnes for the average artic, even allowing for the fact that the double-deck is essentially carrying two layers of freight. This 2.8 tonne difference in average payload weight goes a long way to offsetting the double-deck trailer’s tare weight penalty.

Taking all these factors into account, it has been assumed that double-deck vehicles consume, on average, 4% more fuel than the average articulated vehicle. This figure has, nevertheless, been varied to measure its impact on the fuel consumption and CO$_2$ estimates$^{12}$.

3. Results of the Analysis

Figure 1 outlines the calculation which has been done using an Excel spreadsheet calibrated with 2008 data from the CSRGT. Values sourced from the CSRGT are shown in solid black boxes. The main outputs of the calculation are shown in the boxes with bolded rims.

Data on the average payload weight and average length of haul for double-deck trailers were multiplied to obtain an estimate of the average number of tonne-kms per loaded double-deck trip. Total tonne-kms moved by double-deck vehicles was then divided by this average number to estimate the annual number of trips made by double-deck vehicles on UK roads. In the absence of double-deck trailers, many more trips would have to be made by standard height trailers to move the freight currently handled by double-decks. As discussed earlier, insufficient data is available to determine empirically how many standard trailers it would take to replace the double-decks. It has been assumed that the ratio of double-deck trailer capacity to that of a standard trailer averages around 1.65:1. Applying this ratio suggests that an extra 1.73 million trips by standard height trailers would be required. This number of trips was multiplied by the average length of haul for double-deck vehicles to work out the additional loaded vehicle-kms that would be generated$^{13}$. There is usually a substantial amount of empty running associated with outbound laden trips. In 2008 articulated lorries ran on average 4km empty for

---

$^{12}$ It is worth noting that in the Focus DIY comparison (see footnote 5 above) the fuel efficiency of the double deck trailers was only 0.6% lower than that of the single-deck trailers.

$^{13}$ Since the vast majority of double-deck trips are single-drop there is likely to be a close correspondence between average length of haul and average trip length.
every 10km that they ran loaded \(^{14}\). Once allowance is made for this level of empty running, it appears that transferring freight from double-deck to standard height trailers would add 348 million more lorry-kms to the road network, 71% more than travelled by the double-deck vehicles they replaced. This would increase the total amount of articulated lorry traffic on UK roads by 4.5% \(^{15}\). More lorry-kms mean more congestion, more pollution and more traffic accidents.

**Figure 1: Method of Calculation**

These additional vehicle-kms would significantly increase road haulage costs. An attempt has been made to quantify these additional costs using vehicle operating cost data compiled for the Road Haulage Association by DFF\(^{16}\). These tables do not differentiate between double-deck and single-deck vehicles. They indicate that the cost of operating a standard 44 tonne articulated lorry in 2008 was £1.02 per km (a figure which combines both distance-based and time-based cost elements). A double-deck vehicle is more expensive to operate because of the higher capital and maintenance costs of the trailer and the fuel cost penalty discussed earlier \(^{17}\). The DFF cost tables have been recalibrated to take account of these higher costs. This suggests that double-deck vehicles are around 10% more expensive to operate, at £1.13 per km, assuming the same annual average utilisation as for the standard vehicle. Multiplying this cost per km by the 491million kms travelled by double-deck lorries in 2008 yields a total operating cost of £553 million. According to the earlier calculation, standard lorries would have to travel 839 million km to deliver the same

\(^{14}\) Department of Transport (2010) op.cit.
\(^{15}\) This figure relates solely to UK-registered vehicles and excludes foreign-registered trucks
\(^{16}\) Data obtained from http://costs.dffintl.co.uk/
\(^{17}\) Holter et al (2010) op.cit.
quantity of goods which, at £1.02 per km, would cost £858 million. This is £305million (55%) more that it would cost to distribute the same amount of freight by double-deck lorries. For many companies, the percentage increase in haulage costs would be much greater. In the Focus DIY case study, for example, distributing goods in single-deck lorries was 95% more expensive per unit delivered than delivery by double-deck trailer.

