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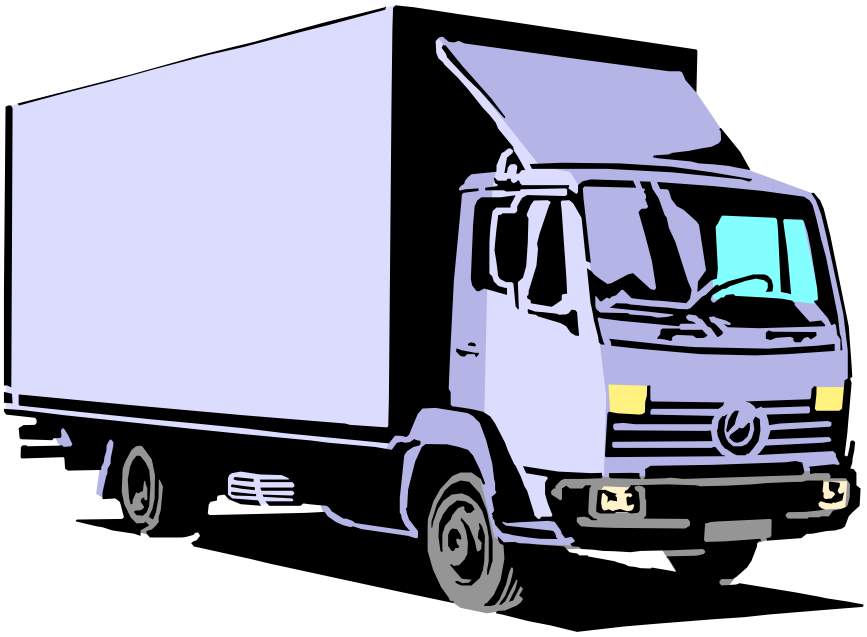

Electronic Kilometre Charging for Heavy Goods Vehicles in Europe

By Per Kågeson and Jos Dings
Revised by Markus Liechti (March 2000)

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European Federation for Transport and Environment
Bd. De Waterloo 34, 1000 Brussels
Tel: + 32/2/ 502 9909 Fax: +32 /2/ 502 9908

Foreword

T&E´s Swedish member Gröna Bilister (The Swedish Association of Green Motorists) who asked the Centre for Energy Conservation and Environmental Technology (CE) to become its partner initiated this report.

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Per Kågeson and Jos Dings

Per Kågeson
Vintertullstorget 20
Nature Associates
S-116 43 Stockholm.
E-mail: kageson@telia.com

Jos Dings
Centre for Energy Conservation and Environmental Technology
Oude Delft 180
NL-2611 HH Delft
E-mail: jd@ce.antenna.nl
internet: http://antenna.nl/ce

Foreword to updated report

The interest in this report exceeded the expectations of T&E and the authors. Therefore, a second print of the study became necessary in early 2000. In order to reflect the developments since the first issue, section 2.2.2 on the Swiss kilometre charging regime has been up-dated.

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Brussels, March 2000

Markus Liechti
T&E European Federation for Transport and Environment
Bd. de Waterloo 34
1000 Brussels
E-mail: markus.liechti@t-e.nu

Contents.

Key conclusions

1. A km charge, differentiated for vehicle weight and environmental impact, is a prerequisite for being able to link user charges closely to underlying costs. This is particularly important where heavy goods vehicles (HGVs) are concerned. This was also recognised by the European Commission in its White Paper on Fair Payment for Infrastructure Use.

2. The km charge should cover the total road network (not only motorways) to be cost-effective. This is also means the km charge can reduce administrative costs by replacing the annual vehicle tax.

3. The km charge should be set at levels considerably above the current vehicle taxes and the Eurovignette to reflect true costs and have any chance of influencing behaviour.

4. The km charge makes it possible to allocate revenues strictly according to the principle of territoriality.

5. The km charge can coexist with road tolls and urban road pricing (or replace them).

6. It is neither necessary (nor wise) to harmonise charge levels, but there is an urgent need for technical harmonisation. The new EU Directive on user charges has already taken care of the necessary classification of HGVs according to vehicle weight and environmental standard. While waiting for technical harmonisation, pioneering countries should strive to make their systems interoperable.

7. The km charge regime should in the longer term be extended to cars and HGVs below 12 tonnes. This would make it possible to allow the km charge to substitute part of the fuel tax and thus enforce a common fuel tax on all users (based on the fuel's carbon content). This would remove the risk of fraud associated with "purple diesel".

8. To avoid intruding on privacy, the km charge for cars should not be geographically differentiated. It should be enough to register border crossings.

1. Introduction

1.1. Electronic kilometre charging for Heavy Goods Vehicles (HGVs)

Road transport by heavy goods vehicles (HGVs)[1] has developed rapidly over the last decades, in absolute terms as well as relative (modal split) terms. The efficiency of the road transport system has been dramatically improved: a dense motorway network has been constructed, EU frontiers have been opened and competition has been boosted by liberalisation. As a result, road transport has become cheaper, faster and better, enabling firms to organise their production in a more efficient way.

However, the rapid expansion of especially international freight transport has given rise to environmental problems (CO_2, NO_x, PM_{10}, noise), and international political problems from unpaid road damage from transit transport. These problems have led to alpine transit restrictions and a system of fixed user charges known as the Eurovignette.

The introduction of an electronic kilometre charge for HGVs could mean a solution to some of these problems, as the system is based on the territoriality principle. It enables Member States to charge vehicles driving on their territory without hindering the functioning of the internal market. The electronic kilometre charge offers Member States a high degree of freedom to optimise their pricing policy for road haulage, and is thus a guarantee for subsidiary. Furthermore it could improve welfare and economic efficiency as the system enables charges to be very closely linked to environmental, infrastructure and congestion costs. For these reasons, interest in electronic kilometre charging, especially for HGVs, is rising in Europe.

The European Commission presented kilometre charging in its White Paper on 'Fair Payment for Infrastructure Use' (1998) as a good instrument for pricing policies in transport. The Commission indicated that future charging schemes should as much as possible be based on the 'marginal social cost charging' principle. The principles set out in the White Paper have for a great deal been inspired by the findings of the High Level Group on Transport Infrastructure Charging (1998), which is currently working on a follow up report.

Switzerland has agreed with the European Union to introduce kilometre charging for HGVs on Swiss territory by 2001. Germany and Austria have demonstrated their interest in such systems as well; they intend to introduce kilometre charging *on motorways* from 2002. Following these developments, there is a growing interest in other European Member States such as the Netherlands, Sweden and the United Kingdom in the potential benefits of electronic kilometre charging for HGVs.

1.2. Aim of this study

The aim of this study is to assess the feasibility of introducing an electronic kilometre charging system at EU level or at the level of one or more of the Member States. The study is targeted at policy makers in countries that are considering the introduction of an electronic kilometre charging system.

[1] A glossary with abbreviations used is included at the end of this report.

1.3. Demarcation

As territory-based kilometre charging gives countries freedom in their pricing policies without distorting markets, it is a very attractive option for internationally operating sectors like international road haulage, international rail transport, shipping and aviation[2]. This report, however, is limited to systems for HGVs. As systems might be quite similar for other road vehicles, transferability of systems to passenger cars and vans will also be touched upon. However, the possibilities to transfer the system to other modes like rail or (inland) shipping will not be considered.

[2] The concept of kilometre charging in aviation has, for example, been described in 'A European environmental aviation charge' |CE 1998a|.

2. Present developments

2.1. Introduction

The possible introduction of a scheme for electronic HGV charging should be viewed as much as possible in an international context. Harmonisation of the charge base (vehicle classes) and, to a certain degree, of the technical and payment systems, is of utmost importance to achieve the maximum efficiency from the charging regime.

In this chapter we present an overview of activities in the countries that are currently most active in the area of electronic kilometre charging for HGVs: Switzerland, Germany and Austria.

Annex A contains a description of experiences with km charging systems in Scandinavia, Australia and New Zealand, as well as experiences and plans with electronic road pricing for passenger cars in Singapore and the Netherlands.

2.2.2. Swiss kilometre charge (2001)

In a recent agreement with the EU[3], Switzerland agreed to replace its ban on HGVs over 28 tonnes with a kilometre-based charging scheme. The scheme is due to be introduced in 2001 for all HGVs with GVW > 3.5 tonnes. The system is unique as it is the only system up to now announced in Europe that will cover all kilometres driven in a country.

Main system

Switzerland has decided to use an OBU (On Board Unit) linked to the tachograph as the primary technology. GPS is used as a backup system in order to perform a check on the kilometres indicated by the tachograph. The OBU will contain vehicle characteristics such as the registration number, GVW etc. The OBU will also contain a function indicating whether a trailer is coupled or not.

The measurement of the mileage is based on the tachograph. Nearly all tachographs currently in use have a built-in output where electrical pulses that are proportional to distance driven are available. Currently, the OBU is connected to this output and counts these pulses. Calibration of the OBU ensures that the mileage reading on the OBU equals the one on the tachograph. In the future, when the new European digital tachograph is introduced, the mileage could be transmitted from the tachograph to the OBU directly as a digital numerical value.

Beacons installed at the Swiss border will work with DSRC (Dedicated Short-Range Communications, microwave) systems. These beacons will serve three purposes:

1 first, they will be installed at the Swiss border in order to switch the system on or off;
2 second, the beacons will perform an extra check by reading OBU-log-file entries to verify whether OBU data (e. g. registered vehicle and trailer characteristics, mileage, user manipulations) are consistent. Video pictures will be taken of HGVs passing beacons in order to check whether the number plate is consistent with the OBU registration number and if the vehicle is articulated or not;

[3] Agreement between the European Community and the Swiss Confederation on the Carriage of Goods and Passengers by Rail and Roads. As it is not ratified yet, it is not officially published as a European legal document. It can be downloaded from the website of the Swiss Federal administration in German, French, Italian and English (http://www.europa.admin.ch/neue_site/e/index_bilat.html).

3 third, they could be installed at entrances to certain transit routes in order to switch to a higher charge level[4].

Exception system for non-equipped vehicles
There is an obligation for all 52,000 Swiss HGVs to have the OBU installed by 2001. This implies an exception system will only be necessary for foreign drivers (who do not want to buy an OBU).

The system is a semi-electronic self-service system with a so-called 'ID-card'. At the border, the driver gets a vehicle ID-card indicating vehicle data and payment data (only tank cards or custom accounts are acceptable). Every time they pass the border, they enter the card and their actual mileage and trailer data (yes / no, weight) into a terminal; then they receive a ticket presenting the relevant data. When leaving the country, the driver fills in their new mileage on the ticket and hands it over to the customs authorities. If the card indicates an account number, payment is made electronically.

Charge levels
In the agreement with the EU, the maximum average kilometre charge (weighted for engine emission class) is related to a reference trip with a length of 300 km. The average maximum level as of 2005 is set at € 180 for a 40-tonne HGV. This level will be increased to € 200 as soon as the first transalpine tunnel is opened, or from 2008 at the latest. The € 200 fee is equal to € 0.5 per tonne GVW for this reference trip, or € 0.017 per gross tkm. The Swiss intend to charge all Swiss road transport with GVW over 28 tonnes the maximum permissible average amount. See Table 1.

Table 1 Maximum permissible km charge rates to be applied in Switzerland for HGVs, in € per vkm |Agreement between EU and Switzerland 1999|

Year	Euro 2	Euro 1	Euro 0	Average	Weight
2001-2004	0.30	0.36	0.42	not fixed	34 tons
2005-2007*	0.52	0.59	0.73	0.60	40 tons
2008-	0.58	0.66	0.82	0.67	40 tons

Based on an exchange rate of CHF 1 = € 0.624.

* If the Lötschberg railway tunnel is opened before 2008, the 2008 rates will apply from the day the tunnel is opened. According to a protection clause, HGV charges may be increased by 12.5% for a maximum period of one year in the case of under-utilisation of the Lötschberg tunnel capacity (less than two thirds used for a period of at least 10 weeks).

The national GVW before 1.1.05 is 34 tonnes. Within the bilateral agreements on transport between the European Union and Switzerland a limited number of vehicles per year of up to 40 tonnes are allowed before 2005. The rates per kilometre for these limited number of vehicles are higher than the normal rates shown in Table 1.

HGVs with GVW up to 28 tonnes may face a slightly lower charge (on average about € 0.0155 instead of € 0.017 per gross tkm from 2008).

Furthermore, in the period 2001-04 there will be a transitional quota arrangement for at most 220,000 trips per year with HGVs with an *actual* GVW up to 28 tonnes (empty HGVs and HGVs with certain light goods). These vehicles will have to pay a flat fee, increasing from € 31 in 2001 up to € 50 by 2004 for each alpine transit. As of 2005 these vehicles will have to pay the normal charge. This is a compromise in the EU-CH agreement.

[4] This function is not foreseen yet, neither has a final political decision being taken with regard to a special HGV tax on alpine transit routes.

Finally, the agreement allows charge level differentiation between alpine transit kilometres and other kilometres on Swiss territory. As maximum charge levels may not be exceeded in any circumstance, this would in practice mean a lower overall charge level. No political decision has yet been taken in Switzerland about the introduction of an alpine transit tax. Therefore, the rates shown in Table 1 will be used for kilometre charging but they also include a potential future alpine transit tax.

As the introduction of the charges is linked to the cost-cutting increase of the maximum permitted GVW from 28 to 40 tonnes, it is expected that final road haulage costs will not increase substantially compared with the current situation.

Costs

The OBU will cost about € 800 per HGV. If we assume 60,000 vehicles (52,000 Swiss, 8,000 foreign) to be equipped with an € 800 OBU, the OBU costs will amount to € 48 million per vehicle generation. Development costs will be about € 25 million, investment costs about € 80m, and operating costs will amount to about to € 16m per annum. If we assume OBU costs to be written off over seven years (the average HGV lifetime), and development and investment costs over 15 years, we find total annual costs of about € 35m. The final revenues of the charging system are estimated at € 1 billion. This implies that total costs will amount to about 3 to 4% of total revenues. It must be stressed that these are only estimates which include a degree of uncertainty which cannot be avoided when looking this far ahead.

