

# Open Research Online

---

The Open University's repository of research publications and other research outputs

## Implications of HGV charging for the UK

### Conference or Workshop Item

How to cite:

Warren, J. P.; Potter, S. and Parkhurst, G. (2005). Implications of HGV charging for the UK. In: 37th Annual Conference of Universities Transport Study Group, 5-7 Jan 2005, Bristol, UK.

For guidance on citations see [FAQs](#).

© [not recorded]

Version: [not recorded]

Link(s) to article on publisher's website:  
<http://www.utsg.net/publication.php?Year=2005>

---

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

---

[oro.open.ac.uk](http://oro.open.ac.uk)

---

## IMPLICATIONS OF HGV CHARGING FOR THE UK

**J P Warren<sup>\*</sup>, S Potter<sup>\*\*</sup>, G Parkhurst<sup>\*\*\*</sup>**

<sup>\*</sup> Author for correspondence –, Faculty of Technology, The Open University in the East of England, Cintra House, 12 Hills Road, Cambridge CB2 1PF. Email [j.p.warren@open.ac.uk](mailto:j.p.warren@open.ac.uk)

<sup>\*\*</sup> Centre for Technology Strategy, Department of Design and Innovation, The Open University, Walton Hall, Milton Keynes MK7 8AA.

<sup>\*\*\*</sup> Faculty of the Built Environment, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY

### 1. ABSTRACT

Road transport taxation in Europe is undergoing a major and radical shift away from fixed charges and fuel duties towards pricing according to distance travelled and externalities produced. Implementation is underway in some states, change being led by national schemes for the freight sector only. The UK is considering such a system for implementation by 2008, to use global positioning system technology.

The paper reviews the current developments and considers charging scenarios, including a scenario for covering the full external costs of the UK freight industry. Implications for taxation policy are considered, including whether the doctrine of revenue neutrality is consistent with 'sustainable mobility'. Consideration is given to a transition strategy which could bridge between the current level and structure of prices and a future, more economically efficient approach.

### 2. Introduction

Road user charging, or pay per distance charging, has been suggested as a more viable alternative to fuel taxation as the main earner for the UK treasury in recent times (Commission for Integrated Transport, 2002). Already various schemes for road user charging (RUC) with a 'congestion charge' have been implemented in London, Durham and elsewhere, clearly targeting the most expensive external costs (congestion) as well as having the possibility to hypothecate the earnings from such a scheme towards improved public transport infrastructure and systems. Ultimately the Department for Transport (DfT) and HM Treasury (HMT) see a global positioning system based in all vehicles working in the heaviest class of lorries from approximately from early 2008, as the final charging system. This final system is proposed to go forward after a test (or trial) period to ensure good working order. This paper assumes that the test period will be anywhere from 18-30 months long.

This paper looks directly at the various incomes that could be gained by moving to such a complex charge scheme for the context of heavy duty trucks within the UK, and what implications this may have for other (vehicle) sectors in the medium to short term future. In this case we propose the possibility of using annual tachometer readings coupled with an accurate statistical picture of road use in order to formulate a sensible charge, or via a black box on board unit (OBU). The study is currently restricted to heavy good vehicles (HGV) based on the premise that this annual (total) accrued mileage will not be greatly changed by a shift in such a charging scheme. In other words although the final charging scheme may lead to major shifts in total times driven, speeds, and time of day for driving, this work assumes that the overall mileage would be approximately the same under the start-up scheme (2008-2010). Thus one of the key points of the bridging scheme is to ensure that correct annual mileages are utilised. A very brief review of HGV activity in the UK is given here and then the main characteristics of the LRUC (lorry road user charge) scheme are summarised in order to familiarise readers with the main parameters of input data that were utilised.

Overall the total heavy goods vehicles make up the following important contributions to the UK transport system - 17 % of all the revenue based on Fuel Excise Duty (FED) and Vehicle Excise Duty (VED), ~13 % of all motorway mileage, the third largest new truck market in western Europe,

with unit sales of 44,000 in 2000, 7 % of the global truck market, and the consumption of ~ 42 % of all diesel sold in the UK.

