Incentives in Action

Analysis of the role of incentives in road transport

Scientific study

CE Delft

IRU International Road Transport Union

Publication Data

Bibliographical data:
B.E. (Bettina) Kampman, N.D. (Max) Smith, B.H. (Bart) Boon
Incentives in action
Analysis of the role of incentives in road transport
Scientific Study
Delft, CE, 2004

Road Transport / Incentives / Effects / Analysis / Regulation / Pricing / Behaviour / Education

Publication number: 04.4334.24

CE-publications are available from www.ce.nl

Commissioned by the International Road Transport Union
Further information on this study can be obtained from the contact person Bettina Kampman

CE

Solutions for environment, economy and technology

CE is an independent research and consultancy organisation specialised in developing structural and innovative solutions to environmental problems. CE's solutions are characterised in being politically feasible, technologically sound, economically prudent and socially equitable.

CE Transform

Visions for sustainable development

The business unit CE Transform provides advice and support to business and government in implementing changes towards sustainable development.

For the latest information on CE check out our website: www.ce.nl.

This report is printed on 100% recycled paper

Contents

1 Introduction

1.1 Project background and objectives

In 1996, the International Road Transport Union's Member Associations adopted a ‘Charter for Sustainable Development’, with which the road transport industry committed itself to a proactive approach towards achieving sustainable development. One year later the IRU presented a strategy to this end, keyed to the ‘three i's’ of innovation, incentives and infrastructure.

In 2002 the IRU issued a report on innovative Best Industry Practices (BIP) in Road Transport, the first of these ‘i's’ [IRU, 2002]. The report sets out a variety of BIP in pursuit of sustainable development, ranging from Environmental Management Systems to driver training and from vehicle technology to improved logistics. As these examples illustrate, there are a wide range of options open to road haulage companies seeking to improve their environmental performance. A second edition of this report was recently published [IRU, 2004].

The IRU now intends to extend its knowledge on what it considers the second prerequisite for sustainable development: incentives. In the road transport context, incentives can be described as engagement by governments to encourage accelerated introduction by transport operators of best available technology and practices.

For hauliers, improving the environmental performance of their vehicle fleet generally means making investments. In some cases these investments will be financially justified by the benefits arising in the form of fuel savings, superior logistics or an improved corporate image, say. When the benefits accrue mainly to society as a whole, though, as with investments in trucks complying with a stricter ‘Euro’ emission class than legally required, hauliers are generally reluctant to implement best practices. Although the economy, the environment and society will all benefit from the reduced pollution, i.e. better air quality, resulting from these investments, haulage companies will see no tangible return on their investments. In such cases it is therefore up to governments to create incentives that make it worthwhile for hauliers to invest in the technologies in question.

Most European countries have therefore introduced true incentives to encourage and help the road transport sector reduce its environmental impact, over and above such familiar regulations as the ‘Euro’ system of emission classes, night-time driving bans and so on. These may be monetary incentives, as in the case of a lower road toll tariff for cleaner trucks or differentiation of vehicle excise duty according to vehicle CO_2-emissions. Alternatively, they may be non-monetary incentives, as with the Ecopoints system regulating the number of transit trips made through Austria, whereby cleaner trucks require less points, or an exemption for cleaner trucks from driving bans in city centres. A third type of incentives is education and awareness-raising, aimed at behavioural change.

Almost every European country has its own incentive scheme in place to reduce the environmental effects of road transport and promote best practices in the sector. In the coming years a number of new incentives will come into force, among them a road pricing scheme in Germany in which tariffs are indexed to the 'Euro' emission class of a truck. As ever, some of these incentives will have more impact than others, on both the environment and haulage firms.

1.2 Study objectives

Against this background CE was commissioned by the IRU to carry out a study evaluating the effects and effectiveness of these government incentives, pursuing the following three specific objectives:

- To describe how the road transport industry is confronted with negative and positive government incentives aimed at promoting environmentally friendly vehicles, technologies and practices.
- To describe the effects and effectiveness of these incentives, focusing on effects on road transport performance, the environment and haulage operators.
- To provide arguments for incentives that both expedite the penetration of best industry practices and technology and have a positive effect on the road transport industry.

CE was also asked to provide recommendations on ways to improve existing schemes.

The scope of the project has been limited to incentives to the road transport sector designed to promote technologies that reduce vehicle emissions of air pollutants and/or CO_2. We have focused primarily, furthermore, on incentives in the ECMT countries[1].

[1] The European Conference of Ministers of Transport (ECMT) is an intergovernmental organisation established in 1953. It is a forum in which Ministers responsible for transport can co-operate on policy. 16 countries were founding members of the ECMT, but the number of members has increased since then. As of October 2003, there are 43 full Member countries, 7 Associate countries and 1 Observer country.

2 Incentives in road freight transport

2.1 Introduction

Governments seeking to promote best practices in the road transport sector have three basic types of policy to choose from:
1 Monetary incentives, i.e. pricing policies.
2 Non-monetary, regulatory incentives.
3 Education and awareness-raising aimed at behavioural change.

Each of these may help encourage best practices in road transport and thus reduce the environmental impact of the sector. They may encourage hauliers to go beyond what is legally required, improve their logistics, opt for low-emission technologies or fuel-efficient driving styles. The first two incentives provide monetary or non-monetary benefits that may make investments profitable for individual firms. The third kind of incentive seeks to promote best practices by improving hauliers' and other drivers' knowledge and awareness of best practices, thus to promote their use.

One example of a monetary incentive is differentiated road pricing, whereby trucks emitting less pollutants or CO_2 are charged less than comparable vehicles with higher emissions. A lower sales tax or annual vehicle tax on cleaner fuels or vehicles are other examples of pricing policies designed to promote the use of cleaner or more fuel-efficient vehicles.

Examples of non-monetary incentives include the Austrian Ecopoint system, which places restrictions on the number of transit trips made through Austria, the ECMT Multilateral Quota system, and exemptions to driving bans for cleaner or quieter trucks. These are all regulatory incentives that provide benefits to operators of cleaner trucks. Monetary and non-monetary incentives may have the same goal, for example to encourage hauliers to either buy a Euro 4 truck before it is made mandatory, or to replace trucks of a lower Euro class with higher Euro class vehicles earlier than they would have done otherwise.

Government promotion of courses in fuel-efficient driving ('eco-driving') or awareness-building aimed at behavioural change are examples of the third type of incentive. The difference between the three types of incentive is not always well-defined, however. For example, if driver training is promoted by a financial incentive, it may also be categorised as a pricing incentive. Nevertheless, in this report we categorise incentives aimed primarily at improving the knowledge base of the sector as non-monetary.

From the individual haulier's point of view we can furthermore distinguish between incentives having a positive financial impact on his business and those with a negative impact. The former help operators implement best practices and improve their environmental performance without increasing costs, as when lower vehicle taxes are levied on cleaner vehicles. 'Negative' incentives, in this context,

are frequently in the form of higher taxes, or charges or regulations that either restrict hauliers' operations or increase their operating costs. The Austrian Ecopoint system cited above is a case in point.

The diagram of figure 1 sketches the possible chain of effects of incentives in road freight transport.

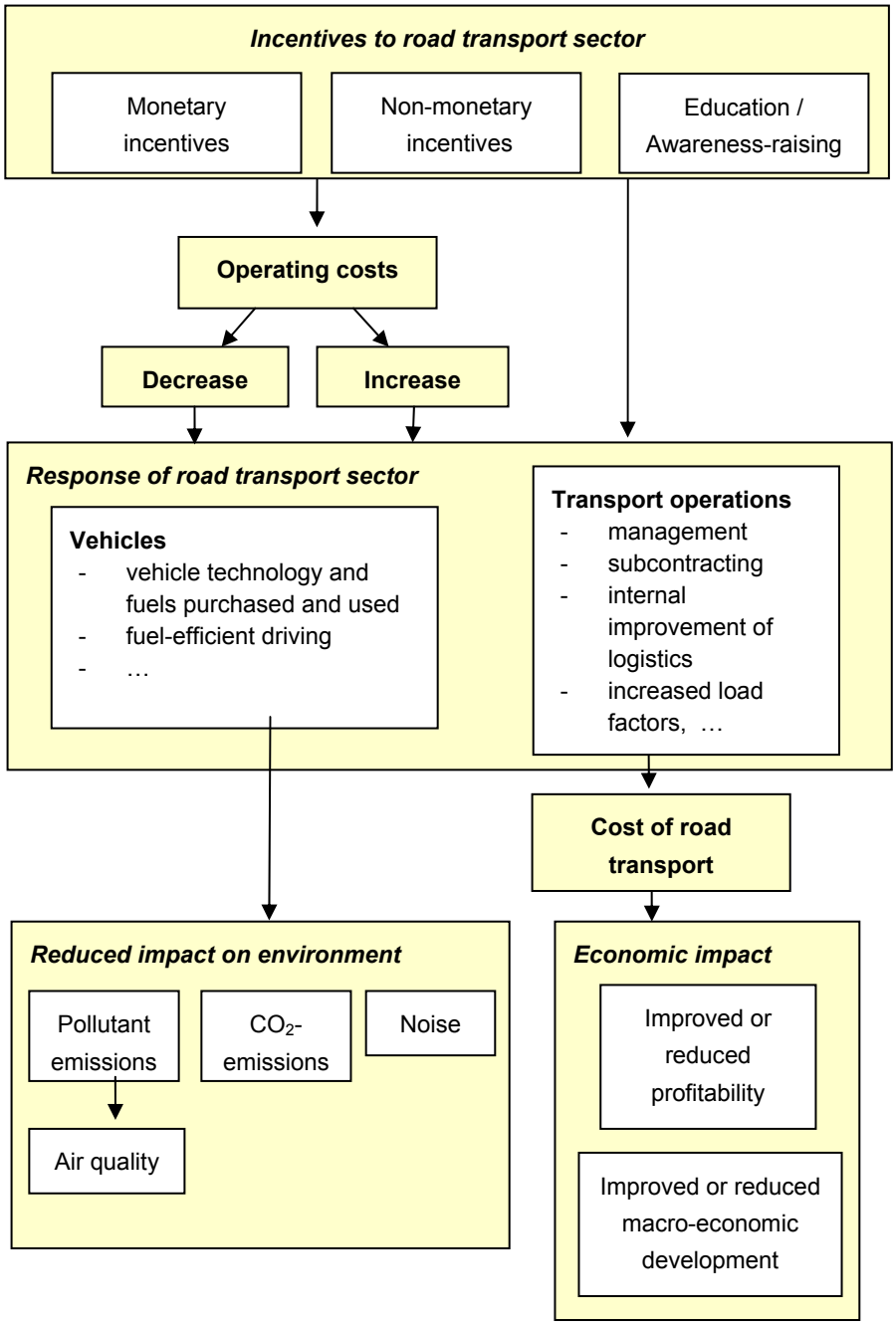
In the first place, many incentives will alter the operating costs of the individual haulier, leading to either a decrease or an increase, depending on the design of the incentive and, in many cases, the specifics of the individual haulage business. In some cases, however, costs will not be directly affected, as with incentives in the third category, above, and many direct financial incentives (for example, policies that compensate for the additional cost of a cleaner truck).