It should be noted here that Switzerland is a pioneer, and that its HGV fleet is rather small. Costs will probably be lower for countries that follow.

The authorities will have to take care to ensure that distortions of competition do not arise between Swiss hauliers and foreign hauliers. The two groups must be offered the systems on the same conditions though with some requirements as guarantees for foreign vehicles.

Payment

For Swiss hauliers, the system will work on a post-payment basis. The OBU entries will be read each month by a chip-card which then has to be sent physically to the authorities. The authorities check the data and send an invoice. At a later stage, the transmission of the OBU-data via the internet could be considered.

For foreign hauliers, electronic post-payment is only considered feasible if they have a tank or a customs account. If not, the evasion risk is considered too high and cash payments will have to be made.

Interoperability

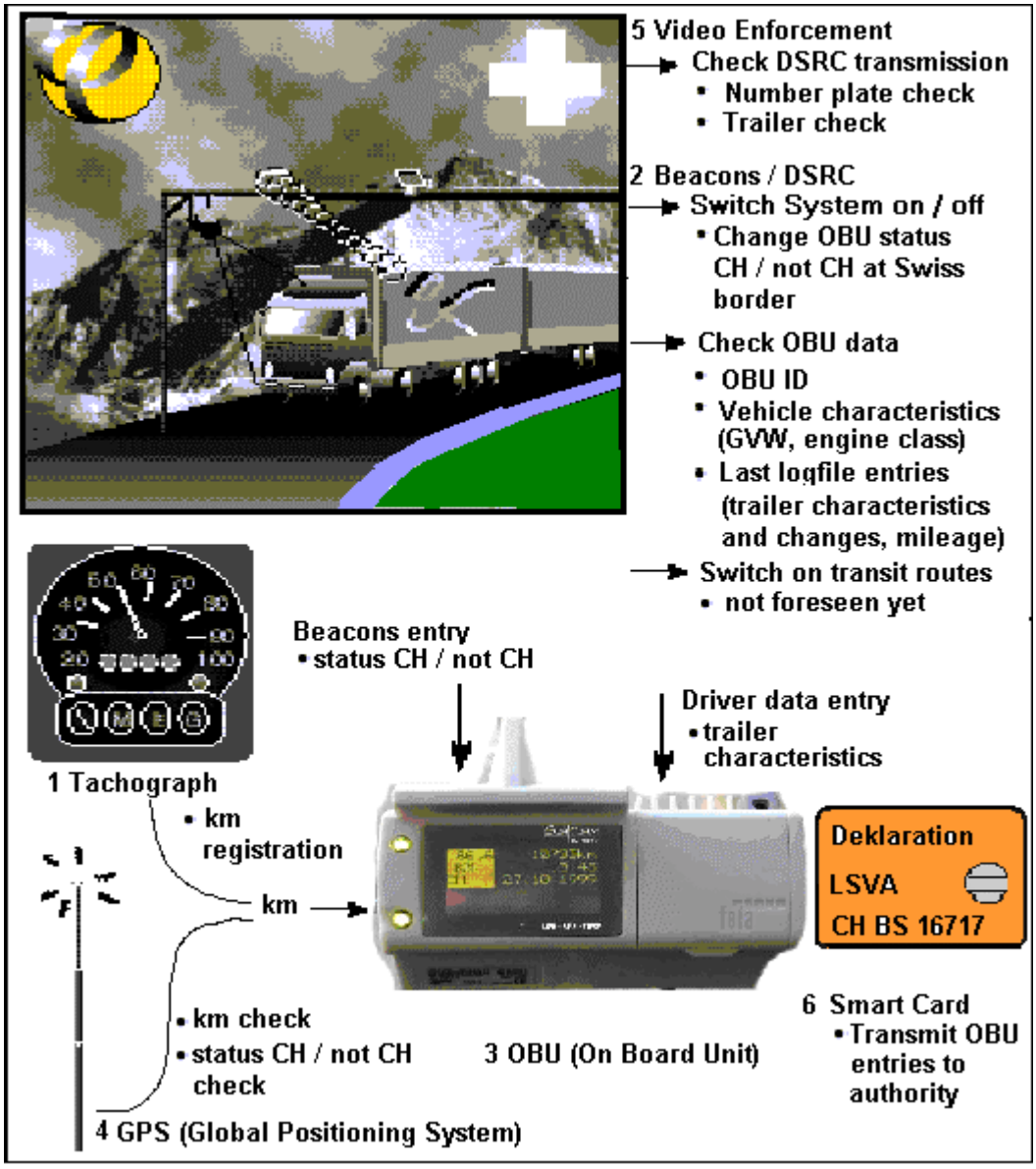
The Swiss strive towards interoperability between their system and other European systems in the following ways:

- by keeping the system's architecture as open as possible;
- by complying with the CEN pre-standards for the DSRC system;
- by having the OBU, border beacons and enforcement stations in different tenders, so that several suppliers are forced to test interoperability for each others' systems in practice. (However, the tendering processes has resulted in limiting the suppliers to Kapsch and Q-Free);

The Swiss system is illustrated in Figure 1. However, it is still an abstract portrayal of the expected reality showing the most important instruments and functions but not every detail

Current information about the Swiss Heavy Vehicles Tax can be found on the website of Swiss Customs Authority |http://www.zoll.admin.ch|.

Figure 1: An impression of the future Swiss kilometre charging system



2.3. German motorway kilometre charge

Germany has announced that it will introduce a kilometre charge for HGVs with a GVW over 12 tonnes. With reference to the agreement between the partners within the German government, the introduction is foreseen early in the near future. This could be before the end of 2002. The charge will only apply to HGV kilometres driven on motorways.

The process is still at quite an early stage. The German government has decided to set up a list of requirements the system should fulfil and have consortia bid for the job. The exact requirements for the system are currently being worked out.

Although, there have not been taken yet any political decision, a expert group has already signalised that the financing of the infrastructure should move from taxes to user charges. The same expert group has suggested to fix the HGV kilometre charge at 0.25 DM/km (www.bmvbw.de) corresponding to € 0.128. However, in recent years no signals on charge levels have been given from the Ministry.

Germany will play a very important role in the progress of kilometre charging in Europe because of its economic weight and central geographical position. Therefore, it is highly recommended that Germany start negotiations with Switzerland, Austria and the Eurovignette countries in order to ensure a smooth introduction and good interoperability with other future km charging systems.

2.4. Austrian motorway kilometre charge (2002)/Ecopoint system

The situation in Austria is uncertain on a political level. However, Austria has also signalled its intention to introduce a km charge for HGVs with GVW over 3.5 tonnes driving on its 'high performance' roads. Austria has about 2,000 km of these roads, 1,700 km of motorways and 300 km of other fast roads.

Currently Austria operates the so-called 'Ecopoint' system for HGVs making full transits. This is a remnant from EU accession negotiations. Part of the deal was abolition in 2003. The introduction of the km charge is currently scheduled for 2002, i.e. before the Ecopoint deadline. In the text below, we first describe the Ecopoint system, then we will describe the new charging plans.

Ecopoint system

In the first years, the Ecopoint system was operated manually. In 1998 automatic point collection with an on-board responder ('Ecotag') was introduced. The system has two switches; green (Austrian transit mode, Ecopoints required) and red (other). When passing the Austrian border, the system is automatically turned green, so the driver has to switch it back to red when he is not going to make a full transit. Beacons register the number of Ecopoints required, give a signal to the Ecotag that the transaction has been performed and send it to the central computer in Vienna. This computer contains data from all firms operating the Ecotag system and checks whether the number of points required is available. When exiting Austria, the system is turned 'green' again.

The system is not watertight due to the manual switch to 'red'. When no manual checks are performed, it is possible to transit Austria with a 'red' Ecotag (so no Ecopoints are registered). There is not much of an incentive to do so, as there is no serious shortage of Ecopoints. However, frequent manual checks are performed. If faulting is detected a fine of ε 1,450 is levied. As hauliers do not benefit from cheating, quite a high percentage of the fines is due to unintended cheating[5]:

- in some cases the beacons do not 'read' the Ecotag, especially when it's raining and the windscreen wipers are working (also sometimes the beacons just do not work properly);

[5] Personal communication with Mr De Bruin (TLN).

- the driver cannot see whether Ecopoints have been read or not;
- the system does not give a signal if the batteries are not working properly;
- the glue to attach the Ecotag to the window is of poor quality.

Austria wants to use parts of the Ecopoint system for the km charge system. Experience to date suggests that Austria will have to do some work to improve reliability and user-friendliness of the system at the same time.

New charging system
The system will consist of an OBU, which will enable the driver to drive his vehicle through a beacon at about 30 km/h. Kilometre registration is not necessary, because the motorway system is closed. Therefore the OBU system only has to contain vehicle and payment data. In total, 90 payment points will be installed. The system will look quite like the French péage, with automatic and manual payment lanes (the latter for the exception system).

Charging levels will be differentiated according to the number of axles (2, 3 or 4+) and will on average amount to € 0.09, € 0.12 and € 0.15 per km respectively. Charges may be higher for expensive bridges, tunnels etc. No environmental differentiation is foreseen yet.

The development and investment costs are estimated at € 290m. Operating costs are estimated at € 55m per annum. OBU costs will be relatively low. If investment costs are assumed to be written off over 15 years, total annual costs will amount to about € 82m. The annual charge revenues are estimated at € 250m. This implies costs will be about one third of the revenue, quite a high value. The main reasons for this are the rather low charge level and the fact that it will be applied to motorway kilometres only.

3. Possible technical system outlines

3.1. Introduction

In this chapter consideration is given to how an HGV charging system would work technically. It should be noted that technology in the area of transport telematics is progressing rapidly and a wide variety of choices must be made for implementation. Therefore we do not claim to present the one and only truth but rather strive to give a first insight into relevant technologies and issues to be dealt with when deciding on their application.

First we will summarise the system requirements and interoperability issues, and then we will describe some fundamental system layout choices.

3.2. System requirements

The system should fulfil the following requirements:

- the charges should be linked as closely as possible to marginal social costs;
- it should be reliable under all operating conditions;
- it should be resistant to fraud and evasion;
- it should not significantly disturb physical transport operations;
- it should be cheap to operate (small system with low overhead costs);
- it should be non-discriminatory;
- the system should as much as possible be interoperable between Member States.

3.3. Interoperability issues

Interoperability is. This should not be confused with ‘compatibility’ which deals with non-interference.

In a 1996 report published by the European Commission |Ketselidou 1996| interoperability is defined as ‘the ability of systems to provide services to, and accept services from, other systems and to use the services so exchanged to enable them to operate efficiently together’. The report mentions three aspects of interoperability

1. contractual (financial agreements);
2. procedural (common procedures and common data definitions);
3. technical (capacity to communicate). The third is probably the aspect of interoperability that is hardest and most expensive to implement.

A recent Communication from the European Commission |EC 1998| defines the following interoperability issues in electronic charging systems.

a) Technical operability: define a common minimum level of functionality for systems to enable drivers to use their on-board payment devices on the network of all the operators in the system. Work is done in EU sponsored projects like the CARDME initiative. Defining standards is a job for CEN.
b) Contractual interoperability: the relevant issues are currently being examined within EU-sponsored projects.
c) Exception system for non-equipped users: charging systems need to be designed so that such users are not subjected to cumbersome and time-consuming alternative payment procedures or to penalising prices.
d) Classification: harmonisation not strictly necessary, but an acceptable set of vehicle attributes needs to be agreed upon, including environmental characteristics;
e) Enforcement: a very important issue, which requires further work on database linking and cross-border information exchange.

f) Fraud: a compromise between an acceptable degree of security and data protection/privacy must be found, which can vary according to different national approaches and traditions.

The communication gives the following recommendations for priority action:
- priority will be given to systems for HGVs and long distance coaches;
- priority for interoperability between urban and inter-urban applications;
- keep the systems' architecture open by relying on multiple technologies, for example a combination of beacons with DSRC technology and GPS systems (see below).

3.4. The (electronic) tachograph

Technical description
All HGVs over 3.5 tonnes Gross Vehicle Weight (GVW) registered in EU Member States must be equipped with a device that registers the actual speeds and the driving times. As of July 2000 a new electronic tachograph will be obligatory for all new HGVs sold in the EU. All vehicles registered in the EU with a GVW > 3.5 tonnes must be equipped with this device.

Major advantages of the electronic version over the existing tachograph are:
- mechanical registration is replaced by an electronic 'mass' memory;
- a personal 'driver card' is introduced together with the tachograph. Data are stored in both the memory of the tachograph and the personal card;
- the system contains a display that shows the driver's driving time and speed, and indicates excess driving times. Both features will facilitate self regulation of the driver;
- data in the 'mass' memory is stored for the previous 365 days; the driver card contains data from the previous 28 days. Roadside checks may be performed for the last day of the previous week, and all the days of the current week;
- a crucial fraud-related issue is the way driver cards are provided (identity checks). Furthermore, no other data than driving times and speeds may be stored, and the tachograph registers interruptions of the electric current;
- tachograph data may be used for other on-board facilities like on-board computers.

Use of the tachograph for charging systems
The tachograph might be a suitable instrument for delivering kilometre data. A big advantage is that it is an existing instrument.

A disadvantage is that, when used as the single system for kilometre registration, it might be susceptible to fraud. There are two possible fraud sources: fraud with the tachograph itself and fraud with the connection of the tachograph to the kilometre registration device.

This implies that the tachograph, especially the old version, might be too fraud-sensitive to act as *the single* kilometre registration device.