**Table 1:** Key characteristics for lorry charging in five countries (adapted from HMT, 2002-2004).

	Switzerland	Germany	Austria	UK	NL
Start date	1/1/2001 (successful start)	Previously 31/8/2003, now 01/01/06	1/1/2004 (successful start)	2006 trial, 2007-08 implement	2004 (part); 2006 (fully)
Charge level	Per km (on all roads) using flat fee (distance based)	Per km of motorway	Per km of motorway	On all roads – fee may vary	All roads
Charge Policy Basis	On max. permitted weight and emissions level	On axle count basis and emissions level	On axle count basis only	Based on axle, weight and emissions.	(not known)
Minimum size	3.5 t	12 t	2 or 4 axle over 3.5 t	Initially only largest lorries	(not known)
Hardware	OBU for Swiss trucks, monthly smartcards	OBU	OBU required for all nationalities	OBU	OBU required
Other regulatory checks	GPS verification. OBU auto on/off via microwave	Uploads GPS data to operating authority*	Gantries along motorway using microwave	Auto-plate readers (ANPR) may also be used	operated by road service provider
Non-national users, or occasional users	OBU not required, border bookings, with odo-checks	pre-book via internet stations or dedicated terminals (no OBU).	OBU compulsory (low cost)	low use method – maybe isolated, smaller OBU	(not known)
Payment method	Monthly declaration by updating card and then e-submission or post	Automatic Billing	Charge levied automatically from bank account, or via pre-paid OBU card.	Debit via e-cards (tbd)	(not known)
Fiscal cuts	None	Some offset cuts planned.	Some offsets, overall lorries pay more for motorways.	Probable fuel cuts	Initially to be fiscally neutral.
Typical charge (£/km)	0.188-0.264/km	0.063-0.097	2 axle ~ 0.09 4 axle ~0.181	To be determined	0.09-0.20

\* In Germany this is done by Toll Collect -a consortium of DaimlerChrysler, Deutsche Telekom and Cofiroute.

Clearly, they are an important part of the national economy as well as to some extent the wider European economy and beyond. One only need consider all the potential supply systems involved with say for example, truck components, to realise how far these systems reach. Yet at the same time the Chancellor has emphasised the core environmental aim within the pre-budget report (HMT, 2003) which was originally expressed in November 2001 in the consultation document for modernising the haulage industry. The purpose clearly stated that the charge was “to ensure lorry users in the UK contribute on a fairer and more equal basis towards the costs that [they] impose”.

At the same time the industry was not to suffer an increased tax burden for operators at least at the time of introduction. These (external) costs can be summarised as climate change, (local) air quality, road maintenance, safety, traffic congestion and noise. Table 1 summarises some of the most important features of five national charging schemes from around the world (note that some of these might not be running to date).

## 2 Implementation and Policy

The UK policy seems to be pursuing the goal of ensuring that HGVs pay their fair share of road damage and congestion as well as other external costs, and in addition would act as a bridging step towards the more sophisticated GPS based charging systems being proposed. Currently the Treasury is advocating a revenue neutral basis for this charge, yet revenue neutrality can have different definitions for different parties and perspectives. From the Treasury view it could mean that the same amount of tax revenue is collected from a more or less similarly constituted vehicle parc, with individual lorries being charged on average more or less. Alternatively, a policy to apply revenue neutrality to the payments of the 'average lorry' could result in total tax-take increasing or reducing, depending on parameters such as fleet size or environmental performance.

It may well be that the eventual position from the HMT perspective is one of revenue raising or generating, rather than revenue neutrality. The neutral position, which is intended for the start-up period, may quickly be offset by gains due to traffic growth or eventual increases in fuel duties if put into place. Contrary to this is the foreseen lowering of fuel consumption as more sophisticated engines penetrated the marketplace. These engines and emissions systems are expected to become more technically advanced (and possibly more frugal in fuel consumption) as Euro Stage V emissions limits become widespread throughout Europe. There is however a chance that in some cases fuel consumption may go up and that certain market niches will not be appropriately allocated for charges (Foley and Fergusson, 2003). Nevertheless, the latest progress report (HMT, 2004) states that -

*The characteristics of the UK charge scheme will include*

- Reduction in fuel duty tax as an offsetting measure
- Repayments will be made electronically (maybe at point of sale/e-cards)
- On-board units (OBU) for all heavy users (above a set threshold)
- Occasional user scheme (utilising low use OBU)
- HM Customs & excise responsible party for LRUC (procurement)
- Will apply to all roads

Thus this paper attempts to model these various factors in such a way as to predict the level of charges one might reasonably expect for road user charging for goods vehicles from the present day to the mid-long term future. Various scenarios have been explored and the results of these in terms of charges and treasury incomes are reported along with some of the potential effects that might be felt by various haulage companies in the UK.