Hauliers may then respond to the incentive by opting for environmentally friendlier trucks, fuels or driving styles or by making operational changes. These responses will generally seek to minimise costs (or rather, maximise profits), with firms adapting operations to the new conditions. In the case of an incentive giving operators of cleaner vehicles an economic advantage, some hauliers will deem it economically attractive to buy and use these vehicles rather than dirtier ones, while others may prefer to cut their costs by subcontracting to hauliers operating cleaner vehicles.

The result is then twofold. First of all, if the incentive is effective the sectoral response will have positive environmental effects. Depending on the design of the incentive, air pollution, CO_2-emissions and/or noise nuisance will be reduced. Second, the cost of road transport will be affected. Individual hauliers will see their profitability either improved or damaged and there may also be macro-economic effects. Note that these cost changes are different from those resulting directly from the incentive, as overall sectoral response will itself also have an economic impact.

In the next chapter these responses and the effects of a range of incentives will be discussed in more detail.

figure 1 Schematic summary of the effects of incentives to the road transport sector



In the remainder of this chapter we first briefly describe how the information in this report has been compiled. We then review relevant EU policies and present the various incentives provided to the road transport industry in the ECMT countries. Subsequently, in chapter 3, we analyse the various effects of these incentives in greater detail.

2.2 Methodology

Considering the size of the road haulage industry, its importance to the economy as a whole and its wide range of economic, social and environmental impacts, we were surprised to make three unexpected discoveries: first, that incentives targeted at this sector are not as well documented as might be presumed; second, that quantitative information on their environmental and economic impact is very scarce; and, third, that a wide range of incentives are in force in the various European countries.

It would seem that the incentives and policies in question are not generally deemed of much international interest and are therefore not that well publicised in the international forums. This is unfortunate, for these national initiatives may provide good examples of effective incentives from which other countries can learn.

Against this background, a two-tiered approach to information gathering was adopted. First, an internet and literature search was conducted. Second, experts in various countries were consulted, among them representatives of several IRU Member Associations.

2.3 The EU policy context

In many cases national policies promoting best environmental practices in road freight transport are based on broad, EU-wide or even global initiatives.

- Many incentives aimed at promoting cleaner vehicles are designed either to promote development and earlier market introduction of vehicles conforming to future Euro emission classes or discourage use of vehicles of older Euro emission class; some even do both.
- EU member states have committed themselves to significantly reducing air pollution in the coming years (by 2010) and promoting cleaner heavy duty vehicles and discouraging older, dirtier models is one option for meeting these commitments.
- Policies intended to encourage use of cleaner fuels are often linked to EU fuel directives.
- Incentives that aim to reduce fuel consumption are often part of a broader national strategy to reduce greenhouse gas emissions under the Kyoto Protocol.

There are also a number of incentives scheduled to come into force in the coming years that have been developed in line with EU policies still in their infancy, among them those concerning harmonisation of prices and taxes and implementation of the ‘user pays' principle. These policies are only now beginning to have practical consequences and can be expected to gain in importance with time. In addition, the ECMT is also actively promoting greater EU-wide harmonisation of the tax *basis* as a precondition for any system of effectively targeted differentiated taxes. The 'polluter pays' principle has been endorsed and studies are in progress on the question of how marginal social costs can best be determined. In this respect the ECMT has recommended changes to fuel taxes as a means of combating CO_2-emissions and a shift from

national vehicle tax to territorial charges (distance-based charging, tolls, etc.) [ECMT, 2000a and 2000b].

At the European level it is probably the European Commission's Green Paper on 'Fair and Efficient Pricing' [EC, 1995] and it is White Paper on 'European Transport Policy for 2010: Time to decide' that have had the greatest impact on the environmental policy of the transport sector. These papers, which include the aim to internalise marginal social costs in the price of transport, appear to be the driving force behind incentives like differentiated road pricing, where pricing structures better reflect actual infrastructure usage by hauliers as well as the environmental damage caused by their vehicles. To this background, the European Commission has proposed to replace the present EU road tax directive (the 'Eurovignette directive') by a directive allowing and promoting distance-based charging and electronic kilometre charging for trucks [EC, 2003b]. Differentiation of road toll tariffs by Euro emission class, for example, will provide an incentive for the purchase and use of cleaner vehicles. As we shall see in the next chapter, the effects of this policy, in terms of the environmental performance of the transport system and the costs accruing to individual road hauliers, will depend on the precise design of the pricing system. In this context, many developments are mediated by technological advance, allowing for lower emissions and better enforcement of pricing without reducing traffic flow and with only modest implementation and operating costs.

Initiatives as the German plans for distance-based charge for heavy duty vehicles, in which tariffs are differentiated according to Euro-class, are in line with these developments. Austria has recently implemented its own distance-based charge, although it is not as well differentiated in environmental terms as the German plans. Switzerland already has a heavy duty vehicle tax in place on its entire national road network, differentiated according to kilometres driven, maximum permitted laden weight and Euro class. Differentiation is limited to Euro 0, 1 and 2 trucks, however, so that this system currently does not provide an incentive for Euro 3 and 4 vehicles. If distance-based charges indexed to vehicle environmental performance become widely implemented across the larger industrialised and haulage-dependent countries of Western Europe, in due course such schemes are very likely to be implemented in other European countries and regions, too, in particular in the Accession Countries and Southern Europe.

Other monetary incentives include differentiation of vehicle tax according to how clean a vehicle is (Euro class) and how damaging it is to the infrastructure (e.g. with or without air suspension). The British vehicle excise duty is a case in point and Sweden is also considering such a scheme. Other countries, including Germany, France and the UK, have policies promoting biofuels and alternative energy sources.

With the recent approval of the EU directive on biofuels [EC, 2003a], there are expected to be significant policy changes regarding these fuels in the coming years[2].

In some countries such as the Netherlands governments provide financial incentives that reduce the cost to operators of cleaner technologies and vehicles, through either tax benefits or incentives covering the additional cost of the item in question. In Finland, for example, incentives are being developed that are differentiated according to the CO_2 performance of vehicles and fuels. Several countries also provide financial incentives in other areas of environmental best practice, such as driver training (e.g. 'eco-driving' courses aimed at increasing fuel efficiency) or logistical advice on how to reduce the number of kilometres driven.

Industry standards such as those covering emissions (Euro class) and fuels (such as the sulphur directive) are aimed at encouraging, or rather obliging, transport businesses to use environmentally superior technologies. However, even though these standards give the road industry a major impulse to improve its environmental performance, we do not consider them here as incentives to implement best practices. As already mentioned, though, these standards provide governments due scope for creating these kinds of incentive by differentiating taxes or introducing suitable regulations.

In table 1 the current EU legislation having a bearing on national policies concerning air pollution and road vehicle emissions is listed. Due knowledge and awareness of developments at the EU level is an essential prerequisite for understanding standing policies in this area and anticipating on changes in the future.

[2] This directive calls for biofuels to be promoted by EU member states and sets indicative targets of 2% biofuels in 2005 and 5.75% in 2010. In 2004 all EU countries are to lay down and report on their national targets and on the policies to be implemented to achieve them.

table 1 Recent EU directives relating to air quality and road vehicle emissions

Directive	Regarding
Air Quality	
2001/81/EC	National Emission Ceilings (NECs) for certain pollutants, sets upper limits for each Member State for total emissions in 2010 of SO_2, NO_x, VOCs and ammonia
1999/30/EC	Limit values for NO_x, SO_2, Pb and PM_{10} in ambient air
2000/69/EC	Limit values for CO and benzene
Road Vehicles	
88/77/EC and its amendments (latest: 1999/96/EC)	Emissions of heavy-duty motor vehicles (incl. Euro classes)
Automotive fuel quality	
98/70/EC	Quality of petrol and diesel fuels and amending Council Directive 93/12/EEC
2000/71/EC	Fuel quality measuring methods
Sulphur content of liquid fuels	
1999/32/EC	Reduction of sulphur content of certain liquid fuels
Promotion of biofuels	
2003/30/EC	Promotion of biofuels

In the following sections we briefly review the most relevant monetary and regulatory incentives in force in Europe.

2.4 Monetary incentives

The principal pricing incentives applied by governments in the ECMT countries are listed in table 2, below. A more detailed description of these incentives is provided in annex A, while their effects and effectiveness will be discussed in some detail in chapter 3.

table 2 Monetary incentives in force in ECMT countries

Monetary incentive		**Country or region**[1]
Charging.	Time-based: Eurovignette.	Belgium, Denmark, Germany, Luxembourg, Netherlands, Sweden.
	Distance-based.	In force: Switzerland and Austria Scheduled: Germany, UK Under investigation: Finland, Netherlands, Sweden.
Differentiated fuel tax on diesel.	50 ppm sulphur fuels.	Tax incentives introduced by Denmark, Finland, Norway, Poland Belgium, Germany, UK, Netherlands [ECMT, 2001c].
	10 ppm sulphur fuels.	Tax incentives in place in Sweden (since 1991), Switzerland, Germany.
Tax incentives for alternative fuels that reduce *polluting emissions.*		Lower fuel tax on LPG and natural gas, e.g. in the Netherlands; subsidies for vehicles using such fuels.
Monetary incentives for renewable fuels that reduce *CO_2-emissions*.		In force in several EU countries, e.g. Germany, under consideration in all others is following implementation of Biofuels directive [EC, 2003a].
Differentiated sales or vehicle tax according to environmental class.		Under consideration: Finland, Sweden, Switzerland, UK.
Differentiated sales or vehicle tax according to CO_2-emissions.		Under consideration: Finland, Switzerland .
Financial incentives for clean, quiet or fuel-efficient vehicles or technologies.		In force: Netherlands.