3.5. GPS and other positioning systems

In this chapter attention is given to the GPS, the Global Positioning System, and Galileo, a European initiative for satellite navigation.

GPS (Global Positioning system)

Technical description

The American Department of Defence (DoD) developed 'GPS' (Global Positioning System) for military purposes. The accuracy of the military system is said to be one or two decimetres. For civil applications, however, accuracy is degraded to typically around 100 m.

Accuracy can be drastically increased by using DGPS (Differential GPS), which uses a fixed reference point for correction of GPS signals. DGPS equipment manufacturers claim to be able to locate which side of the street a vehicle is driving on. Therefore this kind of system would be suitable to detect exact road classes. For road class detection, the system will have to be linked to a road database, which has to be regularly updated. If charge levels are variable per road type, the database should also contain the classification of the road the vehicle is driving on.

GPS does not function well in cases where the equipment cannot 'see' the satellites. This is the case in mountainous areas, and cities with high buildings, and in tunnels and under bridges. For this reason, it might not in all situations be possible to detect the exact road the vehicle is driving on, but this is not a severe problem as long as the charge level per km does not change in these situations. Bad weather is no problem for GPS-based systems.

Use of GPS for charging systems

- GPS-based systems are certainly accurate enough *for kilometre registration*. Sometimes the system cannot 'see' the satellites, but the signal can be readily picked up at any time and the 'lost' kilometres can be calculated. This makes it a perfect backup for the tachograph-based registration. It might also be possible to have the GPS system as the one and only kilometre registration device.
- *Road class detection* might be somewhat more difficult. GPS is in itself most certainly accurate enough to do this. However, the use of GPS for this purpose requires full time operation of a rather complex computer system ('on line' connection with an extensive road database[6] and on line determination of the appropriate road type or charge from this database). This might make the system somewhat too complex to make it a short-term solution. In addition, there is the problem that the satellites should be 'seen' at points where km charge levels change. For a less precise 'area detection' (for example: registration when an HGV enters an urban area) GPS systems might do.

Galileo (GNSS-2)

The European Commission has called upon European Union Member States to give their political and financial backing to Galileo, a project which would aim at developing a Europe-led state-of-the-art Global Navigation Satellite System (GNSS). Such a separate Europe-controlled navigation system has been under discussion since 1994. Galileo, which would cost between € 2,2 and 2,9 billion, would avoid depending upon the GPS or Glonass systems, which are respectively under US and Russian military control. Galileo

[6] This might be an 'on board' database or a centrally managed database.

would be developed on the basis of a private-public partnership with about 50 per cent public funding from the EU Trans-European Networks (TEN) budget (€ 750 million), the fifth Framework Programme, and the European Space Agency (ESA, € 500 million).

Germany is playing an important role in the development of the system, with a contribution of about 30 per cent. The possible transport-related applications of the system are a major argument for participation.

Summarising, positioning systems might be a good option for kilometre registration (probably even better than the tachograph), and area registration. Using them for road class detection might be too complex in the short term. Beacons (see below) might be more appropriate to achieve this goal.

3.6. Beacons

Roadside beacons have been used for a long time in existing tolling systems in, for example, France and Italy. They generally work with DSRC (Dedicated Short-Range Communications), sometimes called microwave, at a frequency of 5.8 GHz. A CEN pre-standard for DSRC has recently been adopted. This standard enables interoperability between several systems, but does not guarantee it |EC 1998|.

In a kilometre charging system, road beacons can have three functions:

1. A switch function: to indicate that the HGV is entering an area with a different charging regime. In this case, spatial differentiation of the charge should be very limited[7].
2. A check function: to perform checks on the HGV by electronic communication with the OBU and/or by taking pictures. It seems that this type of application of beacons is inevitable for effective enforcement.
3. A payment function.

3.7. GSM and other mobile communication systems

GSM, the Global System for Mobile communications and the largest standard in Europe, operates at frequencies between 890 and 960 MHz. Many areas in Europe are already fully 'covered' by GSM. In fully covered areas, frequent communication between the OBU and a central computer is feasible (when communication with beacons depends on the use of the vehicle). Regular, for example daily, contact between the OBU and a central computer has advantages from an enforcement and payment point of view.

GSM technology could take over most of the functions of the beacons as mentioned in the previous paragraph, such as payment, registration and mileage checks. Pictures will, however, probably remain necessary for the physical checking of trailer presence.

Another advantage of applying GSM technology is that the authorities can very efficiently communicate changes in the charge system, for example changes in charge levels.

Therefore, for future charging systems, GSM technology definitely has some major advantages above DSRC systems, although there is more experience with the latter technology than the former.

[7] In cases where only beacons, and no positioning systems, are used for road class detection, thousands of beacons would have to be installed if the charge were spatially differentiated very much.

3.8. Trailer declaration

In an appropriate km charging system, the charge for a vehicle with trailer will be higher than for the same vehicle without trailer. This implies that there is an enforcement problem with respect to trailer declaration. An automatic trailer declaration system will require all trailers to be fitted with an electronic connection to the OBU, and might be susceptible to fraud. Therefore, manual trailer declaration to be performed by the driver seems to be preferable. The driver should activate a switch in the OBU and enter trailer data (GVW and number of axles).

Checks that declarations are correct can either be done on the road by the police (during the normal checks on travel times, vehicle safety and overloading), or by using the Swiss system of electronic registration checks and pictures when an HGV passes a beacon. A central computer can make consistency checks. The computer can make first checks using length-measuring equipment and compare these to OBU data. In cases of doubt, manual check of the picture can increase reliability.

Trailer declaration should not be possible during driving; otherwise the driver could declare the trailer at the moment he spots a beacon.

3.9. Data storage and privacy issues

If and when the km charge system is extended to private cars, it will probably make sense to refrain from unnecessary geographical differentiation to avoid interfering with privacy. Registration of border crossings, however, cannot be avoided if revenues are to be distributed among Member States strictly according to the principle of territoriality.

The issue of the right to privacy is less sensitive where commercial vehicles are concerned. The exact location and travelling patterns of trains and commercial aircraft and sea vessels are already known as a result of traffic control and traffic surveillance. To register kilometres driven by roadside beacons and/or GPS is by comparison a minor interference with privacy.

Nevertheless, it can be recommended to store as many data as possible in the vehicle instead of in a central computer. This would imply that the charge calculations take place in the OBU. The, in this respect, ideal (minimum) amount of data that should be sent to the authorities is what amount to pay to what country. GSM technology seems indispensable for effectively communicating changes in charge levels.

On the other hand, the authorities must be able to *check* the bill for correctness and '*prove*' that it is correct in cases the haulier states that it is not. The minimum data required for 'bill check' purposes seem to be the amount kilometres driven in several charging areas, split up for kilometres driven with and without a trailer.

The 'proof' of bill correctness gives rise to more data requirements. What if the haulier says he has never been in Germany, while the bill shows this is the case? For this purpose, it might first be necessary to store the information from GSM communications and beacon checks in a central computer, so that they can be compared with the OBU data when necessary.

The privacy issue is another argument, besides the technical one, to have the charges differentiated on a 'per area' basis instead of on a 'per road' basis.

3.10. Payment options

Electronic payment can be done on a pre-pay basis, a pay-now basis or a post-pay basis.

In the pre-pay case, an electronic purse (smart card) is credited in advance and is attached to the window. This system has the following disadvantages:

- the large amount of money required on long trips;
- the special recharging network required;
- the large variation in per-country regulation of electronic money.

Therefore it does not seem attractive for HGV km charging.

In the post-pay case, a vehicle pays the charges on a regular basis (for example once a month). Smart cards with the relevant data should be sent to the authorities, or electronic connections can be made with the tax authorities.

The post-pay principle is to be preferred for both the main and the exception system.

3.11 Exception (transitional) system

Besides the main system there is a need for an exception system, for vehicles that are not equipped with the electronic devices required.

The exception system can never be as efficient as the main system. It is therefore important that the use of the exception system is kept as low as possible. This can be achieved by the following actions:

- Do not make the exception system more attractive to hauliers than the main system (but it should also, for fair competition reasons, not be much less attractive as well). This can be done via appropriate charge levels and subsidies on electronic equipment.

- Oblige *all vehicles performing domestic transport in the charging area* to join the electronic charging system. Very low-mileage vehicles (for example < 5,000 km/year) could be excepted from this obligation in order to avoid disproportionate costs. It should be possible to give these vehicles some kind of 'low mileage certificate', and then check the mileage during the annual vehicle inspection and charge them a fixed rate.

- Make the charging area as large as possible to minimise the percentage of vehicles from outside the area.

There are two options for the exception system:

- A daily (time-based) permit system, either analogous to the current Eurovignette scheme, or on a per country basis. This system will only work if the time is very limited, for example one day; otherwise the exception system would become attractive for the vehicles that drive the most kilometres.
  If the km charge would amount to for example € 0.15 per km, a daily charge of around € 75 per day seems necessary in order to prevent high-mileage HGVs from keeping the old system. This implies that the recently proposed maximum daily charge of € 8 would in such a case not be high enough to give an incentive to high-mileage vehicles to switch to the km charging system.
- A distance-based system. Such a system should start to work as soon as a non-equipped vehicle enters the charging area. Semi-electronic self-service systems, analogous to the Swiss 'key card' vehicle registration system, could be used for

hauliers that operate electronic payment systems like credit cards or tank cards. This way, unnecessary paperwork can be avoided, as vehicle and payment characteristics only have to be entered once. However, regular manual odometer checks will remain necessary. Hauliers that do not have an electronic payment system or otherwise do not (want to) take part in the semi-electronic system will have to work with a fully paper-based system. In order to ensure payment in cases where they do not have electronic money, cash transactions will probably remain necessary. It is expected, however, that this will only happen rarely.

The distance-based system is preferable to avoid the rather excessive fixed charges.

It should be noted that a re-introduction of checks at the border of the charging area is unavoidable to properly operate the exception system. This is again an argument for multilateral introduction. Checks will only be needed for vehicles not operating the self-service system. The larger the area, the more infrequent these checks will have to be.

4. Charging strategies

This chapter discusses the pros and cons of shifting from the present European system of heavy goods transport taxation to a regime consisting of a km charge and a fuel tax. It highlights the importance of allowing the km charge to cover the total road network of a country rather than just its motorways. It also discusses the degree of differentiation and harmonisation.

4.1. Present charging systems

Currently the taxes and charges listed in Table 2 are levied in EU Member States on heavy goods transport on roads.

Table 2 Charging systems in EU15

Charging system	Number of EU Member States applying it
Fuel tax	15
Annual vehicle tax	15
Eurovignette	6
Registration / sales tax	5
Road tolls (excluding tunnels / bridges	5
Tax on vehicle insurance premiums	11

An overwhelming part of the overall revenue from taxes on HGVs in Europe comes from the fuel and (annual) vehicle taxes and road tolls, including the Eurovignette. Consequently, registration taxes and taxes on insurance premiums will be disregarded in the following analysis.

Road fuel excise duties in EU15

Taxes on diesel and petrol exist in all Member States. The lowest permissible rates are currently regulated in Directive 92/12/EEC. The Commission, however, has proposed a Council Directive for Restructuring the Community Framework for the Taxation of Energy Products (COM (97) 30 final) which is now being discussed in the Council. Table 3 shows the current minimum levels for excise duties on diesel and unleaded petrol as well as the proposed values originally proposed by the Commission for 1998, 2000 and 2002.

Table 3 Minimum levels of excise duty applicable to road fuels in the EU, € per 1,000 litres, currently and proposed

	Current	Proposed for 1/01/1998	Proposed for 1/01/2000	Proposed for 1/01/2002
Petrol	287	417	450	500
Diesel	245	310	343	393

Source: COM (97) 30 final

Annex B contains a table showing the levels of road transport fuel duties in EU15 plus Norway and Switzerland and the current accession countries.

The Commission's proposal for a new Framework Directive on the Taxation of Energy Products (Com(97)30 final) foresees a situation where Member States begin to introduce

new charging systems for the recovery of transport costs, such as infrastructure, congestion and environmental costs. Article 16 therefore states that a Member State may be authorised to apply duty levels on motor fuels between 60 and 100 per cent of the minimum levels specified in the Directive when it introduces or modifies, on a non-discriminatory basis, a specific charging system for recovering such costs. The Commission shall examine the request, taking into account the proper functioning of the internal market, the need to ensure fair competition, the Community environment and, where appropriate, transport policies. The measure may be authorised for a period of three years, with the possibility of renewal.

Annual vehicles taxes in EU15

The current minimum rates for the annual vehicle tax in the Community is laid down in Directive 93/89/EEC, which also governs the use of toll charges for HGVs. The Directive is to be replaced by a new Directive as it was annulled by the European Court of Justice on 5 July 1995. The Court, however, ruled that the effects of the annulled Directive where to be postponed until new legislation has been adopted.

The tax rate applied on HGVs is in most Member States differentiated according to total weight or axle weight. Table 4 shows the annual vehicle tax for a 40-tonne vehicle combination that frequently operates in international freight traffic. It should be noted that some Member States have derogation allowing them to apply tax rates below the Community minimum rate laid down in Directive 93/89/EEC.