### **From revenue neutral to revenue collection**

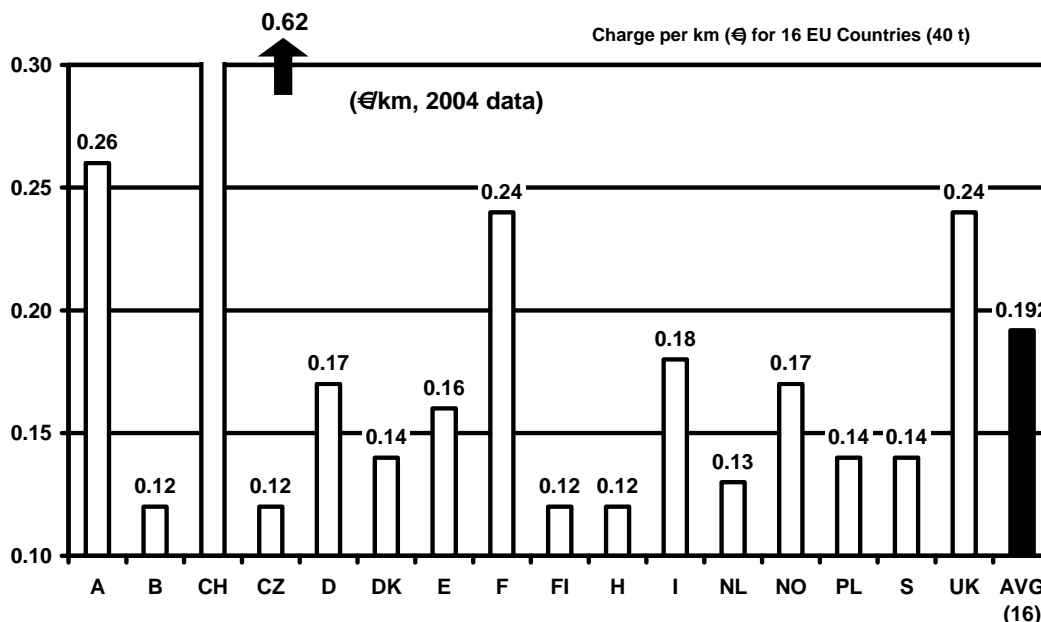
The latest timeline of events for lorry charging within the UK seems set to go ahead in the next few years with charging for articulated lorries beginning in earnest in 2008 (HM Treasury, 2004). It should be noted however that other road charging systems have been met with some systems problems and a brief review (Table 1) of some of these is given here for background information – clearly there may be slippage of dates for the UK system and this might well affect the start-up times of our scenarios, but it does not change the overall trends which are shown here.

The proposal of "making the charge simple at first" is a sensible one, as other charging systems for heavy trucks have been met with criticism and in some cases with the potential threat of government legal action (Tartler, et. al., 2003). This action is due to 'lost tolls' which have not been collected since the tolling consortium has missed the original 'go-live' date. The difference here is

that Germany's Toll Collect is clearly motivated by different factors and intends to offer much more than simply collecting charges (The Economist, 2004). Due to its complexity and to its goals of trying to develop exportable technology the system may be so ambitious that it will take further time to develop it and to ensure the system runs efficiently. The charges range from 0.063-0.104 £/km (The Economist, 2004). This is on top of the 0.118 £/km which ECMT has calculated for a typical heavy haulage lorry (ECMT, 2004).

For the UK scheme, making things revenue neutral (from a Treasury viewpoint) means that there will be lowered fuel duty; a form of offsetting tax cut (HMT, 2004). The fuel repayment scheme is suggested to take the form of electronic cards for controlling and tracking the level of fuel use on LRUC vehicles. But as Goodwin (2004) points out, no system is ever completely revenue neutral – overall the costs must increase if a new charge is added. The nature of any transport system must be defined as dynamic and our model shows that with traffic growth, there will be major changes in HMT income. It would also seem apparent that although the new scheme may be neutral for some, it will generate savings for others, and cost others more. In the new scheme, a dedicated (or designated) fuel has been ruled out (i.e. coloured diesel fuels), which from a supply chain management perspective is arguably a more optimal technical solution. Previous work (Warren, 2000) has shown that the UK is short of tank space in many forecourts and that further fuel fragmentation will add pressure to the entire fuel system. Fraud is a concern and it is not yet clear how this could be solved.