Note 1: Countries and regions where specific incentives are known to be in place or scheduled.

As already mentioned, there is a clear trend towards road tolls based on distance rather than time. Although the charging systems currently in place or under development are all scheduled to apply to both domestic and transit/international transport, there are inter-country differences relating to aspects like whether the system applies to the entire road network or motorways only and whether tariffs are based on Euro class or number of axles only.

In many cases, lowering taxes on 'cleaner' fuels (or raising them on ‘dirty’ fuels) is designed not only to provide an incentive to use cleaner fuels (with an immediate reduction of air pollution) but also to promote (more rapid) introduction of cleaner technology. For example, catalytic after-treatment of vehicle exhausts becomes more efficient as the sulphur content of diesel is reduced, resulting in lower emissions of NO_x and PM_{10}. For certain new technologies the availability of low-sulphur diesel may even be a prerequisite for market introduction.

The low-sulphur fuel initiative is thus a good example of how action at the EU level stands in complex inter-relationship with national and industry-specific actions. It is the availability of these fuels that is one of the key elements allowing present and future standards to be met, for example the Euro 4 (from 2005) and Euro 5 (from 2008) NO_x-emission limits. From these EU-level developments then

follow tax and other incentives developed and implemented by individual member states.

Other developments include policies to promote the use of biofuels and (bio)fuel additives. These fuels, produced from rapeseed, sugar, cereals and other forms of biomass, reduce the CO_2-emissions of the transport sector. Because of their higher cost, these renewable fuels are only likely to reduce the predominance of fossil fuels if specific policies are developed to promote them. Now that the European Parliament has approved a directive promoting biofuels in transport [EC, 2003a], significant fuel tax reductions are likely to be implemented for biofuels in most, if not all, EU countries.

The last three incentives cited in table 2 are aimed at the vehicles themselves rather than their operation or the fuel they use. If sales or vehicle taxes are differentiated according to environmental class or CO_2-emissions, the extra cost of cleaner vehicles will be compensated (at least partly) by a lower tax rate. Other financial incentives for cleaner or more fuel-efficient vehicles will have a similar effect.

Almost all ECMT countries have differentiated systems of fuel and vehicle taxation in place However, whereas at one time these were largely revenue-generating policies, given the price elasticity of transport and transport fuels, the reasoning behind them has evolved. Energy crises and fuel shortage threats have led to fuel conservation policies being implemented. In recent years the social costs of transport have come to be better understood and there is a growing awareness that a large proportion of these costs are not covered by user prices. This has led to a change in the rationale underlying pricing and fiscal incentives, with policies now increasingly aimed at implementing the ‘polluter pays' principle.

At the EU level there are several initiatives under development that will affect the kind of fiscal incentives implemented by member states in the coming years. These include the following:

- Harmonisation of vehicle and fuel taxes, one of the driving forces behind many EU initiatives and actively promoted by the ECMT (guidelines, initiatives, etc.) [EC, 2001; ECMT, 2000b].
- Guidelines on pricing policies, based on marginal social costs and/or air pollution, CO_2 [ECMT, 2000b; ECMT, 1998].
- Guidelines on implementation and taxation of biofuels for transport [EC, 2003a].
- Development of an emission trading system for greenhouse gases, to achieve Kyoto and, after 2010, post-Kyoto targets. When the European emission trading system comes into force in 2005, the transport sector will not yet be included, although it is expected that this will be remedied by the end of the decade [EC, 2003c].

2.5 Non-monetary incentives

When it comes to non-monetary government incentives, a distinction can be made between incentives that directly promote clean technologies and possibly have a major (often negative) impact on the haulage sector and incentives having less impact.

In table 3 the non-monetary incentives identified are reviewed, showing the supra-national body or country in which they are in force, scheduled or under consideration. Like table 2, this table does not report on the effects of the incentives or their respective pros and cons, which will be discussed in subsequent chapters. The list of countries shown is not intended to be exhaustive and is for illustrative purposes only. As mentioned in section 2.1, we have categorised incentives such as support for 'eco-driving' courses and awareness-building as non-monetary incentives, as their main aim is to transfer skills and knowledge. More detailed information on these incentives is provided in chapter 4.

table 3 Examples of non-monetary government incentives in force in ECMT countries

Non-monetary incentive	**Country or region**[1]
ECMT Multilateral quota.	ECMT.
Ecopoint system.	Austria.
Exemptions from traffic bans: weekends/nights, noise- and/or emission-related.	Very few local or regional exemptions to traffic bans in place.
Promoting 'eco-driving'.	Implemented: Finland, Switzerland, Netherlands.
Emissions testing: annually, spot checks.	Implemented: Switzerland, UK.
Promoting telematics and advanced freight logistics.	Finland.
Promoting modal shift to reduce emissions, through awareness-building, advice, research, etc.	Policies and/or strategies in many EU and ECMT countries. NB. Although policies promoting modal shift are often implemented as an environmental incentive, i.e. to reduce transport emissions, they do not always have such a positive environmental impact.
Promotion/stimulation of cleaner technology through awareness building, providing advice, research, etc.	Implemented: Switzerland, Netherlands Scheduled: Sweden.
Speed limiters and limits.	Speed limiters compulsory at EU level; speed limits set at national or local level.

Note 1: Countries and regions where specific incentives are known to be in place or scheduled. The list is most probably incomplete.

In table 4 the recent EU policy guidelines are listed, statements and directives that are expected to have an influence on non-monetary incentives to the road transport sector in the coming years.

table 4 A selection of general EU guidelines, directives or statements of relevance to road transport policies

Publication or guideline.	Country or region	Published	Planned
White paper on common transport policy • Promoting good practice, e.g. regular maintenance. • Promoting modal shift from road to rail or shipping. COM(2001) 370	EU	x	
Directive on the charging of heavy goods vehicles for the use of certain infrastructures. COM(2003) 448 final	EU		x
Treaties of Maastricht and Amsterdam: integration of environmental considerations into all other sectors.	EU	x	
Communication from the European Commission: A sustainable Europe for a Better World: A EU Strategy for Sustainable Development. COM(2001) 264 final	EU	x	

3 How incentives work

3.1 Introduction

Before analysing the effects of the various incentives in detail in the next chapter, we first provide some background information on:

- The general effectiveness of incentives.
- How incentives may be used to reduce the emissions or increase the fuel efficiency of heavy-duty road vehicles.
- The impact of increased costs on the road transport sector.

3.2 Effectiveness of incentives

In most cases a haulage firm implementing best environmental practices will have to invest in one form or another: in cleaner trucks of a higher Euro class, in improved logistics, in an eco-driving course, and so on. Some hauliers may decide to invest in better environmental performance because they consider it their responsibility to reduce their environmental impact. Most transport businesses seek a more tangible return on their investments, however, whether in the form of financial compensation, a permit to drive through environmentally sensitive areas, an improved image (public relations) or driver satisfaction.

The same also applies to vehicle manufacturers. Research and development on cleaner vehicles and engines and their ultimate market introduction involve very significant investments, which need to be justified on economic grounds.

For both hauliers and vehicle manufacturers, governments can provide (part of) the return on investment by implementing the kind of policy measures we here refer to as incentives.

Incentives to promote best environmental practices will therefore have the greatest effect when:

a The financial and commercial benefits are large enough in relation to the additional investments required.
b They are stable, i.e. there is little risk of early termination, due to a change of government or a budget cut, for example.
c They are established in a timely fashion.
d They affect a significant part of the market.

These are prerequisites for vehicle manufacturers to invest in research and development and marketing of new technologies and for road hauliers to invest in these new technologies.

3.3 Reducing emissions

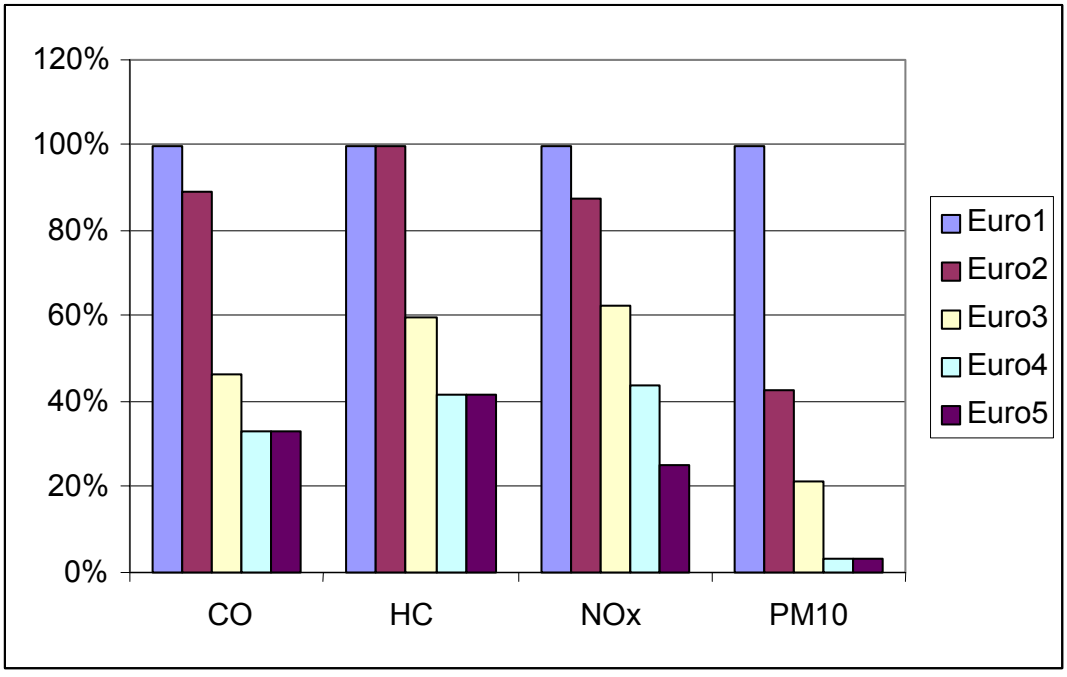
3.3.1 Reducing polluting emissions

Incentives can be based on polluting emissions such as NO_x and fine particles, as these emissions are measured during approval for conformity with Euro emission classes. For all heavy-duty vehicles in the EU, the Euro classification system provides a useful basis for differentiating incentives according to polluting emissions. An alternative is to use only part of the type approval test result as a basis for an incentive: NO_x-emissions, for example.