Table 4 Example of vehicle tax in EU Member States in June 1998 for a 17-tonne HGV with 23-tonne trailer, €/vehicle/year

	HGV + trailer	Comments
Austria	2,723	
Belgium	1,070	25 % reduction for HGV < 5 years. 10-40 % reduction for > 3 HGVs
Denmark	702	€ 516 for HGVs with air suspension
Finland	1,541	
France	213	
Germany	2,641 2,386 1,876 1,519	For ”old HGVs” G1 HGVs S1 HGVs = Euro 1 emission standards S2 HGVs = Euro 2 emission standards
Greece	429	
Ireland	1,028	
Italy	705	regional differences, discount for air suspension
Luxembourg	693	€ 510 for HGVs with air suspension
Netherlands	447	
Portugal	439	€ 423 for HGVs with air suspension
Spain	534	Medium value, large local differences.
Sweden	991	
United Kingdom	2,648	38 tonnes domestic vehicle weight limit
Norway	1,099	
Switzerland	1,646	28 tonnes domestic weight limit, regional differences
EU minimum rate*	929	For vehicle combinations without air suspension

* For 1 July 2000 according to the proposed Council Directive13863/98

Source: Bundesverband Güterkraftverkehr und Logistik (BGL), 1998. Exchange rates between national currencies and DM of 25 June 1998, and exchange rate between DM and € of 12 November 1998.

The Eurovignette and road tolls
On 1 January 1995 an integrated system for user charges known as the Eurovignette was introduced jointly by Belgium, Denmark, Germany, Luxembourg and the Netherlands for HGVs with a GVW > 12 tonnes. Sweden joined the system in 1998. The Eurovignette is a charge for the use of the motorway systems of the participating Member States. The maximum annual charge is € 750 and 1,250 for vehicles with respectively three and four axles.

The future of the Eurovignette is now uncertain as Germany plans to replace it by a kilometre charge. It hardly makes sense for the remaining parties to the Eurovignette to continue this charge regime in a situation where the most centrally located and most important transit country no longer participates. This raises the issue of whether other Eurovignette countries might decide to follow the route taken by Germany.

Road tolls are applied on motorways in Greece, France, Italy, Portugal and Spain. Austria operates a user charge system similar to the Eurovignette on a national basis. Some Member States enforce tolls on certain bridges and tunnels.

4.2. The new Directive on vehicle taxes and user charges

In June 1999 a new Directive (1999/62/EC) on charging of heavy goods vehicles with GVW > 12 tonnes for the use of certain infrastructure was signed by the European Parliament and the European Council. Member states have to be compliant with it by 1 July 2000.

The Directive differentiate the minimum vehicle tax rates according to gross vehicle weight and number of driving axles with a reduction for driving axles with air suspension (or recognised equivalent). The new minimum rate for a 40 tonne HGV with 3 + 2 axles and air suspension will be € 628 per year. Until two years after entry into force Greece, Italy, Portugal and Spain will be allowed to apply rates that are lower, but not less than 65 per cent of the minima laid down in the Directive.

According to the new Directive, Member States may maintain or introduce tolls and/or user charges on motorways and other multi-lane roads with characteristics similar to motorways, bridges, tunnels and mountain passes[8]. Tolls and user charges may not be imposed at the same time for the use of a single road. However, Member States may also impose tolls on networks where user charges are levied, for the use of bridges, tunnels and mountain passes.

The weighted average tolls shall, according to article 9 of the Directive, be related to the costs of constructing, operating and developing the infrastructure concerned. The weighted average can be differentiated according to vehicle emission classes and time of the day (article 10).

The user charges are differentiated for differences in exhaust emissions, and the Directive puts upper limits on the amounts of user charges as shown in Table 5.

[8] However, in a Member State where no general network of motorways or dual carriageways with similar characteristics exists, tolls and user charges may be imposed in that State on users of the highest category of road from the technical point of view.

Table 5 Annual maximum permissible amounts of user charges* (€/vehicle)

	Maximum 3 axles	Minimum 4 axles
Non Euro	960	1,550
Euro 1	850	1,400
Euro 2 and cleaner	750	1,250

* Other than vehicle tax
Source: Council Directive 99/62/EC, Annex II.

Maximum monthly and weekly rates shall be in proportion to the duration of use made of the infrastructure. The daily user charge is equal for all vehicle categories and amounts to € 8.

A strange thing about the new Directive is that the maximum amount of user charges applies regardless of the number of participating Member States and the size of the network. The difference in the size of the motorway networks of, say, France and Belgium illustrates the problem of enforcing the same maximum rate on all Member States. This restriction makes it difficult and in many cases impossible to comply with article 9 of the Directive, which says that the tolls shall be related to actual costs (see above).

The Directive does not prevent the application by Member States of parking fees and specific urban traffic charges or regulatory charges specifically designed to combat time and place related traffic congestion (Chapter IV, Art 9).

4.3. Cost elements and the choice of charge instruments

The European Commission's Green Paper on Fair and Efficient Pricing in Transport (European Commission, 1995) proposed a set of guiding principles for the process of internalising transport externalities:

- charges should be linked closely to underlying costs;
- charges should be differentiated to reflect differences between vehicles;
- the price structure should be clear and transparent;
- charges should be non-discriminatory;
- full infrastructure costs should be recovered (unless the network was constructed for other purposes than just transport)[9].

With these principles as a guideline it is possible to identify in principle the charge instruments best suited for internalising the different costs of road transport. It becomes obvious that damage caused by the chemical composition of a fuel should be internalised by fuel duties, while differentiated vehicle taxes or user charges better handle exhaust pollutants, which vary greatly between different engines. The km charge has in this context the advantage of incorporating both annual mileage and different engine characteristics. Road wear is, of course, better reflected by a differentiated km charge than by fuel tax as the impact on the road surface does not correspond closely to fuel consumption. Accident costs differ greatly between different types of vehicles but do also depend on annual mileage. Fuel tax is a poor measure, considering, for instance, the huge difference in risk per litre of fuel between buses and motorcycles. Table 6 shows the

[9] Cost recovery, however, is given less emphasis in the Commission's White Paper (1998b)

result of an attempt to indicate the first and second best choice of instrument for the various social costs of road transport.

Table 6 First choice and second best instruments for the internalisation of the different costs of road transport

cost type	Best choice	Second best choice
Road maintenance costs	Km charge	Vehicle tax or fuel tax
Running costs*	Km charge	Vehicle tax or fuel tax
Road building and fixed maintenance costs	Vehicle tax	Km charge
Air pollution	Km charge	Fuel tax
Noise	Km charge	Vehicle tax or fuel tax
Greenhouse gases	Fuel tax	Km charge
Traffic accidents	Extended insurance liability	Km charge or fuel tax
Congestion	Congestion road charges	Differentiated km charge

* Running costs are expenditure for roads such as traffic police, operation of signalling and street lighting, snow sweeping etc. To the extent that such costs are variable, they should be viewed as parts of the short-term marginal cost.

It will in the following sections of this report be assumed that a km charge will be the first choice for costs relating to exhaust pollution, noise and maintenance of the road network. Global warming and traffic accidents are assumed to remain elements of the fuel tax. Accident costs, however, may in the longer term be more efficiently internalised by an extended insurance liability.

The fixed costs of the infrastructure and congestion costs are not discussed further, but it should be recognised that a km charge, which is differentiated in time and space, can be used for congestion charging. It is further possible to set the km charge at a rate, which covers the cost to the operator of extending and improving the network.

4.4. Cost elements affected by a transition to km charge

In the previous section, exhaust emissions, noise and the short-term marginal cost for maintaining the road network were identified as potential cost elements of a km charge.

Environmental costs

There are several methods for calculating the social costs of air pollution, noise and climate change. Most commonly used are different varieties of the damage cost approach and WTP-studies (Willingness To Pay). A third method is to estimate the marginal cost of achieving well-defined intermediate or long-term objectives and thereby identify a shadow price. The pros and cons of these methods will not be evaluated or discussed here. The reader is referred to ECMT (1998) for a recent survey. The different methods can result in quite differing costs, but this report will avoid difficulties in this respect by relying on the medium estimates of the ECMT Task Force (ECMT, 1998).

Infrastructure costs

DIW et al (1998) has shown that the existing practice of road cost accounting in EU Member States is heterogeneous. It will presumably take a long time before harmonised methods are eventually adopted, and even then national conditions will have to be respected. There will probably even in the very long term be differing views on how the

fixed maintenance costs and the costs of expanding the road network should be recovered. In this context kilometre charging offers an opportunity for Member States to use differing methods for estimating and allocating costs without undermining the efficiency of the internal market.

An example
Table 7 shows the approximate costs caused by a 40-tonne vehicle combination travelling in Germany.

Table 7 Costs (in € per vkm) caused by a 40-tonne vehicle combination that would be subject to a km charge in a case of full internalisation of short-term marginal social costs (accidents and carbon emissions not included)

	Non Euro	Euro 1	Euro 2	Euro 3	Euro 4	EEV*
Noise	0.050	0.050	0.050	0.050	0.050	0.050
NOx	0.089	0.063	0.049	0.035	0.024	0.014
HC	0.018	0.009	0.008	0.005	0.003	0.002
PM_{10}	0.022	0.016	0.007	0.004	0.002	0.001
Marginal road cost	0.087	0.087	0.087	0.087	0.087	0.087
Total cost	0.266	0.225	0.201	0.181	0.166	0.153

* EEV = Environmentally Enhanced Vehicles (according to COM 97(627) final)

Assumptions:

- ECMT (1998) puts the average unit noise cost at € 0.028 per vkm for road freight at a 55 dB(A) threshold and an average load factor of 2.84 tonnes. A 40-tonne combination creates a great deal more noise (and vibrations) than the average HGV/van. It is thus assumed that the cost of such a combination comes to ε 0.05 per vkm. No improvement is assumed between vehicle generations as a tyre to surface noise dominates noise at speeds exceeding 30-40 km/h.
- The values for NO_x, VOC and PM_{10} are based on the shadow prices for air emissions given by ECMT (1998). Average driving is assumed to consist of 77% rural and 23% urban driving. For PM_{10} the official Swedish cost estimation (€ 20/kg, Samplan 1995) is used for health effects of rural emissions, as ECMT (1998) does not provide a rural value.
- The emission limit values of different EU standards (Euro 1, 2 etc.) are assumed to reflect the average lifetime emissions of vehicles certified according to each regulation, with the exception of NO_x for non-Euro where 80% of the limit value has been used. The values for Euro 3, 4 and EEV are those for the ESC test cycle according to the Council's proposal COM 97(627) final. PM_{10} emissions under non-Euro are estimated at 0.5 g/kWh (there is no limit value).
- Marginal road costs of "lorry with trailer" for the total road network of Germany according to official data cited by DIW et al (1998). This average figure hides the fact that real damage costs depend on axle-loads rather than on total vehicle weight. The long-term marginal cost of extending the network is not included in this estimate.

From Table 7 it is evident that the annual charge for a non-Euro vehicle would be almost twice that of a vehicle complying with the EEV requirements. At an annual distance of 120,000 km (for a long-distance HGV), this corresponds to a difference of € 13,560 per year. The difference between EEV and Euro 4 (at the same annual mileage) stops at € 1,560 per year. The relative impact of differences in environmental costs on the total charge would be somewhat higher for 12 and 25 tonne HGVs as they would pay less for road wear and tear.

4.5. Charging for motorways or the total road network?

The total cost to be recovered by the km charge depends on whether the charge is calculated on the basis of the short-term marginal cost of the public road network, as in Table 7, or only on the cost of motorways. In Table 8, this difference is illustrated for

Germany. The table also includes the average infrastructure costs of HGVs in Germany (including the fixed costs). It should be observed that the figures in Table 8 reflect the way costs are officially allocated between different types of road users in Germany. According to this method, HGVs with GVW > 3.5 tonnes are responsible for 46.8 per cent of the overall costs of the German road network. Using the cost allocation methods of other Member States on German data, the share of HGVs would be between 18 and 48 per cent of total costs.

Table 8 Infrastructure costs for HGVs with GVW > 3.5 tonnes as a group, and for lorries with trailers, in Germany (in € per vkm at 1994 prices)

All HGVs	Marginal cost	Average cost*
Motorways	0.0212	0.091
Total road network	0.0857	0.233
Lorry with trailer		
Motorways	0.0256	0.093
Total road network	0.0870	0.272

* Including fixed costs.

Source: Based on DIW et al (1998)

It is hardly surprising to find that both the marginal and the average cost of HGVs are much lower on motorways than on the total road network (in non-congested situations). From a cost-efficiency point of view motorways should not be charged more heavily than trunk roads as this may stimulate hauliers to shift to roads with a higher marginal cost. Environmental costs and accident risks are also generally higher on trunk roads than on motorways. What might argue in favour of charging more for motorways is only the fact that hauliers will in many cases be willing to pay a little extra for a fast and convenient road.

4.6. Degree of differentiation

On board electronic units provide an opportunity for an extensive differentiation of user charges, especially when based on GPS. Differentiation according to total weight, number of axles, exhaust performance and noise would be based on vehicle registration just as in the case of the current vehicle tax. GPS systems complemented with the tachograph or roadside beacons, would add information on annual mileage in different Member States and on different kind of roads. It is also feasible to vary the charge over the time in order to enforce a night time noise penalty on HGVs or to make it more expensive to use certain parts of the network at times when the roads are usually congested.

Several Member States are now in the process of establishing a computerised national road database, which will in a few years time cover the entire public road system down to its smallest elements. Such a database could also be made to include information on road characteristics such as road surface conditions, accident risks and environmental concerns. In a GPS-based system this provides an opportunity to differentiate charges in order to make (especially) HGVs choose roads where increased traffic will cause a minimum of additional costs (especially road wear and tear).

However, the more complex the charging structure, the more difficult becomes the implementation. The importance of public acceptance, above all, argues in favour of beginning with a system, which is simple. This probably means starting with a system which is based on the vehicle and exhaust categories of the new Directive on vehicle taxation and user charges, and GPS or beacons. The latter would in the first phase be used only for identifying border crossings and intersections between general trunk roads and toll roads, bridges, tunnels and mountain passes. The system, however, should ideally cover all public roads. The charge could be higher on motorways currently covered by tolls or the Eurovignette than on the remaining network, if additional traffic on the motorways can be shown to be more costly to society than traffic on other types of roads.