Currently, European toll charges on haulage vehicles stand at a minimum of approximately 0.08 £/km with typical maximums of 0.17 £/km for various countries; the notable exception being Switzerland which has implemented the HVF (heavy vehicle fee) system, with a pay per distance rate of as much as ~0.43 £/km (ECMT, 2004). These charges are shown in Figure 1 for comparison using the first quarter data of 2004 in most cases. It should be noted that the Swiss HVF is set to be raised in two further steps, from ~0.29 p/km to 0.47 £/km in 2005 and then to 0.77 £/km in 2006 (Balmer, 2004). Others report these fees as: 0.43, 0.69, 0.77 £/km (Perkins, 2004). These increases are much higher than the EU 16 historical average increase of +23% from 2000 to 2004 for the costs of hauling (ECMT, 2004). Note that there are reported discrepancies in the charges both the HVF and overall costs, thus both sets are reported here for completeness.



**FIGURE 1:** Current EU haulage charges for HGV based on 400 km trip using 40 tonne vehicle; these include the charges for pay-per-distance systems for CH (Switzerland), F (France) and Austria (A). Note Switzerland is off-scale at 0.62€/km (approx. 43 p/km); average value is 0.136 p/km and it is not weighted per country-mileage.

It is clear that getting the charge correct in the first stage of implementation will be critical. Some of the attitudes and recommendations towards road pricing have been recently reviewed (Lyons, et al, 2004). Their findings show that there are many issues that need resolving before the successful implementation of road pricing can be carried out. Various charges have been proposed by many parties and although this paper is not a review of potential charges, a range of these is shown in Table 2 for consideration. Other possible charges could be derived from existing charging toll roads, bridges, or congestion zones coupled with typical haul statistics in order to derive a distance per charge even if the scheme was not devised to do this in its original nature. Those charges are not reported here but are forthcoming (Warren, 2005). The charges (in Table 2) range from typical minimum values of approximately 10 pence per kilometre up to nearly £2/km for areas which are perceived as most congested. Perhaps not surprisingly most values place the congestion cost as the major external cost (Goodwin, 2004).

**Table 2:** A range of external costs (£/km) for an articulated heavy goods vehicle

Location and Source	Minimum	Average	Maximum
Toll Collect/Germany (Economist, 2004)	0.063	0.084	0.104
Swiss HVF (Bulmer, 2004)	0.29	0.35	0.43
IPPR (Foley and Fergusson, 2003)	0.069	0.12 (car)	0.204
USA (Forkenbrock, 1999)	-	0.14	-
Austria (Schwarz, 2004)	-	0.188	-
Norway (Erikson, )	0.17	0.45	0.86
UK/Rail/SRA (Goodwin, 2004)	0.041 (rural)	0.511 (weight. avg.)	1.738 (London)
UK/ITS study * (Sansom, et. al. 2001)	0.35	0.43	0.51

\*This data has been adapted from tables 7.4 and 7.5 (p 49 appendix).

Rather than attempt to define a charge per distance and 'stick' to this rigidly, we have applied a range of charges based on previous works which tried to estimate the average (external) costs for HGVs; thus values of 5, 10 and 20 pence per kilometre have been used here. Calculations using 15, 30 and 40 p/km were also performed, but those are not shown here for brevity and clarity.

In order to present an example of what revenue neutrality might look like from a Treasury perspective, the authors have taken the current fleet of ~100,000 articulated lorries and using current costs and economies have been created a scenario of what is paid to Treasury to date, along with what an introduction to LRUC might mean using various charges and rebates. In order to do this calculation a 'standard' average mileage needs to be assumed and this is shown in Table 3 for typical UK goods vehicles.

**Table 3:** Main statistics for heavy goods vehicles (over 35 t GVW) in GB with units given in the table for each item. The details that are shown for this baseline charging system are held constant for all cases.