The first European emission class, Euro 1, was agreed on in 1988 and since then increasingly stringent emission classes have come into force. New vehicles must currently comply with Euro 3 standards, while Euro 4 will come into force in 2005 and Euro 5 in 2008.

In figure 2 below, the development of the emission classes for heavy-duty vehicles is shown for four polluting emissions: CO, HC, NO_x and PM_{10}. The emission standards have clearly been tightened significantly since Euro 1 (current new trucks must be Euro 3) and Euro 4 and Euro 5 will reduce emissions even further.

figure 2 Development of European emission standards for heavy-duty vehicles, as a percentage of Euro 1 class (ESC test, emissions in gram per kWh)

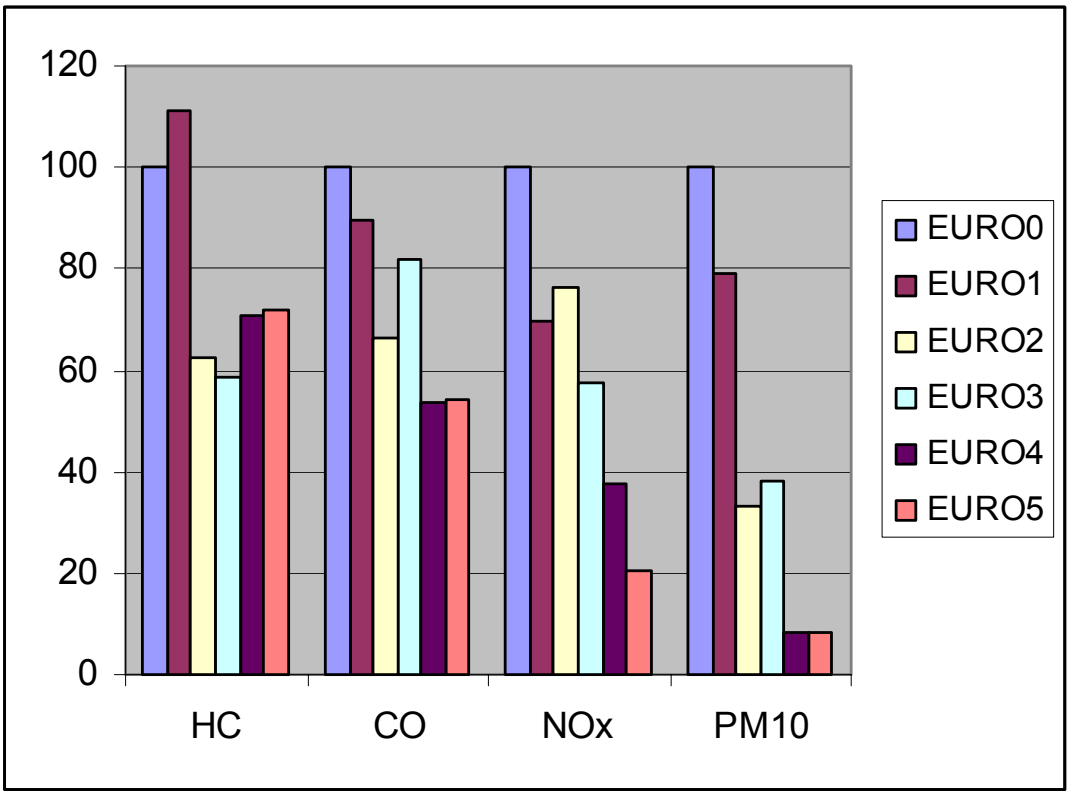


Source: European Commission.
NB: Data are for the steady-state test cycle (ESC) for engines > 85 kW. It is only PM_{10}-emission standards that differ for engines < 85 kW. From Euro 3 onwards, standards are also set for a transient test cycle (ETC), not shown here.

However, measurements have shown that under real-world conditions average emission factors differ significantly from those under test cycle conditions [GUT, 2003].

figure 3 compares actual emission factors under real-world driving conditions (i.e. average emissions per kilometre) of pre-Euro through Euro 5 trucks, for vehicles > 32 tonne. Clearly, very significant gains have been achieved, most notably with respect to emissions of PM_{10} (fine particles) and NO_x. However, the emission reductions are not as large as the emission standards suggest.

figure 3 Development of average emissions of a > 32 tonne truck under real-world driving conditions as a percentage of emissions of pre-Euro vehicles (Euro 0) (grams per kilometre)



Source: UBA, 2004. Data for Euro 0-4 vehicles are based on truck emission measurements under real-world driving conditions, data for Euro 5 are estimates. These emission factors have been derived for average driving conditions and used as input for the German emission registration. These trends have been confirmed by measurements by the Dutch research institute TNO [TNO, 2003].

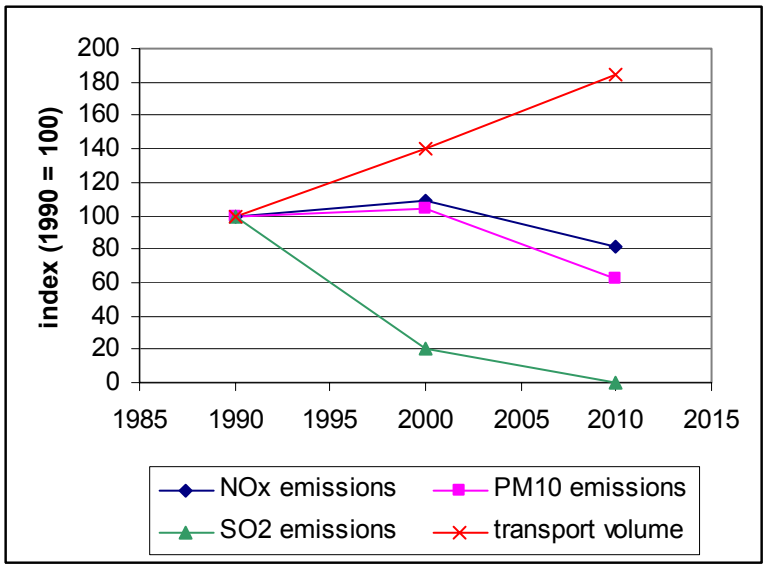
This graph illustrates that the system of emission standards, whereby emissions are measured during a predefined test cycle, has not been flawless. Only recently tests showed that, contrary to the intentions of the Euro standard system, the NO_x-emissions of Euro 2 trucks are actually higher than those of Euro 1 trucks under realistic driving conditions. This was not known at the time the Euro 2 standards were agreed upon and was of course not the intention of the European Commission.

The reason for this discrepancy between emissions standards and actual emissions is the following. Even though the test cycle was defined with the aim of deriving a representative emission factor, the number of measurements performed during the tests was found to be too limited and not sufficiently characteristic of actual driving conditions. This resulted in higher than expected NO_x-emissions, because of the trade-off between NO_x-reduction and fuel efficiency, which is typical for combustion engines: when diesel engines are tuned to lower their NO_x-emissions, fuel consumption increases. As fuel consumption is an important selling point for engines, they were tuned for lower NO_x-emissions only at the points of measurement defined by the Euro standards. On other points of engine operations, however, they were tuned to achieve optimum fuel consumption.

From Euro 3 onwards, a transient test cycle (ETC) has therefore been added to the steady-state test cycle (ESC) used for earlier Euro standards. As can be seen in figure 3, this has indeed resulted in the desired reduction of polluting emissions. As we shall see in the next section, this has led to a (small) rise in fuel consumption, as was to be expected.

Even though Euro 2 trucks have higher real-life NO_x-emissions than comparable Euro 1 vehicles, other pollutant emissions were indeed reduced under the Euro 2 standard - under actual driving conditions, too. These NO_x-emissions have been the only exception to the overall trend of emission reduction since the Euro system was put into place and they were effectively reduced with the Euro 3 and tighter standards. Overall, the Euro standard system has resulted in a very significant reduction in the pollutant emissions of heavy duty vehicles. This is illustrated in figure 4, in which the developments of the total pollutant emissions of road transport in the EU-15 countries are compared with the growth of road transport volume. Clearly, the total emissions of NO_x and PM_{10} have grown much less than the total volume between 1990 and 2000, and a decrease is expected in the coming years. The emissions of SO_2 have been reduced effectively by reducing the sulphur content of the fuel.

figure 4 Development of total emissions by road freight transport, in the EU-15 countries, compared with the development of the total road transport volume (in tonnekm)



Sources: EEA and Eurostat.

The following text boxes provide two examples of effects of incentives that promote the sales of vehicles with higher Euro class. The third text box illustrates that the effect of the Euro class system has not been limited to the EU member states, even though it is only mandatory within the EU.

Promoting the purchase of a Euro 4 instead of a Euro 3 truck

Purchase of a Euro 4 rather than a Euro 3 truck will reduce lifetime vehicle NO_x-emissions by approximately 42% and emissions of fine particles (PM_{10}) by about 80%.

If an incentive causes one thousand Euro 4 trucks of GVW < 10 tonne to be purchased rather than Euro 3 vehicles, savings of approximately 125 tonne NO_x and 5 tonne PM_{10} will be achieved (assuming an average of 75,000 km a year per truck).

For trucks of GVW > 20 tonne the environmental benefits are far greater, as both the absolute emission reduction and the distance driven are higher. With an average of 120,000 km a year, the savings amount to approximately 525 tonne NO_x and 23 tonne PM_{10} per year for every thousand Euro 4 trucks purchased instead of Euro 3 vehicles.

Environmental effects of early replacement of trucks

The average economic life span of a truck is 4 to 5 years. An incentive may make it profitable to replace a vehicle earlier than would be the case in its absence. This will generate environmental gains, as newer trucks comply with lower emission classes.