4.7. Degree of European harmonisation

The km charge will not work properly on a European level unless the vehicle classification is harmonised. The new Directive on vehicle taxation, however, has already taken care of this. In Annex I, it divides HGVs with GVW > 12 tonnes into 15 categories for motor vehicles (according to GVW and number of axles) and an additional 24 categories of vehicle combinations (articulated vehicles and vehicle trains).

The Directive also contains the necessary reference to the European vehicle emission classification. It is recommended, however, to supplement the text with Euro 3, Euro 4 and EEV when the Council and the European Parliament have finally adopted the new Directive on exhaust emissions from heavy-duty vehicle engines. The possibility of engine upgrading should also be recognised.

There is little reason to harmonise the levels of charging for various social costs. The social costs of a national network or a specific road vary due to local and regional circumstances such as traffic intensity, geography, climate, labour costs and willingness to pay for avoiding noise and exhausts. Harmonising charges on a European level will thus prevent Member States from fully internalising the social costs of road transport. The inherent conflict in the new Directive between liability and cost efficiency on the one hand and European harmonisation on the other (see section 4.2 above) should be avoided in a European Directive on a common km charge. Harmonisation is in this case no longer needed as the automatic registration of border crossings makes it possible to impose different charges without negative effects on competition and the allocation of revenues. Charges, however, must be non-discriminatory, based on calculations of real costs and proportionate to the objective pursued.

It would, however, be advantageous to develop a common methodology for calculating the externalities as this would make the process of internalisation more transparent and reduce the risk of Member States trying to enforce charges in a discriminatory way.

There is also an apparent need for harmonising the technical systems for km charges, road tolls and congestion charging or making all such systems interoperable. This is strongly underlined in the Commission's White Paper on Fair Payment for Infrastructure Use (European Commission, 1998).

4.8. The size of the km charge

Following the principles of the Commission's Green Paper and White Paper, it was suggested above that the km charge would be used for internalising the true costs of noise, exhaust emissions and the short-term marginal cost of the road network. As shown in Table 7 these costs would amount to approximately ε 0.2/vkm for a 40-tonne truck

using the German road network. Assuming an annual mileage of 120,000 km, charging € 0.2/vkm would increase the annual road user charge by 770 per cent compared to the maximum Eurovignette and the current German vehicle tax for a 40-tonne Euro 2 truck (€ 250 + 1,519). Such a sharp increase on present levels may be difficult to enforce without allowing the km charge to replace part of the fuel tax (which would be perfectly in line with the Commission's principles).

It should be noted, though, that Switzerland will charge € 0.30/vkm for Euro 2 (vehicle with GVW of 34 tonnes) in 2001, rising to € 0.52/vkm in 2005. Switzerland does not plan to reduce its current diesel tax, the rate of which is well above the European average. The Swiss charges (km charge + diesel tax) appear to recover more than the short-term marginal cost, and it is, of course, perfectly feasible to use a km charge for recovering fixed costs.[10]

Introducing a km charge that replaces only the current levels of vehicle tax and the Eurovignette would provide little scope for differentiating according to road costs and environmental damage. Adding the maximum vignette to the minimum vehicle tax (40-tonne Euro 2 with air suspension) is equal to less than 8 per cent of the costs identified in Table 8 (120,000 km/y in Germany). Such small differences will not make hauliers modernise their vehicle fleets in order to avoid tax (and reduce damage).

The success of differentiated fuel taxes for shifting to unleaded petrol and low-sulphur diesel (the latter mainly in Finland and Sweden) has been due to large differences in tax levels. The tax differentiation between leaded and unleaded petrol in Europe has in most cases been within the range of € 200-500/kg of lead. This is far above the per kilogram charge levels used for different air pollutants in Table 7. Enforcing charges far below those of Table 7 will not provide enough incentive. Even if the current Eurovignette and vehicle taxes were differentiated only for differences in exhaust pollutants, the charge would be much too small to have anything but a negligible impact on behaviour.

An optimal use of different charging instruments thus would imply shifting part of the current diesel tax to the km charge. At least in the longer term this is needed. The incremental cost of introducing a km charge probably would not be justifiable if the new regime was only to substitute current vehicle taxes and the Eurovignette.

4.9. Replacing part of the fuel tax?

It was suggested in section 4.3 that the negative impact on the climate of the combustion of road fuels and possibly the costs of traffic accidents should also in future be covered by the fuel tax.

The marginal cost of meeting the European Union's previous commitment to stabilise emissions of greenhouse gases at the 1990 level is calculated by ECMT (1998) at € 50 per tonne of CO_2 for measures implemented within the Union. Reducing overall emissions by 15 per cent would according to ECMT roughly double that shadow price. No estimate is given for cutting overall emissions by 8 percent, corresponding to the EU's commitment at the Kyoto Conference on Climate Change. The shadow price for meeting this target is here assumed to be € 75 per tonne (or € 0.075/kg). In reality, however, marginal costs will

[10] By comparison, the average road toll for HGVs on French toll roads is currently ε 0.2 per vkm (Atkins et al, 1998).

differ between Member States reflecting their national commitments according to the Union's burden-sharing agreement. Such differences are disregarded in this report.

The above medium-term shadow price of € 0.075 per kg is equal to € 0.197 per litre of diesel (2.62 kg CO_2/litre) and € 0.177 per litre of petrol (2.36 kg CO_2/litre).

The average accident cost for HGVs is set at € 0.05 per litre of diesel by ECMT (1998). This means disregarding the fact that fatalities and injuries per vehicle kilometre (vkm) differ greatly between Member States, as does the willingness to pay for avoiding a statistical fatality or injury.

If the above assumptions by the ECMT Task Force are accepted, the average diesel tax in EU15 will stay at around € 0.25 per litre in a case where noise, air pollution and infrastructure costs are internalised by a km charge. This level corresponds roughly to the current EU minimum rate for road diesel excise duty (€ 245 per 1,000 litres) and is equivalent to 64 per cent of the proposed minimum rate for 2002. The latter falls in the range (of reduction) allowed for Member States that apply specific charges for infrastructure and environmental costs (in the Commission's proposal for a framework Directive on the Taxation of Energy Products).

Replacing existing vehicle taxes with a km charge need not give rise to any fiscal difficulties as demonstrated above. To allow the km charge to replace part of the fuel tax is more complicated, at least in a situation when road infrastructure and other social costs of cars and less heavy HGVs are still to be internalised mainly by charges on diesel and petrol. Possible ways of handling a shift from diesel tax to km charge for HGVs are further discussed in annex C.

While waiting for cars and vans to be covered by the km charge regime, it may be preferred to base the model on the pre-existing diesel tax and a km charge, which only replaces vehicle tax and the Eurovignette. The Swiss example shows that it is possible even under such circumstances to set the level of the km charge at an appropriate level.

4.10. Coexistence with toll roads and urban road pricing

A km charge based on GPS or roadside beacons can coexist with toll roads, toll tunnels and toll bridges. One option is to include toll roads in the km charge, perhaps with a different km charge, another to stop the km counter at the interface between the ordinary network and the toll road. In the first case private owners of bridges or motorways would be part of the consortium that is administrating the km charge. In the latter case tolls would continue to be charged at the road site.

The km charge system can also be extended to include elements of urban (or motorway) congestion pricing. This, however, would require charges to differ over the hours of the day. Revenue from congestion pricing can be separately accounted for. To make the road pricing system work efficiently it would also have to include cars and vans.

4.11. Number of participating Member States

The introduction of a km charge is not dependent on the number of participating Member States, but the advantages of the system become more evident in a case of a broad participation. If a single or a few Member States want to introduce the system, they have to make sure that foreign vehicles are effectively prevented from filling up at pumps for low-tax diesel.

When vehicles liable to a km charge leave the participating countries for a non-participating Member State or a country outside the EU, this will be registered. The distance driven in non-participating countries can be free of km charge if the countries concerned impose road tolls or a vignette on foreign vehicles. However, it would also be possible for non-participating countries to enforce a km charge on these vehicles provided that the charge equals the tolls or vignette that vehicles from non-participating countries pay. Such an arrangement would, of course, have to be based on bilateral agreements or a common European decision.

4.12. Distribution of revenues

The km charge model described in earlier sections allows the charge revenue to be distributed among Member States strictly according to the principle of territoriality. It means that the charge for every kilometre driven will be correctly allocated. This is one of the major advantages of the system. In a case of many participating Member States and neighbouring countries (accession countries, Norway and Switzerland) would the most efficient method for collecting and distributing the revenue probably be to establish a common authority for this purpose. It would be something similar to current system of collecting en route charges for aircraft by Eurocontrol.

4.13. Extending the charge to cars and light commercial vehicles

Restricting the km charge to vehicles above 12 tonnes means that only a small fraction of all road vehicles will be affected (1.0-1.5 per cent in most Member States, motorbikes and tractors excluded). Cars and light duty vehicles could in a later stage be incorporated in the km charge system. Five or ten years from now most new cars will probably be equipped with GPS and have an onboard computer that could be made to work as a simple tachograph. Small family cars may turn out to be an exception, as the GPS in their case will make up a larger part of the overall cost.

Extending the charge to cars and light commercial vehicles running on diesel would relieve society of all the difficulties and administrative costs associated with a dual diesel tax system. In such a situation the fuel tax would be based strictly on the carbon content of the fuel and would in addition, possibly, be used for internalising the external costs of traffic accidents.

In addition, extending the scheme to cars will give Member States an opportunity to tax petrol and diesel fuelled cars in a similar manner. This means putting an end to the current problems connected to differing taxes on diesel and petrol.

There may also be cause to contemplate other developments that may benefit from a general transition to a km charge. The expected shift from internal combustion to fuel cells in cars and heavy duty vehicles means that the engines of these vehicles may be used for peak load power production (for the national grid) at times when the vehicles are not used on the road. This means road fuels will to some extent be used for generating electricity which is not utilised on board. Fuel used for this purpose ought not to be taxed differently than the same fuel used in a traditional power station. If society wants to prepare for a new era of power production and if it wishes to combat greenhouse gases at least cost, it has to start thinking about how the charge system should be changed in order to facilitate the shift. This becomes particularly important if cars are powered by fuel cells. The private car is used on the road on average only 4-5 per cent of the hours of the year.

If and when the km charge system is extended to private cars, it will probably make sense to refrain from unnecessary geographical differentiation to avoid interfering with privacy (as discussed in chapter 3).

4.14. When is the optimum date for a shift to a km charge

It is obvious from the Commission's Green Paper and White Paper that the present road transport charges are not an efficient method for internalising social costs. Governments will sooner or later have to shift to charges that are linked more closely to underlying costs and which can be differentiated to reflect annual mileage and differences between vehicles. The question then is whether there is a point in time, which is optimal for shifting from the current mix to a km charge?

Waiting for ten or 15 years has the advantage of giving hauliers and other vehicle owners ample time to install the necessary equipment (provided that this becomes mandatory for new vehicles within a few years). If this preparatory method is used also for light commercial vehicles and cars, one would have to wait for about 12 years before three-quarters of the vehicle fleet was properly equipped.

Waiting for ten years or more has some disadvantages:

- It will take longer until Member States can internalise social costs without risk of losing revenue or hurting the competitiveness of their industry and hauliers.
- The km charge cannot be used to differentiate between dirty and less dirty vehicles under the period when this is most beneficial (10 years from now the differences will be much smaller than today as most non-Euro vehicles will have been scrapped).

The conclusion is that the shift to a km charge must not be postponed. The formal decision should be taken as soon as the legal, technical and economic aspects have been thoroughly analysed. The implementation, however, can be gradual.

5. Possible effects of kilometre charging

5.1. Introduction

This chapter focuses on the possible effects of kilometre charging regimes. The effects are split up into effects on the transport sector, macro-economic effects and environmental effects.

When analysing the economic effects of the reform of the charging system it is important to separate effects resulting from changing the charging system and effects that follow from an internalisation of external costs.

Therefore we are splitting the description of possible effects. In sections 5.2, 5.3, and 5.4 we describe the effects of introducing a km charging system as such, independent of the exact charge differentiation or levels. A logical starting point is that the charge is introduced in a non-discriminatory manner (foreign HGVs will face the same charge as domestic HGVs).

In the other sections of this chapter, we describe the possible effects of the internalisation of external costs. Although it is not the aim of this study to make political choices on optimal charge levels and differentiation, we take as a starting point for this description the following assumptions:

- the kilometre charge is valid for *all roads* in a specific country, not just motorway kilometres[11];
- the kilometre charge is at least differentiated for engine exhaust emissions, number of axles and permissible axle loads;
- the kilometre charge will, if used for internalising social costs, lead to a 20 per cent rise in average HGV kilometre prices (currently about € 1.05 on average, might increase to € 1.25 - this price increase would result as a consequence of marginal social cost charging as advocated for in the EC's White Paper on Fair Payment for Infrastructure Use[12] and is consistent with the indicative calculations in the previous chapter of this report);
- *in the longer term* it is possible that the price increase might become lower as a result of hauliers' reactions:
  - transporting more tonnes per vkm (efficiency effect);
  - applying lower axle loads (reduced road wear and tear effect);
  - using cleaner vehicles (environmental effect).

5.2. Implementation costs and benefits

The cost of allowing the km charge to replace vehicle tax and part of the fuel tax should be calculated as the incremental cost compared to a situation where the existing charging structure is maintained.

New HGVs used in international transport are in most cases already equipped with GPS, and electronic tachographs will within a year become mandatory for new European vehicles above 12 tonnes (and mandatory for all such vehicles as of 2005). The

[11] The reason for this is explained in the previous chapter: marginal social costs are much lower on motorways than on other roads. From a welfare point of view it would thus even make more sense to charge all kilometres *except motorway kilometres*.