Parameter	Value for 2002 (units)	Variation until 2015
Annual mileage	93,000 km	Growing ~20 % over 10 yrs
HGV Parc	~105, 000 vehicles	Growing ~7% over 10 yrs
Typical annual fuel duty	Approx. £ 9, 100/yr/veh.	FED may grow slightly but in real terms stays

		constant – held at 0.471 p/L until 2015
Typical annual VED	£ 1, 400/yr/veh.	Static for all scenarios
Fuel consumption	34-38 l /100 km	Decreasing by 10% in 10 yrs

Table 3 shows the main HGV related information (for a typical goods vehicle) which was used to model the baseline case which is applied from 2002-2007. In addition to this, foreign lorries are also included once the LRUC system comes into place in 2008. For non-UK lorries it is assumed that their penetration into the UK will grow by 14% (over 10 yrs) and that their annual mileage will grow slightly higher than that of UK based lorries (see TSB, 2003 for more information). All vehicles are assumed to be diesel powered in our cases and it is recognised that this is not accurate since there is some small penetration of alternate fuels in the lorry parc. The numbers are minor and affect the overall trends very minimally and thus are not included here.

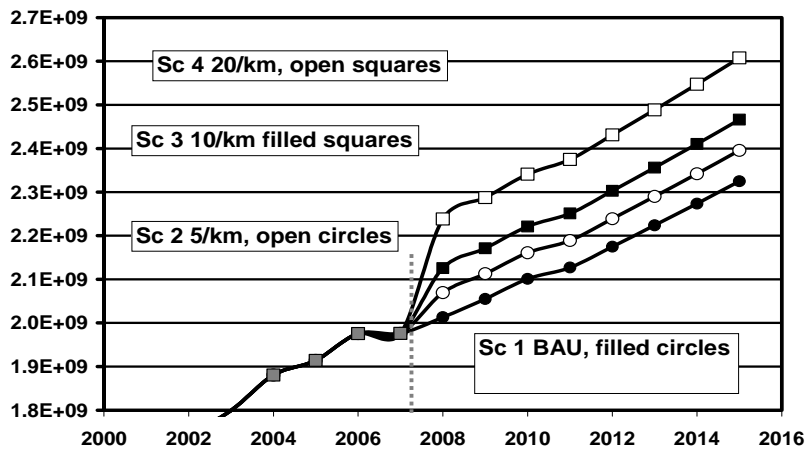
The Treasury has argued that getting the charge correct is a critical exercise in ensuring that the adoption of the LRUC is carried out smoothly based on what other charging systems have achieved to date. Currently that charge is not yet known, but here the external costs are applied to the above scenario in order to derive the 'revenue neutral case'. In this case getting the charge right, means '**not penalising UK haulage**' yet at the same time ensuring the system is relatively easy to operate and manage. It is unclear what it means for the long term as it can be shown that revenue neutrality (RN) may well disappear quite rapidly depending on which conditions are applied.

### 3 Charging Scenarios

To arrive at RN, the most straightforward method was to collect FED and VED and the distance charge. Then the distance charge derived from UK based lorries can be separated out and subtracted from the FED to be rebated. The mechanics of this are simple although 'messy' in the sense that the number of operations is increased. The rebate can also be examined in terms of how much tax cut there would be needed in the fuel duty (per litre) since the fuel economy is known for future years. These rebate levels can then be compared to the total fuel tax in order to draw useful comparisons. Thus, one can probe issues such as – when does the distance charge become a larger earner than the fuel tax for the Treasury? At what level of traffic growth does a bonus occur for which charge level? How significant is VED? What impact does non-UK freight have on the entire scheme? What happens when very high congestion charges are put into place? This paper does not attempt to definitively answer all of these issues but the modelling presented here can lend powerful insight into understanding revenue neutrality and revenue generation.