For example, if a Euro 1 truck of GVW > 20 tonne is replaced by a Euro 3 vehicle 120,000 km earlier because of an incentive, the environmental gains are the effects of driving 120,000 kilometres with a cleaner truck. If the incentive causes one thousand of these early replacements, the total emission reduction will be almost 180 tonne NO_x and 30 tonne PM_{10}.

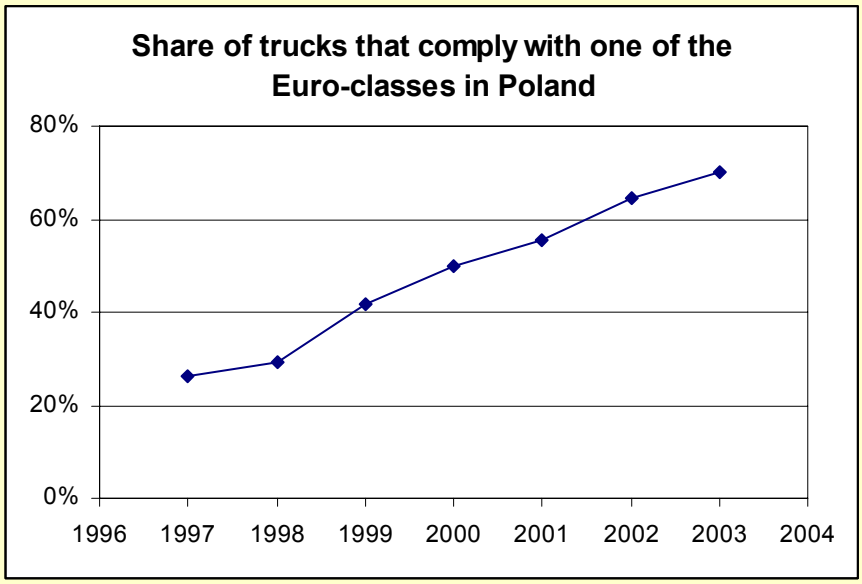
The environmental benefits will be far greater still if the Euro 1 trucks are replaced by Euro 4 rather than Euro 3 vehicles: over 600 tonne NO_x and 50 tonne PM_{10} will then be saved (again, assuming one thousand early renewals and 120,000 km per truck).

The environmental effect of an incentive like this will be greatest if older, more polluting vehicles are *permanently* removed from the fleet rather than that they continue operations for another company, as second hand vehicle. It is therefore relevant to consider what happens to these older trucks that are replaced by newer, cleaner ones. Export of the older trucks to countries with no, or less effective, incentives might be regarded as the export of pollution. This may be true if the exported trucks are used to expand the vehicle fleet of the country in question, however, it is not the case if they are used to replace even older, more polluting vehicles.

Euro classes - effects not limited to EU member states

The Euro classes are emission standards that must be met by all new vehicles sold in EU member states. At the same time, though, they have a significant impact beyond the EU, as illustrated in the following figure, which shows how the share of trucks in the Polish vehicle fleet complying with Euro class (Euro 1, 2 or 3) rose from 26% in 1997 to 70% in 2003.

This share is even higher for vehicles of over 20 tonne loading capacity, the trucks most frequently used for international transport: 84.6% of the total international fleet. For example, in August 2002 Euro class vehicles constituted 67.7% of the total fleet, while the share of Euro class vehicles in vehicles > 20 tonne loading capacity was 78.2%.



Source: Mrs. A. Pogonowska - Szuszkiewicz, ZMPD, Poland

3.3.2 Fuel efficiency and CO_2-emissions

Apart from polluting emissions such as NO_x and fine particles, vehicles emit CO_2, a major contributor to the enhanced greenhouse effect. The CO_2-emissions of trucks are directly proportional to the carbon content of the fuel burned and cannot be reduced by catalysts or filters, as with emissions like NO_x and PM_{10}. For every litre of diesel burned, 2.6 kg of CO_2 is emitted. Therefore, there are two options to reduce the CO_2-emissions of a truck: either the fuel efficiency can be improved (i.e. the amount of fuel used to transport a given load over a certain

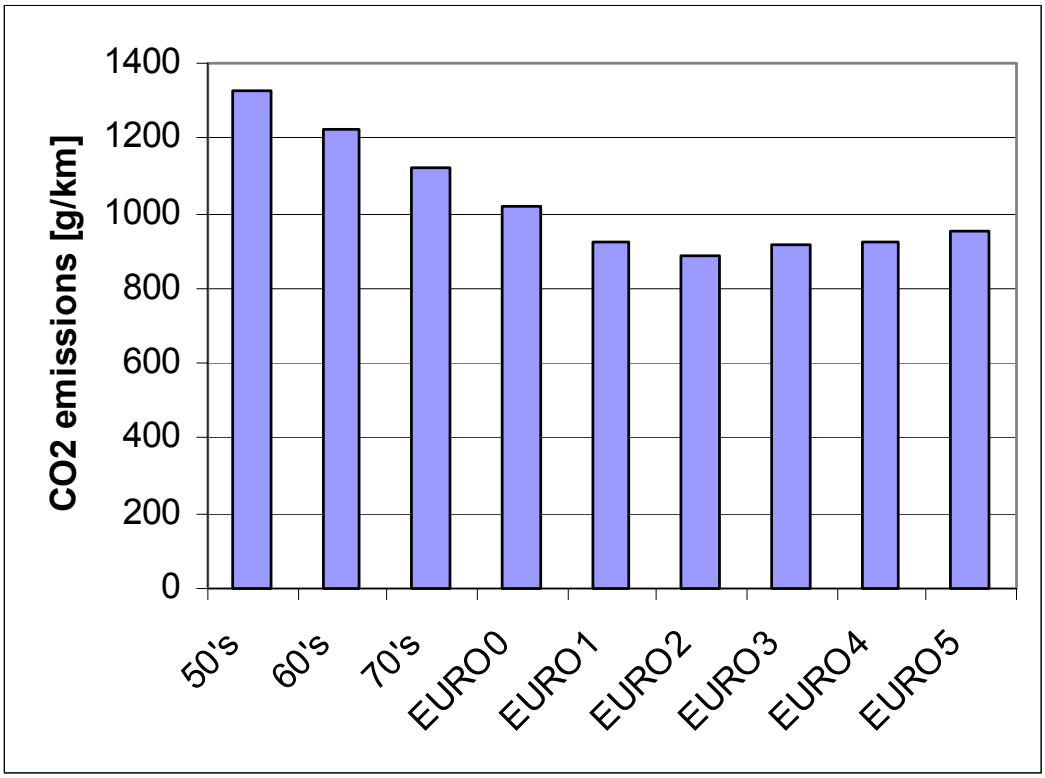
distance, expressed in litres/tonnekm), or renewable fuels like biofuels can be used[3].
There is no fuel efficiency or CO_2-emission test for heavy goods vehicles in place at the moment. Incentives cannot therefore be based directly on vehicle CO_2-emissions, as in the case of passenger cars.

Even though they are not generally considered environmental taxes, fuel taxes obviously constitute a government incentive to improve fuel efficiency. At present the only other way to encourage reductions of per-kilometre vehicle CO_2-emissions is through incentives like subsidised driver training ('eco-driving').

[3] Vehicles running on biofuels will emit the same amount of CO_2 as fossil-fuelled vehicles. In the first case, though, total (life-cycle) CO_2-emissions will be lower because the biomass from which the biofuel is produced absorbs the same amount of CO_2 during growth. The life-cycle greenhouse gas emissions of biodiesel are nonetheless non-zero, because of the emissions arising during biomass cultivation, production and distribution.

Measurements and model calculations by the University of Graz [GUT, 2003] show that the CO_2-emissions of trucks under real-world conditions have varied over the years, as shown in figure 5. Since CO_2-emissions are linked directly to fuel consumption, average fuel efficiency has improved significantly up to and including Euro 2 vehicles. Since then, however, fuel consumption has risen, because of measures implemented to achieve conformity with the Euro 3 standards. Fuel consumption is expected to rise even further when Euro 4 and Euro 5 standards come into force.

figure 5 Trend in average CO_2-emissions of a truck > 32 tonne under real-world driving conditions (gram/km)



Source: UBA, 2004.

As explained in the previous section, there is a trade-off between the NO_x-emissions and fuel consumption of diesel engines. Tightening NO_x-standards therefore leads to higher fuel consumption and thus to higher CO_2-emissions. Furthermore, Euro 4 standards for particles (PM_{10}) can probably only be met by equipping engines with particle filters, which will again increase fuel consumption.

This does not mean that manufacturers have not focused sufficiently on fuel efficiency. On the contrary, keeping CO_2-emissions fairly constant while drastically reducing polluting emissions has been quite an achievement. At the same time, economics has always been a strong driver of improvements in fuel efficiency.

Fuel efficiency reduces CO_2-emissions and costs

An example: if the fuel efficiency of 1,000 trucks with a GVW > 20 tonne driving 120,000 km/year with a fuel consumption of 1 litre per 3 kilometres is improved by 3%, 1.2 million litres of diesel will be saved per year (1,200 litres per truck). This reduces CO_2-emissions by a total of 3.1 ktonne a year. At a diesel price of € 0.70 exclusive VAT, this corresponds with savings of € 0.84 million a year (€ 840 per truck, exclusive VAT).

3.4 Effects of cost increases

Many of the incentives promoting best environmental practices push up the cost of road transport, which may have a negative economic impact on the sector. We can distinguish economic effects at two different levels: the road transport sector as a whole, where there may be an increase in average haulage costs, and individual haulage firms, some of whom may be adversely affected by a given policy measure, with others benefiting.

Just about every environmental incentive will lead to some increase in total haulage costs. Because cleaner vehicles are usually more expensive than their dirtier counterparts, incentives that effectively promote their use will increase the total (average) cost per vehicle and thus also the cost of transport. Depending on the type and design of the incentive, these additional costs will be paid for either by governments or by the transport sector. In the latter case, the incentive may improve the environmental performance of the road transport sector but at the same time affect it adversely in financial terms.

Some incentives may improve both the environmental and the economic performance of the haulage sector, though. Examples of these win-win situations are incentives to reduce the amount of water used for vehicle cleaning or those to boost fuel efficiency, by reducing the number of empty trips, for example, or teaching drivers a fuel-efficient driving style.