[12] Studies by ECMT |1998| and CE |1998b| show that full internalisation would initially increase transport prices by 10 to 30%.

incremental cost to the haulier of installing hardware and software for the km charge in these vehicles is limited. It is less obvious that new HGVs in the range of 12-25 tonnes will be equipped with GPS for other reasons than the km charge, but this may change in a few years' time as a result of reduced prices and improved and enlarged national road databases.

In a case where the geographical differentiation of the charge is based on roadside beacons, participating Member States would have to pay for the installation of beacons at border crossings and at all entrances and exits of tolled areas. In addition they would have to install beacons in a number of locations all over the country in order to make regular checks on vehicle registration, trailer declaration and vehicle mileage.

If the low fuel tax scenario came into play, filling stations would have to invest in new pumps and lanes in cases where an existing lane and pump cannot be designated to vehicles liable to a km charge.

The cost of running a modern, electronically based, km charging system is probably not much different from the cost of administrating the current vehicle tax. Moving from the existing system to a km charge means from a fiscal point of view that the costs generated by the current vehicle tax will be replaced by the expenditure caused by the km charge. The cost to the treasury of enforcing the fuel tax will remain unchanged since it has no relation to the charge level.

Enforcement costs are likely to be higher for the km charge than the vehicle tax especially during the first phase when there are still many non-equipped vehicles, and it may stay relatively high in Member States with a large amount of HGVs from countries not belonging to the Union. Efforts will also have to be made to limit the risk of cheating and fraud.

In a case where cars and light commercial vehicles are part of the shift to the km charge the risk of people cheating with low-tax diesel will disappear, as all diesels will be subject to the same (carbon) charge.

The shift to the km charge will have no direct effect on state revenue in a situation where governments do not use the new charge to raise the degree of internalisation. If they, on the other hand, decide to increase the general tax burden on road freight, this will result into fewer overall vkm by HGVs but higher revenues. A Member State that wants to implement the reform in a revenue-neutral manner can do so by allowing the additional income to finance cuts in other taxes.

Investing in GPS and onboard computers may be more burdensome to vehicle owners in the accession countries because of lower levels of income. However, if the shift is not made mandatory, it will be up to the individual Member State to decide for itself if and when it wants to take the step.

5.3. Competition between hauliers

The kilometre charge will boost fairness of competition between hauliers. This holds both for competition between hauliers from the same nationality and for hauliers from different nationalities.

Differences in annual vehicle taxes can potentially cause distortions in international competition between hauliers. The annual vehicle tax, however, makes up less than 2 per cent of the overall costs of road haulage in Europe (Kågeson, 1999). The existing differences in vehicle taxation do not appear to be large enough to cause anything but minor distortions. A shift to a km charge would nevertheless be favourable as it removes the remaining risk altogether.

Differences between Member States in diesel tax levels have only a minor effect on international freight transport. This is because hauliers from high-tax countries can to a large extent decide where to fill up without changing the routes they would otherwise take. A high diesel tax, however, makes domestic movements of goods more expensive which distorts somewhat competition between industries based in Member States with differing tax levels.

Large HGVs have fuel tanks that enable them to travel over 1,000 kilometres without filling-up. This means cross-border traffic can in many cases choose where to buy its fuel. This contributes towards a loss of tax revenue in countries with high rates. A shift to a km charge would enable Member States to keep the diesel taxes for heavy-duty vehicles within a narrow band, which would diminish the risk of revenue losses.

A km charge differentiated for axle loads (total weight + number of axles) will impose higher costs on owners of HGVs with relatively few axles or force them to gradually introduce more axles. The latter may increase the operator's capital and tyre costs but will nevertheless constitute a lower socio-economic cost when the reduction in road wear costs is also considered. The same could happen as a result of differentiated vehicle taxes. The difference is only that the km charge is able to accurately reflect the distance driven.

Competition in the road haulage sector is often very tough. Profit margins are as low as 1 or 2 per cent. An important reason for this is the distortions in competition caused by low-wage firms. They may be small family-type firms, who drive much more hours than the official maximum, or firms from countries with lower wages. As the share of variable, kilometre-dependent costs in road haulage increases as a result of a km charge, the relative benefits of lower wage costs will decrease.

5.4. Effects of unilateral introduction

A km charge would make it possible for the more progressive Member States of the Union to internalise the social costs of road transport without having to wait for an unanimous decision in the Council and without running the risk of losing tax revenue or making life more difficult for their own industries and hauliers. This is probably the most important benefit of the km charge.

However, multilateral introduction of a km charging scheme is still to be preferred from a technical and implementation point of view, especially with the burden of the 'exception scheme' for non-equipped vehicles.

5.5. Effects on competition from other modes

As a primary result, other modes might benefit from a unilateral increase in the price of road haulage. The cross price elasticity (the percentage of road freight shifted to rail, short sea and inland shipping as a result of road freight price rises) is often estimated at around 0.1 or 0.2. This means a 20 per cent price rise in road transport might lead to a 2 to 4 per

cent shift of road freight to other modes. Exact outcomes of course largely depend on local market circumstances.
Such a shift might look moderate, but for example in the Netherlands, where the railway's share in transport volumes is below 5 per cent, a 2 per cent loss of road transport volume to rail might mean a volume increase of rail transport of several dozen percentage points. Multi-modal transport involving containers and swapbodies might in particular become much more popular.

5.6. Effects on road transport volume and final product prices

In this section we will describe the effects on road transport volume of the introduction of a km charge as described at the beginning of this chapter. We will analyse separately the amount of vkm (a good indicator for external effects) and tkm (an indicator of economic benefits).

A recent international survey into own price elasticity of road transport conducted by CE |CE 1999| drew the conclusion (based on nine studies) that road transport's own elasticity lies between -0.5 and -1.0 at a macro level (excluding the effects of modal shift). This implies that, in a situation in which there were no competing transport modes, every one per cent price increase of road haulage would decrease volume by 0.5 to 1 per cent. In a situation involving tough intermodal competition, own elasticity of road freight would of course be higher.

A Danish study |Bjørner, 1999| gives explicit attention to the volume effects of kilometre based price increases. It comes to the conclusion that the elasticity for vkm is about -0,8 at a macro level, while the elasticity for tkm is about -0.45. This is not very surprising: as the charge is based on vkm, it will provide incentives to move as many tonnes per vkm as possible. This study proves, by applying transportation costing models, that kilometre charging might improve transportation efficiency. It shows that possibly half the initial price increase is absorbed by higher transportation efficiency (more tonnes per vkm).

The elasticity as presented above does not take into account the possibilities of avoiding the charge by applying lower axle loads or cleaner vehicles. They should be considered as maximum values. The more hauliers react to the charge (i.e. the better it works), the lower the volume effect.

When comparing the price increases and volume decreases in a historic perspective, the following trends can be identified, taking the Dutch situation as an example:

- First, real road transport prices have fallen by about 30 per cent in the last two decades. A 15 per cent price increase would thus put road transport costs about a decade back;
- Second, the amount of tkm transported on Dutch territory has increased by on average four per cent per annum over the last 25 years. With a tkm elasticity of -0.45, a 20 per cent price increase would lead to a nine per cent reduction in tkm. This would only stop tkm growth for 2.5 years or so.
- Third, the amount of kilometres driven on Dutch territory has only increased by 1.8 per cent per annum over the same period. A 20 per cent kilometre price rise might lead, via 0.8-price elasticity, to 16 per cent less vkm. This implies that the kilometre charge increase might lead to a standstill in vkm growth for a period of eight years or so.

It should be emphasised that these estimates are upper boundaries, as the effects of avoiding the charge (by applying lower axle weights and cleaner vehicles) are not

included. The better the differentiation in charges, the better the charge 'works' and the lower the volume effect (and economic damage).

5.7. Price increase in combination with longer (25.25m) HGVs?

The current EU Directive 96/53 on permissible vehicle sizes and weights contains an article leaving Member States the opportunity to admit longer vehicle combinations on their territory. Sweden and Finland have many years of experience with these types of vehicle, and in the Netherlands selective admission is under discussion. For reasons to do with the smooth functioning of the internal market, these longer combinations are only allowed if modular concepts with 'standard' elements are used (i.e. 7.85m or 13.60m trailers). Combinations with lengths of 25.25m (40 per cent more loading volume than current 18.75m combinations) might be used as a result of this article. In particular container transport might benefit from it as transport of three 20-foot Equivalent Units (TEU) will become feasible, which is 50 per cent more than the currently permitted two TEU.

It is clear that introduction of these vehicles might lead to substantial cost reductions. Costs per tkm might in some cases decrease by 20 to 25 per cent. Such sudden cost decreases, unique in the European road transport history, might be a very serious threat for other modes of transport. Also, it might boost total transport volume (a 'rebound' effect), which might outweigh initial efficiency gains.

An initial 20 per cent price rise via kilometre charging would, in combination with the larger vehicles, give rise to:

- more efficient transport due to the larger vehicles;
- no negative secondary effects via indirect transportation growth or distorted intermodal competition.

Therefore, longer vehicles should not be permitted without internalising social costs by km charging.

5.8. Environmental effects

As shown above, the kilometre charge might lead to a 16 per cent decrease in vkm and nine per cent decrease in tkm. The reduction in CO_2 emissions will be in between these two, as per km emissions are likely to rise because of the heavier vehicles used. A 10 per cent decrease in CO_2 emissions from road transport seems to be a fair estimate.

NO_x and PM_{10} emissions could fall more rapidly as a result of accelerated scrapping of dirty vehicles and accelerated sales of cleaner vehicles. Studies show |e.g. CE 1996| that the costs of making cleaner HGV engines are lower than the marginal environmental costs internalised in the charge (i.e. cleaner HGV engines reduce emissions in a cost-effective way). Therefore, the market for cleaner vehicles would almost certainly be boosted when environmental costs are fully internalised in the kilometre charge.

5.9. Macro-economic effects

The effects from internalising the marginal social costs of road transport have been analysed in general terms by the European Commission (1995) and in some detail by the ECMT (1998). According to calculations carried out by the ECMT Task Force, the internalisation of road transport externalities in rural areas will require user charges corresponding to ε 790 and 970 per 1,000 litres for petrol and diesel respectively (ECMT, 1998, Annex D).

The Task Force notes, that fuel taxes, km charges and annual vehicle taxes all have different impacts on income distribution. Fuel taxes put a smaller burden on low-income groups compared to other car-related duties. This is explained by the fact that high-income earners tend to have larger and more fuel-consuming cars and they also drive more kilometres per year. ECMT underlines that the tax cuts used to recycle the revenues from increased road charges will largely determine the net impact on personal income distribution.

Based on studies by CE (1990), CPB (1996) and DRI (1994), ECMT (1998) draws the following conclusions on the economic impact of taxes that are substantially higher than those proposed by the European Commission (1997):

- the macro-economic impact is likely to be very small and depends on the details of the policy package;
- the impact on GDP growth may be slightly positive or slightly negative;
- the impact on employment is likely to be positive.

The macro-economic impact would be limited. This can largely be explained by the limited initial increase of transport prices, the fact that the transport market has quite a broad range of options to adapt to a new charging system, and that transport costs make up only a few per cent of the overall costs of most branches of industry. Recycling of charge revenues diminishes the impact by reducing other cost elements.

6. Summary, conclusions and recommendations

As underlined in the Commission's White Paper on Fair Payment for Infrastructure Use and the Final Report from the High Level Group on Transport Infrastructure Charging, electronic kilometre charging for heavy goods vehicles (HGVs) is an attractive policy option for achieving fair and efficient pricing. In order to achieve this goal, the system should fulfil the following requirements:

- charges should be linked as closely as possible to underlying costs;
- charges should therefore apply to all kilometres driven, not just kilometres on certain road types[13];
- charges should be non-discriminatory for the nationality of the vehicle and the origin or destination of the goods transported.

6.1 Current Plans

Switzerland is the only European country so far with concrete plans to introduce a charge on all HGV kilometres driven on *its whole territory* (not only its motorways). Switzerland is also the only country to have made some decisions on major technical issues. The Swiss system will consist of:

- an on board unit (OBU) stored with vehicle data, linked to the tachograph;
- a GPS system for checking kilometres measured by the tachograph;
- road-side beacons (some of them mobile) with a triple function:
  1. to switch on / off the system at Swiss border;
  2. to verify the proper functioning of the system by checking vehicle data and OBU entries;
  3. to make random checks for correct vehicle registration by taking photographs;
- an obligation for domestic vehicles to have an OBU and incentives for foreign vehicles to buy an OBU by introducing manual financial transactions on a per trip basis.

Austria and Germany have plans to introduce km charging systems within a few years but only for their motorways. They have not yet made any formal decisions on major technical issues. Austria will most probably reform its current beacon-based Ecopoint system into a financial transaction system. Germany is in a pre-tendering phase.

6.2 Possible system outline: technology and charges

What follows is an outline of a system, which is a possible compromise between optimal charging and feasibility. This model would charge for all kilometres driven within a Member State. In the first phase it is probably too ambitious to differentiate the charge between individual roads (with differing cost characteristics). However, differentiating the charge for countries, certain geographical areas and certain specific roads like motorways is feasible.

The system should be based on GPS, an electronic On-Board Unit (OBU), GSM communications, and some roadside beacons. The GPS system would be used for kilometre registration and for registering when the vehicle enters a new charging area. The OBU will store vehicle characteristics: registration number, number of axles,

[13] From a welfare point of view it would make even more sense to charge for all kilometres *except motorway kilometres*, as the marginal social costs of driving on motorways are lower than marginal social costs of driving on other road types. This implies a charge on motorway kilometres only could even *reduce* welfare.

permissible axle loads, engine emission class, the presence of trailer and, if so, trailer data. The OBU would also be used for storing data on the number of kilometres driven in different charging areas, with/without trailer, and the charge levels in these areas. The OBU can calculate the charge itself, any changes in levels for certain vehicles or areas can be entered via the GSM system. The GSM system can be used identify the vehicle, to tap its OBU for data on actual mileage, kilometres driven in different charging areas, and for payment. The beacons would be used for enforcement purposes (check for the presence of the trailer by pictures) The beacons could also be used for indicating that a new charging area is being entered. This function, however, could alternatively be carried out by the GPS system.