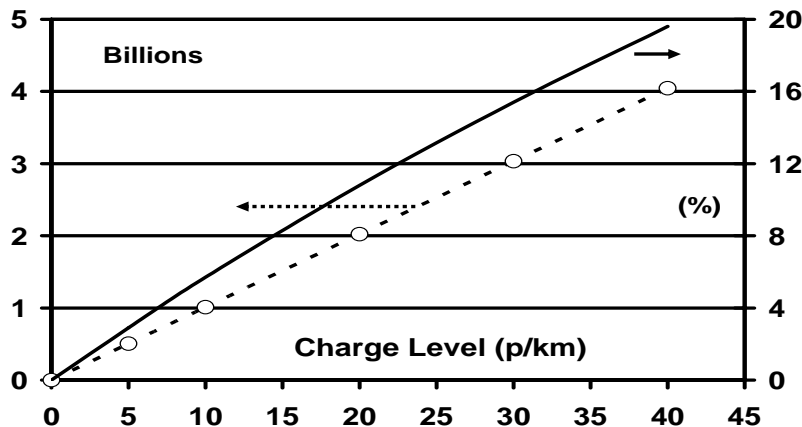
The four scenarios (Sc 1, Sc 2, Sc 3, Sc 4) modelled were business as usual (Sc 1) and three distance charging schemes using 5, 10 and 20 pence per kilometre charges. Even with these relatively low charges interesting results emerge within a very short time span. In Sc 1, income would grow based solely on traffic increases and losses in fuel economy as well. FED would remain as today the main driver for income. This scenario is shown in Figure 2 as the line associated with filled circles; income rises from just under £2 billion to ~ £2.6 billion for the period studied.

This study has not modelled any secondary effects, such as drop in traffic levels, or any effects due to efficiency gains in the fleet from hauls not completed/not required. Clearly these could be appended by addressing the correct factor of elasticity against each vehicle class. It should be noted that the charge scheme is also simply 'turned-on' at a certain point (in all cases 01 January 2008) and this also may not be the final case.



**FIGURE 2:** Potential income (billions £ UK/year) derived from articulated lorries operating under a charge scheme of non charge (Sc 1) and charges of 5, 10 and 20 p/km. The grey dotted vertical line illustrates the point at which LRUC goes live. The grey squares (pre-2008) are identical for all cases and represent 'traditional' fuel and vehicle tax incomes.

For the highest charge (of 20 p/km, or Sc 4, open squares in Figure 2) the gain in earnings amounts to just over two billions pounds over the ten year period; this is equivalent to about ~11% of all the income for this vehicle sector. In summary, the scenarios can be described in simple terms; for every + 10 pence increase in the distance charge, the overall budget is increased by about £1 billion over the 2008-2015 period. A charge of 40 p/km would yield more than £4 billion pounds over the time period and would lift the distance charges to 19.6% of the income; it is felt that although a high charge such as this might be feasible, implementation of high charges would come some time after the scheme has been running for at least 4-6 years. The general trends for a charging series are shown in Figure 3.



**FIGURE 3:** Extra income (billions, £) as a function of distance charge for articulated vehicles over 32t GVW\*.

\*Solid line refers to additional cumulative HMT revenue over the period modelled. The dashed line represents the percentage of additional HMT revenue that is due to the LRUC.

Figure 3 depicts both the added extra income calculated on a period of 2008-2015 for the various charge levels investigated including 40 p/km. with no charges the income of the same period is ~£ 2 billion. The underlying data within the chart shows that rebate levels increase from ~0.16 p/L (at 5 p/km) to 'revenue neutrality' at approximately 16 p/km (0.468-0.472 p/L rebated). Above this point



the distance charging system is collecting more funds than the FED mechanism. Obviously one would not expect the situation to be as static as this for the period studied and further work is needed to apply a more complex scenario whereby distance charges could be raised, other vehicle sectors could be added in and there may be other exemptions coming into force in the longer terms (such as hybrid/hydrogen/alternate vehicle uptake).

Clearly, the picture is complex and it would be quite straightforward to allow fuel costs to rise slightly in the next 1-1.2 years in order to maximise revenue, whilst still allowing for a future of overall reduction in fuel duty. This could help build up the surplus funds for a period when the distance charge will begin and various pieces of hardware will need to be purchased. This is where VED may be able to substitute for the hardware needed to provide a working system.

When this analysis is applied to the entire fleet of vehicles the revenue due to the external charges is in the order of £8- 28 billion per annum; this analysis is highly dependent on the actual road user charges applied, how they are applied (i.e. varied, flat fees, etc.). This approximation is based on the current fleet, predicted growth and relatively low charges ranging from 12-39 p/km for all vehicle classes (except passenger cars). This is also approximately the order of magnitude expected to be 'lost' from efficiency gains and uptake of lower taxed fuels (Parkhurst, 2002).