Faced with an increase in operating costs, road hauliers and shippers will often try to cut costs in response (see for example [NEI/CE, 1999] or [UBA, 2001]). The NEI/CE report describes and quantifies the likely responses, for the Dutch situation, in the case of a rise in fuel prices. That report shows that an increase in haulage costs has three effects: optimisation of efficiency, substitution and decline in demand.

a Efficiency effects

An increase in the cost of road transport will encourage hauliers to improve their transport efficiency. For example, hauliers may introduce logistical changes to increase vehicle loading and thus save trips. They may also replace smaller vehicles by larger ones, so that fewer trips are required. In general, efficiency improvements will reduce the number of vehicle-kilometres without reducing tonne-kilometres.

Depending on the reason for the cost increase, other efficiency measures may also be feasible. For examples, if the cost increase is indexed to the Euro class of the vehicle (with older, dirtier trucks having to pay more), there will be a shift to trucks of higher Euro class.

b Substitution effects

As efficiency improvements will not be able to compensate fully for the rise in costs, hauliers will still be faced with higher costs, which will be passed on to customers, at least in part. Shippers will then seek other options for transporting the goods in question. If the higher price of road transport makes other forms of transport (i.e. rail, waterway, air) more attractive, in terms of price and quality, some fraction of the goods transported will shift to one of more of these competing modes.

c Decline in demand

In cases where the first two effects do not sufficiently compensate for the higher costs, shippers may take other measures to avoid additional expenditure. For example, they may relocate production and distribution operations so that less transport is required. The result will be a decline in transport demand. Additionally, more expensive transport may increase the price of the goods being transported, causing a decline in consumer demand.

These effects occur irrespective of *how* the cost of road transport increases. Their magnitude will depend on the specific situation, including in particular the scope of shippers and hauliers for improving efficiency and the costs and characteristics of competing transport modes. Using price elasticities, however, the average effect of cost increases on transport volumes and distances can be calculated [NEI/CE, 1999]. The German Umweltbundesambt has estimated the effects of several possible designs of a road toll system in this way, concluding that a large fraction of the additional transport costs due to tolls will be compensated for by efficiency improvements. Substitution effects, i.e. a modal shift, are estimated to be very limited [UBA, 2001].

Many of these changes have positive environmental effects, as the UBA report also concludes. However, this is certainly not true of every modal shift and whether or not a given shift is of benefit to the environment depends on many factors, including the comparative environmental performance of the truck and the alternative, the detour required, the load factor and the characteristics of electricity production for railway transport. A recent comparison of the environmental performance of the principal modes of transport, for the years 2000 and 2010, can be found in [CE/RIVM, 2003]. A comparison of road transport and combined road/rail transport can be found in a recent study commissioned by the IRU [IFEU, 2002].

Owing to the above chain of effects, only part of the cost increase will lead to higher consumer prices. The negative impact on the economy will be even smaller. Studies show that these negative economic effects are limited [NEI/CE, 1999]: a transport cost increase of 5% will cause an average increase of product prices of at most 0.25%.

However, the adverse economic impact of a rise in costs may be far more significant for the road transport sector itself. For example, if the vehicle tax is differentiated by Euro class while keeping government revenue constant, the cost of operating older vehicles (Euro 0, 1 and 2) will increase. Hauliers with a relatively old vehicle fleet are then faced with a significant cost increase and a

depreciation of their fleet. The severity of the economic blow will depend largely on three factors: the quantitative cost increase, the scope for hauliers to avoid additional costs and/or the scope they have for passing extra costs on to customers without losing competitiveness. The latter two depend on the precise nature of the cost increase. For example, is it the same for all hauliers (including international competitors)?

Many of the incentives considered here grant a financial or non-financial benefit to hauliers operating cleaner vehicles. This gives them a potential competitive advantage. This will certainly be the case for hauliers for whom implementation of best environmental practices would also have been financially justified without the incentive. For others, the benefits will be smaller, as the incentives are required to offset the additional costs incurred.

Example: differentiated road use charge

The German infrastructure charge scheduled for introduction in 2005 will give cleaner trucks a financial benefit compared to more polluting trucks (this system is discussed in more detail below).

For 4-axled trucks complying with Euro 2 or 3 emission classes and driving 120,000 km per year on highways through Germany, the annual infrastructure charge will amount to € 14,400 in 2005. Trucks of the same size complying with Euro 1 class will pay € 16,800 toll for the same kilometres driven. The financial incentive for the Euro 3 trucks is thus € 2,400 per year.

This incentive will have the following effect on hauliers with Euro 1 trucks:

- Some hauliers will keep their Euro 1 trucks and be faced with a cost increase of 2,400 €/year compared to their competitors with Euro 2 or 3 trucks. For them, the cost of vehicle renewal will be greater than the incentive that is given.
- Some hauliers will replace (some of) their older trucks with Euro 2 or 3 trucks earlier than they would have done without the incentive. This will be the response of hauliers for whom this incentive of € 2,400 is enough to make an earlier replacement financially attractive.
- Hauliers operating a vehicle fleet comprising a variety of Euro classes will adapt their logistics such as to have mainly Euro 2 and 3 trucks operating on German highways, with Euro 1 trucks being used mainly for other trips.

Whether or not the rise in transport costs caused by an incentive is justified from a governmental (i.e. social) point of view depends primarily on the measure's cost-effectiveness, i.e. the ratio of social cost to environmental benefit. Costs to society often differ from costs to hauliers. Transport taxes and charges, for example, are not considered costs to society because they are simply a shift of money from hauliers to governments, after which they are still available to society. Costs to be considered in this context include the production costs of cleaner vehicles, investments in improved logistics, etc.

Ideally, governments compare the cost-effectiveness of policy options available for achieving sustainable development goals, allowing them to determine the most cost-effective option and implement a policy that is 'optimum' from an economic and welfare point of view. In practice, however, other criteria will also play a role, such as political or social considerations.

4 Effects of incentives

4.1 Introduction

As set out in the previous chapter, there are a wide variety of incentives in place promoting best practices and technologies in the road transport sector. In this chapter we examine the main kinds of incentive in greater detail, comparing their effects on:

- The environment.
- Government revenue.
- The road transport sector as a whole.
- Individual haulage firms.
- Spin-off (e.g. improved transport safety, more rapid penetration of new technologies in other sectors, new research opportunities).
- Acceptance by the industry and haulier experience.

Below, we consider the following nine types of monetary and non-monetary incentives.

Monetary:

- A road use charge differentiated according to emission class, based on:
  - time (e.g. Eurovignette).
  - distance (e.g. German or Swiss infrastructure charge).
- A sales or vehicle tax differentiated according to emission class.
- Financial incentives for clean vehicles or technologies, fleet renewal schemes.

Non-monetary:

- The multilateral ECMT quota system (differentiated according to Euro class).
- Ecopoints (differentiated according to Euro class).
- Exemptions from driving bans for cleaner or quieter vehicles.
- Promotion of 'eco-driving'.

This choice was motivated by the potential environmental and economic impact of the respective incentives on the haulage industry within the ECMT region.

We have thus included all the major incentives currently in place at the European and national level, as well as several more minor ones. All of them aim to improve the environmental performance of the road haulage industry by promoting best practices such as the use of less polluting vehicles or logistical optimisation. Some of the incentives have been in place for a while, while others are new or still under development, allowing us to assess whether current policy trends will benefit the environment as well as the haulage industry.

4.2 Differentiated road use charge based on time

4.2.1 Current policy

Since 1995, six European countries[4] have applied a time-based charging scheme for heavy goods vehicles on their motorways: the Eurovignette. Under this scheme, charges must be paid for all heavy goods vehicles and articulated vehicle combinations having a maximum permissible gross laden weight of 12 tonnes or more, and intended exclusively for the carriage of goods by road, regardless of whether or not they are laden[5]. Under European directive 1999/62/EC the Eurovignette tariff was indexed to the damage caused to the environment and road infrastructure. In 2003 the maximum annual charges were as shown in table 5. Hauliers may also choose to buy a Eurovignette that is valid for a week or a month, with a maximum charge proportional to the annual charge.

table 5 Maximum annual charge for Eurovignette, in € (2003)

Vehicle emission class	3 Axles maximum	4 Axles maximum
Euro 0	960	1,550
Euro 1	850	1,400
Euro 2 and newer	750	1,250

The Eurovignette does not distinguish between vehicles complying with Euro 2, 3 or 4.

The European Commission has recently issued a proposal to amend the aforementioned directive [EC, 2003].

A vignette system is also in place in Austria, the *Strassenbenützungsabgabe* (SBA). However, as the tariffs are not differentiated according to environmental performance, but only by gross vehicle weight, it provides no incentive to use cleaner trucks.

4.2.2 Effects of differentiated road use charge based on time

General impact

A time-based road use charge indexed to vehicle emission class can provide a monetary incentive for using cleaner vehicles and replacing older and more polluting vehicles with newer ones. In financial terms, hauliers gain directly by switching to cleaner vehicles, (part-)compensating them for any additional costs of that decision.

[4] The Netherlands, Belgium, Luxembourg, Germany, Denmark, Sweden and Austria.

[5] *Information on Time-Related Motorway User Charges for Heavy Goods Vehicles,* Federal Ministry of Transport, Building and Housing, Berlin, 2001.

The larger the reward for operating cleaner vehicles and the more Euro classes are included in the differentiation, the greater the likely impact of such differentiation. However, if the incentive is not large enough to compensate for the higher costs, charge differentiation will lead to higher costs for hauliers operating older, dirtier vehicles. In the case of the Eurovignette, hauliers receive a relatively small financial bonus of up to € 150 a year for replacing a Euro 1 vehicle with a Euro 2 or newer vehicle.

Time-based road charging also creates an incentive to plan transport more efficiently, as extra weeks or months on the road will cost more. However, it provides no incentive for driving less kilometres during the period the vignette is valid.

Environment

A vignette makes transport more expensive, thus providing an incentive to increase transport efficiency, as explained in section 3.2. Any optimisation of logistics or other improvements to transport efficiency will thus be rewarded financially in the form of a lower charge for road use. In itself, then, a road use charge based on time may well lead to environmental gains, as efficiency improvements will reduce the kilometres driven and therefore emissions of CO_2 and pollutants such as NO_x and fine particles.