As an alternative to GPS, the tachograph may be used for kilometre registration. In a case without GPS, beacons must be used for making the OBU record that the vehicle is passing the border between two charging areas. Another possibility is to use the tachograph for checking that the mileage data given by the GPS is correct. However, it is doubtful whether such a redundancy is really necessary. If in a later phase the km charge regime were extended to vans and cars, it would hardly be feasible to demand that owners of such vehicles should invest in two separate systems for recording mileage. GPS would probably be preferred in this case as it provides supplementary benefits such as the possibility of having access to electronic road maps.

Payment of the km charge can be done on a pay-later basis by the vehicle owner sending smart cards linked to the OBU to the tax authority. Electronic transmission of OBU data to a central computer is an alternative solution. A pre-pay approach appears less attractive as long as Member States use different types of electronic money.

6.3 Exception system

Member States wishing to introduce km charging of HGVs are recommended to oblige all hauliers performing domestic transport to join the system and to consider the feasibility of subsidising part of the cost of furnishing pre-existing vehicles with the necessary equipment. Exceptions could be made for low-mileage vehicles. They could be offered the option to pay a fixed charge. Mileage checks could be made during the annual roadworthiness inspection of these vehicles.

The advantage of this strategy is that the ‘exception system’ for non-equipped vehicles can be limited to foreign vehicles that have chosen not to obtain an OBU. For such non-equipped vehicles, a semi-electronic self-service system with vehicle ID cards, manual declaration of mileage on the basis of tachograph readings, and central registration can be used to avoid unnecessary paperwork. A paper based permit scheme on the basis of freight papers and tachograph readings can serve as a last backup. The enforcement of the exception system requires a re-introduction of border checking which is, however, limited to a small share of foreign HGVs.

6.4 Replacing other taxes and charges

In the first phase Member States are recommended to allow the km charge to replace the Eurovignette, the annual vehicle tax and tolls on motorways, bridges and tunnels (if any). They should also take the opportunity of using the new charge instrument for internalising the marginal social costs of HGVs but this can be done gradually over a longer period or in a second phase of the development.

In the medium to long-term Member States should also consider replacing any part of the existing fuel tax that is not related to CO_2 emissions (or accidents) by the kilometre charge as this would achieve an optimal cost allocation. The best moment to do this might be when the external costs of accidents have been internalised by extending the vehicle insurance liability (e.g. via a tax on the vehicle insurance). Taxing diesel fuel only for carbon emissions means the same tax can be enforced on all use of diesel provided that the km charge has by then been extended to cars and vans. This would have the advantage of making tax evasion very difficult (and purple diesel would not have to be used for differentiating between high and low taxed fuel).

6.5 Introduction policies

A single Member State who wishes to tax vehicles according to the damage and the costs they inflict on society can use the km charge. A unilateral action would not have any negative impact on the internal market, as the charge is non-discriminatory and based on the principle of territoriality. A major advantage of the km charge is to allow Member States to apply the principle of subsidiary on charges for the use of their national road networks.

However, a unilateral introduction of km charging is less attractive than multilateral for the following reasons:

- risks of harming interoperability;
- higher implementation costs for governments and/or the transport sector (depending on who pays what);
- a high percentage of non-equipped users, for whom an inefficient exception system will have to be operated;
- risk of border trade with diesel fuel and loss of tax revenue in neighbouring countries as a Member State that uses km charging for internalising social costs is likely to keep the fuel tax at the lowest permissible level.

In principle, every Member State can decide for itself whether it wants to introduce a general km charge or only apply the charge to traffic on motorways. The latter has two obvious disadvantages:

- it will force the Member State to maintain a vehicle tax regime for HGVs which will approximately double the administrative cost of taxing these vehicles;
- it will result in a non-optimal cost allocation.

Member States interested in km charging of HGVs are strongly advised to enter into multilateral negotiations. To avoid problems with interoperability (which may double or triple overall implementation costs), it is essential that Germany, Switzerland and Austria participate in such an effort. Other parties to the current Eurovignette should also take the opportunity of influencing the new system for charging HGVs in Europe. It is particularly important that the OBUs used in Switzerland have the capacity to store data from beacons used in countries that may shift to km charging at a later stage, and that beacons deployed at the Swiss borders can provide different signals for different countries. However, there is no need to harmonise charge levels.

At least in the longer term Member States as well as neighbouring countries should consider the feasibility of erecting a common authority for kilometre charging and distribution of the revenues among the participants. Such an authority could be an

extension of the current Eurovignette organisation. In the aviation sector, there is already a common agency with responsibility for collecting and distributing fees for the use of European flight corridors, Eurocontrol.

There may also be cause to contemplate the co-existence of km charging and congestion charging. The Netherlands should study the possibilities of integrating a km charge system with their regime for congestion charging. As the km charge system will most probably work on a 'pay later' basis and the congestion charging system on a 'pay before' basis, this will require some analysis.

6.6 Need for European legislation

Establishing a unilateral or a common European scheme for km charging may require some changes in existing and proposed EU Directives. The new Directive on HGV taxation and user charges should be changed to allow a Member State that wants to introduce km charging on its entire public road network to replace the annual vehicle tax with the km charge. Not allowing such a shift means forcing Member States to use two different tax regimes for the same purpose. In addition the Directive should no longer put a specified upper limit on the amount of user charges that Member States are allowed to collect. It may also be a good idea to include in these Directive passages on interoperability of national systems for km charging as well as rules on how to handle non-equipped vehicles from non-participating Member States. With relatively small changes and amendments this Directive could be turned into a Framework Directive for European km charging of HGVs. The Directive already contains the necessary vehicle classification. Environmental differentiation, however, should be based not only on Euro 0, Euro 1 and Euro 2 but also on future vehicle standards that have already been decided upon (i.e. Euro 3, Euro 4 and EEV). Some vehicles will be able to meet these requirements in advance.

There may also be cause to contemplate some minor changes in the Commission's existing proposal for a new Directive on the taxation of energy products (COM(97) 30 final). This proposal foresees a situation when Member States start introducing km taxes as a means of internalising social costs. According to Article 16 of the Directive, a Member State may be authorised to apply levels of taxation of motor fuels between 60 and 100 per cent of the minimum levels specified in the Directive when it introduces, on a non-discriminatory basis, a specific charging system to recover such costs. In the light of the existing plans for km charging it may be wise to review the proposal in order to find out whether the proposed level of reduction is appropriate.

Glossary

CARDME	European initiative aiming at interoperability of electronic payment systems in transport
DGPS	Differential GPS, more accurate version of GPS, accuracy maybe 1 or 2 metres.
DSRC	Dedicated Short-Range Communications, communication frequency set at 5.8 GHz, well suited for beacon-OBU contact. Frequency may be altered in the future.
ε	Euro, European currency unit as of 1 January 1999
EC	European Commission
ECMT	European Conference of Ministers of Transport, OECD body for co-ordination of European transport policies in which almost all European states participate.
EEA	European Economic Area, EU15 including Switzerland, Norway and Iceland
EEV	Environmentally Enhanced Vehicles, proposed extra tough European emission standards, equal to Euro 5
ELR	European Load Response test, a European heavy duty engine emissions test to be introduced as of 2000
ESC	European Steady-state Cycle test, a European heavy duty engine emission test to be introduced as of 2000
ETC	European Transient Cycle test, a European heavy duty engine emission test to be introduced as of 2000
ERP	Electronic Road Pricing
EU	European Union
EU15	the 15 Member States of the European Union: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom
Euro 2 etc.	indicates an engine emission class according to European heavy-duty engine emission standards. Euro 5 is the 'cleanest' version. Mandatory for new vehicle engines as of 1993, 1996, 2000, 2005 and 2008 for Euro 1, 2, 3, 4, and 5 respectively.
Glonass	Russian satellite based positioning system
GNSS	Global Navigation Satellite System, European initiative for a satellite based positioning system (alternative to GPS)
GPS	Global Positioning System, satellite based, accuracy (without extra provisions) about 100m
GSM	originally Groupe Spéciale Mobile, later Global System for Mobile communications, communication system that works at a frequency band of 890-960 MHz
GVW	Gross Vehicle Weight, empty weight + load, in this report generally *maximum permitted* gross vehicle weight (empty weight + maximum permitted load)
HGV	Heavy Goods Vehicle, in general a road vehicle primarily designed for carrying goods, with a maximum permissible GVW > 3.5 tonnes. In this report, however, in most of the cases the GVW considered is 12 tonnes.
OBU	On Board Unit, electronic device to be installed in a vehicle, in which data can be stored (i.e. vehicle registration number, engine class, GVW, kilometres driven), charges can be calculated and payments made.
TEU	Twenty-foot Equivalent Unit, unit size for maritime containers

tkm	tonne kilometre(s), indicator of transport performance
vkm	vehicle kilometre(s)

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Electronic Kilometre Charging for Heavy Goods Vehicles in Europe

Annexes

T&E 99 / 6

A. Past and far off experiences

This annex describes past experiences with km charging systems for HGVs and current experiences and plans with electronic road pricing, mainly for congestion reasons.

A.1. Kilometre charging systems

A.1.1. Sweden and Norway

For close to 20 years Sweden and Norway imposed km charges on diesel fuelled road vehicles. The arrangement was ended on 1 October 1993 and replaced by an annual vehicle tax and tax on diesel fuel used in road vehicles. The main reason was that Sweden and Norway needed to harmonise their charge structures with the European Union when joining the European Economic Area (EEA).

The Swedish km charge was introduced in 1974 with the aim to differentiate between road vehicles (liable to the new charge) and other diesel fuelled vehicles and machinery. Prior to the reform Sweden had experienced problems with enforcing different levels of taxes on diesel used in road vehicles and diesel used for other purposes. It was also believed that charging for use of the vehicle would be more efficient than charging for the vehicle without considering the annual mileage. The Swedish and Norwegian km charges increased progressively with GVW as research had shown road wear to increase progressively with the axle load.

Under the km charge regime, every owner of a diesel fuelled road vehicle, including vans and cars, had to fit their vehicle with an instrument (odometer) able to record the distance driven. There were two kinds of odometers, cable-driven and hub-mounted. They had to be of a type approved by the National Charge Board and mounted by a garage or workshop approved by the Board. After being fitted to the vehicle, the odometer was inspected and approved by the National Motor Vehicle Inspection Company.

The odometer had a stamping device, which the owner of the vehicle used for stamping a special card three times a year (Sweden). They then sent the card to the central car registration authority where the imprint was read optically and fed into a computer. On the basis of the registered information the authority sent an invoice to the vehicle owner for the amount of charge to be paid.

Distances travelled in countries other than Sweden, Norway and Finland could be deducted. To qualify for such deduction, the person in charge of the vehicle had to stamp a special card (available at the customs office) on both leaving and re-entering the country. Foreign diesel fuelled vehicles had to pay special charges on entering Sweden and Norway. Sweden used a simplified system, based on total weight and the number of days within the country. Norway tried to enforce a distance-related charge, which proved not to be acceptable to several countries. This led to negotiations and bilateral agreements whereby vehicles from both countries were exempt from road charges in the other country. Applying different rules for different nationalities made the Norwegian system complicated to administer.

Having no charge on diesel fuel made it necessary for Norway and Sweden to limit the maximum permissible amount of diesel fuel allowed at border crossings when leaving for countries that imposed charges on diesel used in road vehicles. This was easy to control but added to the administrative burden and made border crossing time-consuming.

The odometer was sealed with lead seals to make tampering difficult. Nevertheless a fair amount of cheating took place. Most of the cheating occurred with vehicles equipped with cable-driven odometers. It was more difficult to tamper with the hub-mounted meter (Hans Blomgren, the National Charge Board). Many, perhaps most, cases of tampering were revealed as the result of regional charge authorities investigating vehicles with suspiciously short distances and odometers being subject to an annual inspection by the Motor Vehicle Inspection Company.

The cost of administrating the Swedish system was estimated in 1985 at 2.6 per cent of the charge revenue (legal costs associated with cases of fraud not included).

A.1.2. USA

Currently only five US States, Oregon, New Mexico, New York, Kentucky and Idaho, operate weight-distance-related charges. Other states also used to operate kilometre-based fees in order to recover infrastructure costs, but the schemes were repealed because of legal pressures (discrimination between transit and intra-state transport), high administrative costs or massive evasion. States operating charging regimes on a per-trip basis have abandoned the schemes because the costs were too high.

The most sophisticated schemes use the Heavy vehicle Electronic License Plate (HELP) system. In this system, HGVs are equipped with Automatic Vehicle Identification (AVI) transponders to provide information on their registration number, last date of safety inspection, number of axles, etc. Vehicle loads are determined by weight-in-motion (WIM) systems. With the information, charges are calculated for the amount of miles driven. The charge bills are sent to the companies. This system operated in Oregon has overhead costs of no more than 4 per cent. States that use very simple flat-rate schemes can reduce this to 2 per cent.

A.1.3. Australia and New Zealand

Australia and New Zealand operate axle-weight-based kilometre charging systems for their HGVs. The main goal of these systems is to cover road maintenance costs. Both systems are still paper versions

The New Zealand system operates on a pre-paid permit basis and includes a 10 per cent goods and service tax, as it is considered a normal payment for a (government) service, namely roads. In 1997 New Zealand initiated trials to move to an electronic scheme. Such a scheme is expected to be more efficient (especially with respect to the current pre-payment requirement) and to lead to lower evasion rates.