#### 4 Effects of the Charge Scenarios

There has been much debate about revenue neutrality and revenue raising charge systems and the possible implications for either system in the UK. A wider study is needed to assess the potential impacts for all transport sectors in order to ensure the best system goes forward and to see if there are any unwanted detrimental impacts as well. Some potential issues emerge when moving from fixed to variable costs (e.g. flat fee to distance charges) and these warrant further work. They are identified here (but not modelled) and are summarised in the table below. The question marks are used to identify areas where it was unclear how charging might affect the parameter.

**Table 4:** Secondary effects of charging within the freight sector and other factors for consideration when implementing charging

<p>Might encourage shorter journeys - ?</p> <p>Should encourage higher efficiencies (less empty hauling)</p> <p>May penalise long distance trucking (since based on km?)</p> <p>Penalises non-UK trucking systems</p> <p>May encourage short sea shipping/ship to road – more containers/more piggyback systems</p> <p>Should encourage more fuel efficient vehicles</p> <p>If Eco-performance gains discount (Euro-factors) then scale of purchasing become important</p> <p>Could be an explosion in another niche (like medium hauling/white vans/other area)</p> <p>Eco-niche could also expand (LPG, CNG trucks)</p> <p>Could encourage regenerative braking/diesel-electric or weight sensitivity?</p> <p>Private costs will continue to grow as external costs continue to fall</p> <p>UK rail freight increases (analogy to Swiss HVF)?</p> <p>Freight decreases overall?</p> <p>Potential for traffic redistribution to 'get' shorter routes since all roads are charged</p> <p>Time shift (towards night driving) if congestion based costs implemented – potential for accident rate increase (?)</p>
--

Although it is difficult to know which freight operators will win or lose, it seems that in general terms, those worst off are likely to be SMEs, travelling with relatively high mileage, using Euro 0/1/2 and operating under poor conditions (low efficiency, lower cash flows). Those who might benefit would

be travelling modest miles, using the best equipment (Euro 4/5) with high efficiencies (full loads, no empty back hauling, excellent driver training programmes) and having access to corporate behaviour. This could include bulk buying powers (for equipment purchases) and where VED amounts to little importance in the overall budgeting. The new charging system may also favour those who only operate in specific segments as well, but this is difficult to speculate currently.

From a policy point of view the use of a specific sector is a sensible one as this will allow time for all the stakeholders to become more familiar with the technological constraints of the system and leave time for imbedded learning. It could be suggested that this imbedding could spread across from the heaviest vehicles to the next (lighter and smaller) goods classes. Almost immediately the treasury would probably see a gain in terms of revenue for all these classes as long as the hardware and maintenance is not too costly, and again, if the charge is right. Also a rise in the charge with less offset will also accomplish a revenue gain.

## Conclusions

From the data above total potential revenue was calculated for each of the various classes of vehicles assuming a 'flat' charge for congestion (i.e. the congestion charge did not vary for peak and off-peak times). Even the lowest levels of charging for a specific sector of the fleet gave rise to large incomes in the long term for the Treasury, even if initially based on a revenue neutral policy. In simple terms an increase in charges of about 10 pence per kilometre results in a £1 billion gain over an 8 year period when all other factors are held constant as previously described. With expected marginal increases in fuel duty and traffic growth in both UK and non-UK sectors, even with VED being scrapped, the overall income is expected to be increased. These increases in turn will outcomes for many haulers and these secondary effects are more difficult to model at this stage.

In the later phases of road charging there is reason to suspect that the overall incomes should increase for all vehicles classes, except those which may be highly inefficient and thus are reduced to nil. Road pricing however is a difficult path and this area warrants much further work, with joined up modes being a more key objective. In the freight and passengers arena, both road to rail most be revisited in order to look at the various potential issues before the scheme is put in place. This work asks the question – what political conditions should be put into place in order to effectively introduce nationwide UK charging? It seems that by using a smaller segment of the vehicle sector such as articulated lorries the government has potentially found an ideal solution. The system can be trialled: with relatively few units, using low technology in the initial steps, and provides a way to enable fuel rebates. It also gives exposure to charging for other sectors (just as London has for other cities) and begins to slowly open the doors of internalising charges. In the early stages it probably can not solve congestion but IPPR work suggest that traffic growth might be curbed by ~9% and CO<sub>2</sub> emissions lowered as well. Thus this type of modelling can become a potentially useful and highly flexible instrument for assisting the introduction of further policy measures.

## References

ACT Research (2004). *Global Commercial Vehicle Forecasts*. Columbus, IN. LMC Auto. Serv. 80-88.