If the tariff is further differentiated according to environmental (Euro) class, the transport sector has an additional incentive to improve the environmental performance of the individual vehicles used. Investments in cleaner vehicles can then be (partly) financed by the resultant savings on road tolls. Obviously, the ensuing environmental gains will depend on the height of differentiation and the range of environmental classes included. More specifically, differentiation can reduce emissions of NO_x, fine particles, hydrocarbons (HC) and CO.

If the vignette system also applies to foreign vehicles (as is currently the case), the incentive is not limited to the domestic fleet but also extends to international hauliers driving through or within the country in question. This obviously means a marked increase in the number of vehicles affected and therefore also greater environmental gains.

Unfortunately, the Eurovignette does not promote the use of Euro 3 or cleaner trucks, as costs are differentiated only from Euro 0 to Euro 2. The environmental benefits of the system can therefore clearly be improved by extending differentiation to higher Euro classes. After all, the NO_x-emissions of an average Euro 3 vehicle are approx. 20% less than those of a Euro 2 vehicle and PM_{10}-emissions approx. 12% lower.

Government revenue or costs

Every road charging scheme generates government revenue while at the same time placing a financial burden on the transport sector. However, *differentiation* of the charge according to Euro class does not necessarily affect total government income, as long as the average tariff is held constant.

As the vehicle fleet is continuously moving towards cleaner trucks, total revenue will decline over time if the differentiated tariff system is not adapted regularly. Keeping revenues constant therefore requires anticipation of fleet renewal and of the introduction of future emission classes. A good example of how this can be done is described in the next section, on the road toll system in force in Germany.

Since differentiated road pricing promotes accelerates fleet renewal (the extent in which this will happen will depend on the height of the financial benefits given), the average cost of road transport will rise, as explained in section 3.2. Governments may opt to cover (part of) these costs with a small decrease in tariffs.

Road transport sector

On its introduction, the Eurovignette increased costs for the road transport sector as a whole, as no other tax was concurrently reduced or abolished. However, the *differentiation* of the charge, creating the incentive to use cleaner trucks, did not have any additional impact on total sectoral costs. The situation was different for individual hauliers, however, as the actual cost to a haulier depends on the Euro class of his vehicles and whether or not they are driven in the countries where the vignette applies.

As a result of accelerated fleet renewal, there will be a slight increase in the average cost of road transport. In the case of the Eurovignette this effect is expected to be limited, however, as tariff differentiation is limited in height and extent. It does nothing to promote purchase of the more expensive, cleaner vehicles complying with the Euro 3, 4 or 5 standards. Thus, hauliers are encouraged only to replace a Euro 0 or Euro 1 vehicle by a (used) Euro 2 vehicle. Furthermore, the maximum bonus under the Eurovignette scheme of € 150 a year is relatively small compared to the cost of truck replacement.

Haulage firms

Within the road transport sector, differentiated road use charge based on time may cause a shift of volume from hauliers operating older, more polluting vehicles to those with cleaner vehicles, as the latter will have a (small) financial benefit compared to the situation without the Eurovignette. Hauliers with dirtier vehicles have due scope for reducing this impact by opting for cleaner vehicles. However, whether or not this is an economic option will depend on the position of the individual haulier and on the degree of tariff differentiation.

This incentive will have a negative impact on the profitability of those transport firms faced with a cost increase, in this case hauliers with older, dirtier trucks. In the longer term these additional costs will generally be passed on to customers and eventually added to the prices of the products transported. However, under a differentiated charge scheme hauliers with dirtier vehicles will probably have difficulty passing on the additional costs to customers, for competitors with a cleaner vehicle fleet face no cost increase.

As the road use charge under discussion applies to *all* vehicles driven on a country's roads, it gives no competitive advantage to either national or international haulage firms. It may, however, impact negatively on competition with other transport modalities if it causes an increase in road transport costs, as described above.

Spin-off
If the tariff is sufficiently differentiated according to existing and future Euro classes, a road use charging scheme will promote faster penetration of new technologies. This is not the case with the current Eurovignette, however.

Acceptance by the industry and haulier experience
A differentiated system of road charging, whether based on time or distance, is generally accepted by the road transport industry as long as the average cost of road transport does not increase. A small decrease to compensate for the additional cost of the environmental measures will help avoid any competitive disadvantage relative to other modalities and therefore increase acceptance by the industry.

4.3 Differentiated road use charge based on distance

4.3.1 Current policy

In several EU member states governments are working on the transition from road use charging based on time to charging based on distance. As explained in the previous chapter, this is encouraged by the 1995 EU Green Paper on Fair and Efficient Pricing [EC, 1995]. The amendments to the Eurovignette proposed recently by the European Commission [EC, 2003] also encourage linkage of tolls to distance travelled, location and emissions, among other factors.

A road toll for heavy goods vehicles is currently in place in Switzerland, the *Leistungsabhängige Schwerverkehrsabgabe* (LSVA). Austria introduced a distance-based toll at the beginning of 2004, while Germany is now planning to start its 'Maut' scheme in the beginning of 2005. In other countries such as the Netherlands, governments are also considering implementing this kind of system in the longer term.

Switzerland[6]
The LVSA scheme introduced in Switzerland on 1 January 2001 requires trucks to pay a fixed toll per vehicle tonne-kilometre. In brief, the system comes down to the following:

- The basic objective of the system is to implement the 'user pays' and 'polluter pays' principles. In addition, Switzerland will use the revenue to pay for investments in rail infrastructure, as a means of achieving a modal shift from road to rail.

[6] Source: www.bav.admin.ch.

- The toll is indexed to environmental class: Euro 2 or cleaner vehicles pay least, Euro 0 and no Euro classification the most. In the future the toll rate will be adapted to changes in the vehicle fleet, so that the total revenues remain constant. In the future (expected: 2005) Euro 4 and 5 will become the cheapest categories.
- The toll is levied on all Swiss roads.

Parallel to introduction of the LVSA, the weight limit for heavy goods vehicles was increased, from 28 to 34 tonnes in 2001 (and to 40 tonnes in 2005).

Germany
Germany is planning to introduce a toll system for heavy goods vehicles in 2005. In brief, the main elements of this system are the following[7]:

- The objectives are:
  - To bring the system of infrastructure funding into line with the 'user pays' principle.
  - To establish fairer conditions of competition for road and rail transport.
  - To bring in additional revenue for maintenance and upgrading of roads, railways and waterways.
  - To play a pioneering role in this field of technology in Europe and worldwide.
- The toll rate is differentiated according to the vehicle's number of axles and emission category, with an average toll rate of 12.4 €ct/km.
- The toll is levied on motorways only.
- The toll system is limited to heavy goods vehicles with a gross weight in excess of 12 tonne.
- Coaches are exempted from the toll (as well as certain other categories such as police and military vehicles).
- When the toll system is introduced, the Eurovignette will no longer be required in Germany.

The tariffs will be as shown in table 6, the environmental classification system as shown in table 7. Clearly, cleaner trucks will benefit from lower tariffs, thus rewarding hauliers for investments in cleaner trucks. The categories are to be redefined over time so that the lowest tariffs of category A are always reserved for vehicles complying with more stringent emission classes than required at that time for new vehicles.

table 6 Proposed tariffs for German toll system for trucks in €/km

Category	Vehicles with 3 axles	Vehicles with 4 or more axles
A	0.09	0.10
B	0.11	0.12
C	0.13	0.14

[7] Source: German Ministry of Traffic, http://www.bmvbw.de/LKW-Maut-.720.13835/Facts-about-the-toll-system-for-heavy-goods-vehi.htm.

table 7 Definition of categories used in German toll system

Category	Until 30 September 2006	1 October 2006 - 30 September 2009	From 1 October 2009 onwards
A	S 4[1], S 5 and EEV class 1	S 5 and EEV class 1	EEV class 1
B	S 3 and S 2	S 4 and S 3	S 5 and S 4
C	S 1 and no S-class	S 2, S 1 and no S-class	S 3, S 2, S 1 and no S-class

[1] S1 - 5 are emission classes in line with Euro classes 1 - 5. EEV = Environmentally Enhanced Vehicles, an optional emission standard that is stricter than Euro 5.

Austria

On 1 January 2004 Austria implemented a road toll system that differs somewhat from the planned German system. Its main features are as follows:

- Toll is levied on all vehicles with a gross weight in excess of 3.5 tonne and on all national motorways (*Autobahnen* and *Schnellstrassen*).
- Tariffs are differentiated only according to number of axles:
  - 2 axles: 0.13 €/km.
  - axles: 0.18 €/km.
  - axles: 0.27 €/km.

  The average toll is approximately 22 €ct/km.
- Apart from this standard tariff, an extra toll must be paid on certain specific roads, the so-called *Sondermautstrecken*.

As such, this toll system currently provides no incentive for using cleaner vehicles. It does, however, promote more efficient vehicle usage, as it increases the kilometre cost.