Estimates of the distances travelled annually by double-deck lorries and the equivalent number of standard articulated vehicles were also used to calculate the extra fuel consumption and CO₂ emissions. As noted earlier, the average articulated vehicle with a gross weight over 32 tonnes had an average fuel efficiency of 2.7 kms per litre (or 7.6 mpg). The average fuel efficiency of double-deck vehicles was increased by 4% to allow for their greater aerodynamic drag, as explained earlier. If double-deck vehicles had been replaced by standard lorries in 2008 total fuel consumption would have risen from 190 to 312 million litres, a 64% increase. As CO₂ emissions are a direct function of fuel consumption, these emissions would also have increased by 64%, from 0.50 million tonnes to 0.82 million tonnes. This would represent a 4.3% increase in the total amount of CO₂ emitted by British-registered articulated lorries operating in the UK. In terms of CO₂ emissions, it would be equivalent to adding an extra 151,000 new cars to Britain’s roads. This calculation is based on the average new car emitting 150 gCO₂ / km¹⁸ and travelling 14200 kms per annum¹⁹.

An analysis was conducted to determine the sensitivity of the estimated increase in fuel consumption and CO₂ emissions to the assumptions made about the ratio of double-deck to standard trailer carrying capacity and the fuel penalty incurred by double-deck vehicles (Table 1). In the ‘worst case’ considered, where a double-deck trailer had on average 50% more carrying capacity than a standard trailer and the double-deck fuel efficiency was on average 6% lower, the removal of double-deck vehicles would still increase fuel and CO₂ emissions by 46%. On the other hand, if, on average, double-deck capacity was 80% higher and the fuel penalty was only 2%, switching from double-deck to standard trailers would raise fuel use and CO₂ emissions by 84%.

<table>
<thead>
<tr>
<th>Double-deck capacity as % of standard trailer capacity</th>
<th>2%</th>
<th>3%</th>
<th>4%</th>
<th>5%</th>
<th>6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>150%</td>
<td>52</td>
<td>50</td>
<td>49</td>
<td>47</td>
<td>46</td>
</tr>
<tr>
<td>155%</td>
<td>57</td>
<td>55</td>
<td>54</td>
<td>52</td>
<td>51</td>
</tr>
<tr>
<td>160%</td>
<td>62</td>
<td>61</td>
<td>59</td>
<td>58</td>
<td>56</td>
</tr>
<tr>
<td>165%</td>
<td>68</td>
<td>66</td>
<td>64</td>
<td>63</td>
<td>61</td>
</tr>
<tr>
<td>170%</td>
<td>73</td>
<td>71</td>
<td>70</td>
<td>68</td>
<td>66</td>
</tr>
<tr>
<td>175%</td>
<td>78</td>
<td>77</td>
<td>75</td>
<td>73</td>
<td>72</td>
</tr>
<tr>
<td>180%</td>
<td>84</td>
<td>82</td>
<td>80</td>
<td>78</td>
<td>77</td>
</tr>
</tbody>
</table>

Table 1: Percentage increases in fuel consumption / CO₂ emissions resulting from the removal of double-deck trailers.

4. Conclusions

Serious concern has been expressed by large operators of double-deck vehicles in the UK, such as the pallet-load networks, that the imposition of a 4 metre height limit on new trailers would have serious economic and environmental consequences. While the European Commission’s goal of harmonising many aspects of European transport systems is very worthy and widely supported, it can have unintended consequences. The use of double-deck vehicles in the UK is well-aligned with the EU’s declared policy of improving the sustainability of logistics across the continent. Its ‘Freight Transport Logistics Action Plan’, for example, seeks to ‘ensure a competitive and sustainable freight transport system in Europe’ 20. It seems perverse, therefore, that, in an effort to standardise vehicle dimensions, the EU should try to constrain one of the most effective means that UK-based companies have to improve the sustainability of their distribution operations.

The analysis outlined in this short report has attempted to quantify these effects on the basis of available data for 2008. It suggests that eliminating double-deck trailers and replacing them with trailers of standard height would increase the amount of UK-registered articulated lorry traffic on UK roads by around 4.5%, add £305 million per annum to road haulage costs and increase fuel consumption and CO₂ emissions by 64% against the double-deck vehicle baseline. A sensitivity analysis has indicated that this percentage increase could vary between approximately 46% and 84% depending on the values assigned to two key parameters in the calculation. More survey data will be required to refine this calculation, permitting more accurate estimation of the relative carrying capacity, loading, fuel efficiency and operating costs of standard height and double-deck trailers. Given the scale of the potential economic and environmental costs of introducing a 4 metre height limit on trailers operating in the UK, a strong case can be made for further research on this subject.

---