Balmer, U, (2004). The Window of opportunity – how the obstacles to the introduction of the Swiss Heavy Vehicle Fee have been overcome. International Conference on Managing Transport Demand Through User Charges – Experience to Date (ECMT), London, January 23, 2004.

Commission for Integrated Transport, 2002. *Paying for Road Use*, final report, February 2002.

Department for Transport (2002). *Transport Statistics Great Britain 2002*. TSO, London, Table 4.9.

European Conference of Ministers of Transport (2004). *Road Haulage Taxation Database*. ECMT Group, Quarter 1.

- 
- Eriksen, KS, (2000). Calculating external costs of transport in Norway. *European Journal of Transport and Infrastructure Research*. Special Edition on Sustainable Transport, **0**, (0), 9-25.
- Foley, J and Fergusson, M (2003). *Putting the brakes on climate change*. IPPR, London.
- Forkenbrock, DJ, (1999). External costs of intercity truck freight transportation. *Transportation Research A*, **33**, 505-526.
- Goodwin, P, (2004). *The economic costs of road traffic congestion*. Discussion paper for Rail Freight Group (May).
- HM Treasury (2001). *Modernising the Taxation of the Haulage Industry – a consultation document*, November 2001. Accessed from [www.hm-treasury.gov.uk/media/OB8E8/Haulage.pdf](http://www.hm-treasury.gov.uk/media/OB8E8/Haulage.pdf)
- HM Treasury (2002). *Modernising the Taxation of the Haulage Industry – Progress report one*, April 2002, HM Treasury. Accessed from [www.hm-treasury.gov.uk/media/5AC1C/modernising\\_haluage.pdf](http://www.hm-treasury.gov.uk/media/5AC1C/modernising_haluage.pdf)
- HM Treasury (2003). *Modernising the Taxation of the Haulage Industry - Lorry Road-User Charge – Progress Report Two*, May 2003. HM Treasury
- HM Treasury (2003). *Pre-Budget Report 2003*, Chapter 7 (Protecting the Environment), 147-166.
- HM Treasury (2004). *Modernising the Taxation of the Haulage Industry Progress Report 3: March 2004*. [http://www.hm-treasury.gov.uk/media/244/F5/lorry\\_road\\_user\\_charge\\_290404.pdf](http://www.hm-treasury.gov.uk/media/244/F5/lorry_road_user_charge_290404.pdf)
- Lyons, G, Dudley, G, Slater, E and Parkhurst, P, (2004). *Evidence Base Review – attitudes to road pricing*. Accessible from [www.dft.gov.uk](http://www.dft.gov.uk) Contract PPAD 9/160/01.
- Office for National Statistics, (2003). *Transport Statistics Bulletin: “Survey of Foreign Vehicle Activity in GB -2003”*.
- Parkhurst, G (2002). Transport planning in a world of more efficient cars, *Town & Country Planning*, **71**, Jun., 156-158
- Perkins, S (2004). [Charging for the Use of Roads: Policies and Recent Initiatives](http://www1.oecd.org/cem/online/speeches/SPpavia04.pdf) 5th Annual Global Conference on Environmental Taxation Issues, Experience and Potential, Pavia, Italy, 9-11 September, <http://www1.oecd.org/cem/online/speeches/SPpavia04.pdf>
- Sansom, T, Nash, C, Mackie, P, Shires, J, Watkiss, P (2001). *Surface Transport Costs & charges, Great Britain 1998*. ITS Leeds and AEA Technology.
- Schwarz, P., (2004). <http://www1.oecd.org/cem/topics/env/London04/Schwarz.ppt>, 5th Annual Global Conference on Environmental Taxation Issues, Experience and Potential, Pavia, Italy, 9-11 September.
- Tartler J, and Kroder, T, (2003). German toll group faces claim for €700m damages. *Financial Times*, 23 October, p.24.
- Warren, JP (2000). *Cost implications of various Euro 4 and 5 after-treatment solutions for heavy duty diesel vehicles*, IMechE paper C588/015/2000, in 21<sup>st</sup> Century Emissions Technology (2000), Professional Engineering Publishing, Bury St. Edmunds. pp. 35-45.
- Warren, JP, (2005). A review of various road charging systems and charges – a focus on heavy duty freight. (Unpublished paper)
-