A.2. Congestion charging systems

This section will briefly describe the most ambitious congestion charging systems in operation and being researched: the current Singapore scheme and the Dutch scheme planned for introduction as of 2002.

We emphasise that congestion charging schemes should not be introduced for HGVs exclusively, even though this is possible under the other systems described in this chapter. Congestion charging schemes should ideally charge vehicles according to their road capacity utilisation, as road space is the right indicator for the external costs of congestion. Capacity utilisation factors can be expressed in PCUs (Passenger Car Units). For example, in the Dutch scheme for allocation of infrastructure costs, rigid and articulated HGVs count as for 2 and 3 PCUs respectively.

A.2.1. Singapore

Singapore has many years' experience of congestion charging. In 1975 the first system was introduced, which excluded taxis, 'carpoolers', motorcycles, vans, HGVs, freight and public transport. Over time, tariff times were expanded. In the beginning, tolls were levied from 7.30 till 10.15 am, as of 1994 tolls are levied in the RZ (Restricted Zone) from 7.30 a.m. till 6.30 pm. Currently only public transport is excluded.

In 1998 the first *Electronic* Road Pricing (ERP) was introduced, in order to control the traffic flow during rush hours. A second goal of the ERP system is to shift the cost of car traffic from fixed costs per car to costs for car use during the congestion hours. On 1 April the East Coast Parkway (ECP) was charged, on 1 September the Pan-Island Expressway (PIE), the Restricted Zone (RZ) and the Central Expressway (CTE) were charged.

People, who want to use one of these motorways or want to enter the restricted zone are obliged to install a device in their car, which enables it to obtain an amount of money from a smart card. When the paying station is passed without such a device, the car is photographed and a substantial fine must be paid.

The system works with an OBU and two DSRC radio communication ports. While entering the first port, the car is registered and the port will 'tell' the device to debit the smart card. The second port will check whether the debit was successful. If not, a camera takes a picture of the rear of the car, so a fine can be sent.

The costs are differentiated over time and the different types of vehicles. There is also a differentiation for the different motorways and the RZ. Table 9 shows the charges.

Table 9 Singapore ERP charges, in ε

Type	7.30am-8.00am	8.00am-9.00am	9.00am-9.30am
Car	0.53	1.06	0.53
Motorcycle	0.26	0.53	0.26
Taxi	0.19	0.37	0.19
Van	0.13	0.26	0.13
HGV	0.21	0.42	0.21
very HGV and large bus	0.26	0.53	0.26

Exchange rate: S$ 1 = ε 0.53

Commercial vehicles do not have to pay the full price. In order to make it easier to adapt, they start by paying 25 per cent of the levies.

The system has proved to be very effective. The traffic entering the RZ during the ERP operating hours has dropped by 20-24 per cent on weekdays and 19 per cent on Saturdays. The roads within the RZ became under-utilised so for charge was lowered by ε 0.26 for passenger cars.

The overall traffic conditions have improved on the motorways (the average speed has gone up), except on the CTE where there is 23 per cent more traffic than before. This is caused by the relatively lower prices for commercial vehicles on this road, which caused an increase in commercial traffic.

A.2.2. The Netherlands

The Netherlands intend to introduce congestion charging on the heavily used parts of their road network in the western part of the country (the 'Randstad') as of the year 2001. The charge will not be based on vkm driven, but on the number of passages through selected beacons. The beacons will be placed in cordons around the four major Dutch cities Amsterdam, Rotterdam, The Hague, and Utrecht. Not only motorways, but also smaller entry roads will be provided with beacons in order to avoid 'evasion' traffic. Payments will be made on a per passage basis. A test with four different payment systems has just been finished. There are two payment options, via the main system and the exception system:

- The main system consists of an On Board Unit (OBU) attached to the front window. The OBU cost is not known yet but will indicatively amount to about ε 50. The OBU contains a smart card that is automatically detected by the beacons. After checking the smart cart validity and the amount of money stored on it, a charge will be paid which has not yet officially decided upon but will amount to about ε 2.3 per passage;
- If no valid smart card is detected, the numberplate will be photographed, and the bill will be sent to the owner of the vehicle. An extra amount (indicative level: ε 0.90) will be charged in order to cover administrative costs and to create an incentive to buy an electronic OBU.

All vehicles will be subject to the same charge, passenger cars, vans, HGVs and even motorcycles. The charge will be levied from 7.00 am till 9.00 am, so just the morning peak will be covered.

The main (technical) bottlenecks for the system seem to be:

- the required accuracy of only 1 fault per 2,000 transactions;
- the speed of communication required. The system should work with cars which have speeds up to 160 km/h;
- number plate recognition in bad weather circumstances such as fog or snow;
- fraud with number plates (bills sent to wrong addresses);

The law on Road Pricing with the elements as described above will be discussed by the Dutch Parliament this summer or this autumn.

B. Excise duty levels in Europe

Table 10 and shows the levels of motor fuel excise duties in EU15 plus Norway and Switzerland in September 1998. In addition, the table provides information on how many individual countries will have to increase their excise duties in order to comply with the proposed EU minimum levels for 2002.

Table 10 Excise duties on diesel and unleaded petrol (€ per 1,000 litres and percentage increase) in the countries of Western Europe as of 1 April 1999 and required increase for complying with the proposed EU minimum levels for excise duties in 2002.

Member States	Petrol excise duty	Petrol excise duty % required increase	Diesel excise duty	Diesel excise duty % required increase
Austria	414.4	21	289.7	36
Belgium	507.2	0	290.0	36
Denmark	506.5	0	307.7	28
Finland	559.7	0	304.7	29
France	589.5	0	371.7	6
Germany	531.8	0	347.7	13
Greece	318.5	57	256.6	53
Ireland	378.7	32	330.1	19
Italy	541.8	0	403.2	0
Luxembourg	347.3	44	252.9	55
Netherlands	586.8	0	[a]323.3	22
Portugal	498.8	0	295.3	33
Spain	371.7	34	269.9	46
Sweden	486.9	0	[b]291.1	35
United Kingdom	624.5	0	[c]609.0	0
Norway[d]	565.0	0	438.0	0
Switzerland	456.0	6	473.0	0

a Includes a payback arrangement for > 100 litre filling-up actions of € 22.7 per 1,000 litres;

b Ultra sulphur diesel (environmental class 1) which dominates the Swedish market. The charge on standard diesel (class 3) is € 346 per 1,000 litres;

c Low sulphur diesel, which has gained a large market share since the beginning of 1999. The rate for normal diesel is € 638.8;

d Levels as of 1 September 1998.

Sources: EC DG XVII's Oil Bulletin 28 March 1999 (including ε 31 increase for petrol and diesel in Germany as of 1 April 1999), and T&E´s member associations in Norway and Switzerland.

C. Problems when replacing part of the fuel taxes

At least three different means of differentiating the fuel tax between vehicles liable to the km charge and other vehicles can be identified.

One option is to use colour additives in different diesel pumps according to how the fuel is taxed. This method is already widely used within the Community for differentiating between road fuels and 'red' diesel used by off-road vehicles in agriculture and forestry. To introduce an additional colour will require more tanks and pumps at filling stations and will increase the risk of fraud. The consumption of diesel enjoying special fiscal treatment will increase considerably.

Another possibility would be to offer low-tax road diesel at selected pumps at lanes for large HGVs and to demand that vehicles using these pumps should carry special signs. To prevent drivers and hauliers using part of the fuel for other purposes, it would probably be necessary to make drivers identify themselves and to equip these HGVs with some kind of sealed mobile electronic device which can be used by the sales person to record the purchase. The annual amount of fuel can later be compared to the mileage recorded by the tachograph. Non-participating vehicles would not be allowed to fill-up at these pumps and would not have access to the electronic fuel counting device.

In the case of dedicated lanes and pumps it would probably be possible to use diesel fuel from a container that also serves pumps for normal-tax diesel. Some small filling stations, however, would have to invest in additional pumps and lanes. Larger stations with several pre-existing lanes for diesel would be able to use one or several of these for low-tax diesel available for vehicles above 12 tonnes.

A third option would be to create a system for refunding owners of HGVs the difference between the generally applied tax on road diesel and the rate which should be enforced on vehicles liable to the km charge. Multiplying the annual mileage could do this by the specific fuel consumption of each type of HGV or vehicle combination. This method, however, cannot take into consideration short-term alterations in the vehicle configuration (such as driving without the trailer). Refunding would have been easy to implement in circumstances of a harmonised European diesel tax or in a situation with minor differences between Member States. The fact that the highest tax level in EU15 is more than twice that of the lowest makes things more complicated.

High tax Member States will lose if the refunding is based on the tax difference in the country where the vehicle is registered. Hauliers filling up a large part of their fuel in high tax countries are not likely to agree with a system based on average differences. The conclusion is that refunding cannot be used unless the existing large differences are made smaller by a substantial increase in the common European minimum rate. The alternative of refunding hauliers on the basis of receipts from filling stations in different Member States would probably be regarded as too bureaucratic as it involves a lot of paper work and reshuffling of money between countries. Things would become easier if a common European authority were to carry out the administration of the km charge. Such a body could also be commissioned to handle the refunding of part of the diesel tax.

The conclusion is that for the time being (with large differences in intra-European tax levels) the second option is to be preferred.

D. Road freight price elasticities

This annex contains a summary of a recent survey road on freight transport's own price elasticities.

Table 11 Own price elasticities of road freight transport per commodity, from Oum (1990)

Commodity	most probable value (negative values)
Chemicals	1,0-1,9
metal products	0,3-1,1
agricultural products	0,7-1,0
Machinery	0,1-1,2
paper, plastic, rubber	1,1-3,0
liquid fuels	0,5-0,7
stone, clay, glass	1,0-2,2
Vehicles	0,5-0,7
wood and wood products	0,1-0,6
aggregate, incl. substitution (modal shift)	0,7-1,1
aggregate, excl. Substitution (modal shift)	0,5-1,0

The results of two Danish studies from 1997 en 1999 |Bjørner and Jensen| are given in Table 12. Their second study starts with the assumption that price rises are implemented per vkm, which is of particular interest to the study at hand. Elasticities are split per vkm and tkm.

Table 12 Own price elasticities of Danish road freight transport from two Danish studies |Bjørner and Jensen|.

Sector	% of tkm	study 1997	study1999[b]	
		tkm	tkm	vkm
Industry	29	-0,6		
Construction	16	[a]-0,5		
Trade	37	[a]-1,0		
Services	6	-2,4		
Total	100	-0,9	-0,47	-0,81

[a] Statistically not significant.

[b] Sensitivity of freight transport by large HGVs for price increases per vkm. The elasticity for tkm is lower than for vkm, as shippers and hauliers will avoid part of the charge by increasing the amount of tonnes transported per vkm (increase of the load factor).

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About this report

In its White Paper on Fair Payment for Infrastructure Use the European Commission has identified a kilometre charge as the most appropriate instrument for making heavy goods vehicles (HGVs) pay their true costs. This report explains how such a km charge, differentiated for vehicle weight and environmental damage, could be introduced by individual Member States. It highlights the importance of allowing the km charge to cover the total road network of a country rather than just its motorways. To reflect the true costs and have any chance of influencing behaviour, the charge should be set at levels considerably above the current vehicle taxes and the Eurovignette.

The report says the km charge regime should in the longer term be extended to cars and HGVs below 12 tonnes. The authors do not find it necessary to harmonise the charge levels but they see an urgent need for technical harmonisation. With much of the necessary vehicle classification already covered by an existing proposal for EU legislation, this paper puts forward a realistic framework for a fair and efficient pricing of road transport.

About T&E

The European Federation for Transport and Environment (T&E) is Europe's primary non-governmental organisation campaigning on a Europe-wide level for an environmentally responsible approach to transport. The Federation was founded in 1989 as a European umbrella for organisations working in this field. At present T&E has 35 member organisations covering 21 countries. The members are mostly national organisations, including public transport users' groups, environmental organisations and the European environmental transport associations ('Verkehrsclubs'). These organisations in all have several million individual members. Several transnational organisations are associated members.

T&E closely monitors developments in European transport policy and submits responses on all major papers and proposals from the European Commission. T&E frequently publishes reports on important issues in the field of transport and the environment, and also carries out research projects.

The list of T&E publications in the annex provides a picture of recent T&E activities.

T&E member organisations

Aksjon Naermiljo og Traffikk (Norway)
Associació per la Promoció del Transport Públic (Spain)
Associación Ecologista de Defensa de la Naturaleza (Spain)
Aviation Environment Federation (UK)
Cesky a Slovenský Dopravní Klub (Czech and Slowak Republics)
Danmarks Naturfredningsforening (Denmark)
Environmental Transport Association (UK)
Estonian Green Movement (Estonia)
Fédération Nationale des Associations d'Usagers de Transports (France)
Gaja Network (Slovenia)
Gröna Bilister (Sweden)
Groupement des Usagers des Transports Intercommunaux Bruxellois (Belgium)
Komitee Milieu en Mobiliteit (Belgium)
Liikenneliitto (Finland)
Magyar Közlekedési Klub (Hungary)
Norges Naturvernforbund (Norway)
Polish Ecological Club (Poland)
Pro Bahn (Germany)
Pro Bahn Schweiz (Switzerland)
Quercus (Portugal)
Society for Nature Protection and Eco-development (Greece)
Romanian Traffic Club (Romania)
Stichting Natuur en Milieu (Netherlands)
Svenska Naturskyddsföreningen (Sweden)
Transport 2000 (UK)
TRANSFORM Scotland (UK - Scotland)
Verkehrsclub Deutschland (Germany)
Verkehrsclub Österreich (Austria)
Verkehrsclub der Schweiz (VCS/ATE/ATA) (Switzerland)

<u>Associate members</u>
Alpine Initiative
BirdLife International
Community of European Railways
European Cyclists' Federation
International Union for Public Transport
Worldwide Fund for Nature