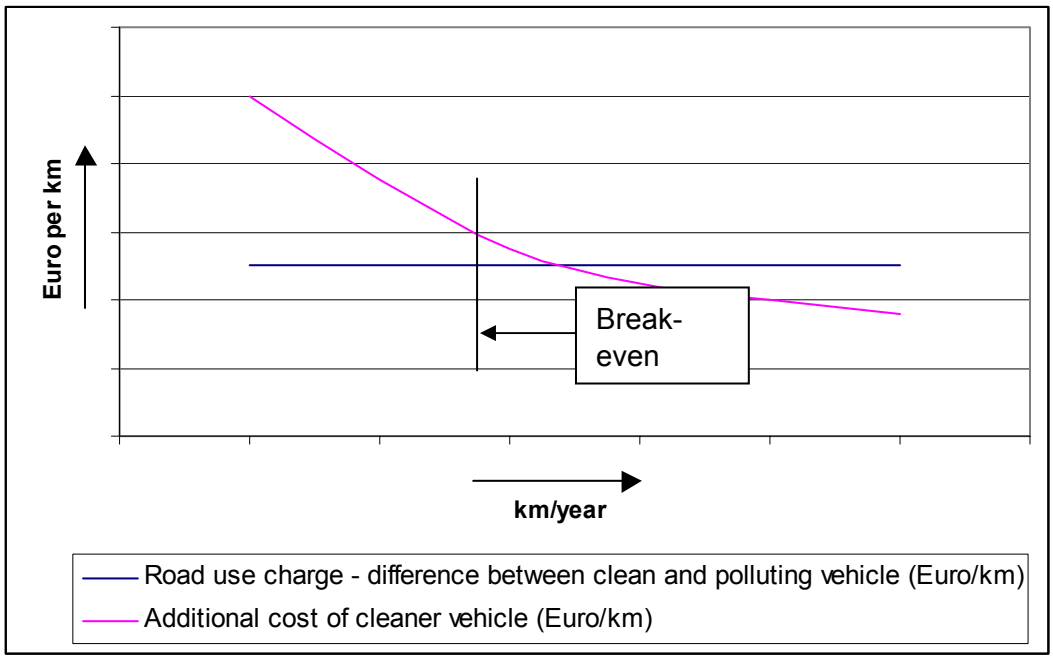
4.3.2 Effects of differentiated road use charge based on distance

General impact

A differentiated road use charging system based on distance is generally considered to have greater environmental benefits than one based on time, as it establishes direct linkage with the kilometres driven and therefore with the pollution caused. Under this kind of scheme, vehicles that are driven less and/or are cleaner pay less tax than those that are driven more or pollute more. Most experts and other parties to the debate consider this to be a fair pricing system, at least when applied to *all* road users and to *all* modes of transport [EC, 2003] [TLN, 2002]. If competitive modes are not obliged to pay for the pollution they cause, the system will give them a competitive advantage that will have negative economic implications for the road transport sector. It may also have a negative environmental effect, as the resultant shift of goods to other transport modes will not be based on environmental considerations.

A differentiated road charge based on distance driven provides a direct and effective means of implementing the 'polluter pays' principle. As the financial consequences depend on kilometres driven, it creates a very direct incentive to optimise transport efficiency and provides the greatest incentive to those vehicles that are driven most. Both these effects increase policy effectiveness.

figure 6 Illustration of the incentive created by a road use charge. If the kilometres driven are higher than the break-even point, it is financially attractive to invest in a cleaner vehicle



The road use charge itself encourages and rewards hauliers who improve their transport efficiency (by increasing load factors, for instance). If the charge is differentiated according to vehicle emissions, for example by Euro class, it provides a clear incentive to shift transport volume to cleaner, less polluting vehicles.

Environment

A road pricing incentive based on distance will generally have a positive environmental impact, as it makes transport as such more expensive and thus provides an incentive to reduce transport volume (see figure 1 in section 2.1). This will reduce road transport emissions of both CO_2 and air pollutants (NO_x, fine particles, etc.). The exact magnitude of these cuts will depend on whether or not other taxes are reduced concurrently to compensate for introduction of the road toll.

If the tariff is additionally differentiated according to environmental class, the environmental gains will be even greater, as an incentive to use cleaner vehicles is also provided [UBA, 2001]. Investments in cleaner vehicles can then be (partly) financed by the ensuing savings on road tolls (see the text box in section 3.4). In

addition, hauliers with vehicles in the lowest Euro classes have a greater incentive to reduce their kilometres than those with cleaner vehicles.

Obviously, the environmental impact depends on the extent of the differentiation and on the range of environmental classes included. In the case of the German Maut scheme, the full range of possibilities for differentiation has been implemented: tolls are differentiated according to old, current and new Euro classes. Vehicles complying with future emission classes pay less than those complying with recent classes (currently Euro 2 and 3) and vehicles polluting more pay the most. The higher costs of cleaner trucks can thus be (partly) recovered. As foreign vehicles pay the same toll as German vehicles, the system will also provide an incentive to foreign hauliers to use cleaner trucks when driving through or within Germany.

The environmental impact of a road toll will depend, furthermore, on the scope of the system: does it apply to all roads or only to highways, and does it apply to all vehicles or only to some fraction?

For example, the German Maut system is limited to highways and to trucks with a minimum gross weight of 12 tonne. The first restriction has a negative environmental and health impact, as it encourages the use of secondary (non-highway) roads, which are often located closer to (or go through) areas where more people are generally affected by the polluting emissions than on the highways [UBA, 2001]. On average, this effect is estimated to be approximately 2 to 4%, but it could be more significant in certain specific areas[8]. The restriction of the system to trucks > 12 tonne obviously means that it provides no incentive to improve the environmental performance of vehicles < 12 tonne.

Both these restrictions are in line with the current EU Eurovignette directive 1999/62/EC. The proposed amendment to this directive aims to broaden the scope, however, by allowing road pricing for vehicles down to 3.5 tonne as well as tolls on trunk or main roads closely matching a motorway route. This would clearly increase its positive environmental impact.

In Austria no differentiation is scheduled according to Euro class, although this is expected to be introduced at a later stage. The Swiss LVSA system differentiates according to Euro classes 2, 1 and 0 only, which will have some positive environmental effect. However, this could be improved if differentiation would be extended to the much cleaner Euro 3, 4 or 5 vehicles.

[8] Source: http://www.bmvbw.de/LKW-Maut-.720.htm and [UBA, 2001].

Effects of the LSVA

The Swiss LSVA was introduced in 2001, at the same time as an increase in the weight limit for heavy duty vehicles, from 28 to 34 tonnes. The effects were recently evaluated [Rapp, 2003]. As the policies were implemented concurrently, it is difficult if not impossible to define what share of the effects is due to the differentiated road toll. Overall, though, the following effects were reported:

- Renovation of the truck fleet. In the year before the system was introduced, total truck sales increased by 45%. As expected, with a higher weight limit imminent, there was a marked increase in sales of vehicles over 28 tonne GVW. No shift was observed to vehicles not subject to the LSVA.
- A concentration of the transport industry was reported, through mergers or closure of small companies. This was apparently due to the fact that larger fleet operators are able to manage their vehicles and loads more effectively, avoiding empty trips more easily.
- Following introduction of the system, the growth rate of heavy duty vehicle traffic declined. However, part of this decline was due to a slowing of the economy.
- The LSVA was implemented mainly to offset the advantages of the higher weight limits to transit traffic. This seems to have been largely achieved (unfortunately, no data are reported).
- Thus far, no significant influence on rail transport performance could be established.
- The LSVA had a negligible effect on prices.

Government revenue or costs

Road use charging is a means of generating government revenue. As other taxes such as the Eurovignette or vehicle tax are generally reduced or abandoned to compensate users for these tolls, however, the net effect is often limited. Differentiation of tariffs according to Euro class (or other environmental yardsticks) can be designed in such a way that total government revenue is left unchanged.

In the German example the tariff scheme has already been fixed for several years, including future adjustments to respond to changes in the vehicle fleet triggered as future emission classes are introduced. This ensures a permanent incentive to use cleaner trucks as well as a relatively stable level of government income. If this is not done, revenues will decline over time as a result of continuous fleet renewal.

Governments may choose to pay hauliers for (part of) the costs of the environmental investments promoted by this incentive by some (small) reduction in average tariffs or other taxes.

Road transport sector

For the road transport sector, the road toll (to be) introduced in Germany, Austria and Switzerland leads to an increase in costs, even though in the first two countries there is some compensation, due to abolition of the (Euro)vignette. This cost increase will have the same effects on the transport sector as a road charge based on time: an improvement in transport efficiency and a decline in road transport demand. Clearly, the latter effect will have a negative effect on the economic performance of the road transport sector.

Differentiation of the tariffs, which provides the incentive to use cleaner vehicles with a higher Euro class, will increase road transport costs slightly compared with an undifferentiated toll system generating the same revenue. This is due mainly to accelerated fleet renewal, which requires investments in cleaner vehicles. As

already mentioned, governments may opt to reduce the extra burden on the road transport sector through some small reduction of road toll tariffs.

As with a road use charge based on time, a distance-based toll gives no competitive advantage to either national or international transport companies. It will, however, have a negative impact on competition with other modalities.

Haulage firms

As with a time-based toll, differentiation of a distance-based toll will push up the costs of hauliers operating older vehicles, while those with cleaner vehicles will gain financially compared to a flat tariff. This cost increase or tax benefit will depend mainly on the exact details of the toll scheme compared to the vignette (or other tax) system it replaces, the Euro class of the vehicles involved and the number of kilometres driven.

In the examples of the previous section, part of the toll costs are compensated by abolition of the vignette system once the road toll is introduced. For many vehicles, however, the toll to be paid will exceed the cost of the vignette. This change from a time-based vignette to a distance-based toll therefore means a cost reduction for only a small fraction of transport companies, viz. for those driving relatively few kilometres, and a cost increase for those driving more.

As with any cost increase, this will reduce the profitability of the haulage firms in question. Ultimately, however, a large part of these additional costs will be passed on to customers and, eventually, incorporated in the prices of the products transported. As studies of the German and Austrian toll systems have shown, with the toll rates currently applied the resultant increase in the price of common consumer goods will be very limited [UBA, 2001].

Spin-off

If the tariff is (sufficiently) differentiated according to existing and future Euro class, road tolls will promote faster penetration of new technologies. For example, it may encourage research, development and early market introduction of Euro 4 and Euro 5 vehicles. The German mode of differentiation rewards hauliers investing in vehicles that conform to future emission classes, which will undoubtedly encourage truck manufacturers to develop and market these cleaner engines even before they are obliged to. These technological advances are also likely to benefit other vehicle categories where similar engines can be fitted, such as light commercial vehicles.

Acceptance by the industry and haulier experience
If a road toll is designed such that it leads to an increase in the cost of road transport, the haulage sector will oppose it. However, *differentiation* of the toll is often better appreciated, as it provides scope for reducing costs by using environmentally friendlier vehicles. This kind of system is considered fair and efficient by many of the parties and people involved [TLN, 2002].

4.4 Differentiated sales tax

4.4.1 Current policy

Sales tax (also known as purchase or registration tax), to be paid on purchase of a new vehicle, is quite common for passenger cars but not for heavy-duty vehicles. A sales tax differentiated according to emission profile might serve as an effective financial incentive to buy a vehicle of higher Euro class than legally required. At present, however, we are aware of only one European country that has such a scheme in place for trucks: France. In Sweden a sales tax had to be paid until the end of 1996, when it was replaced by an increase of the annual vehicle tax [INFRAS, 2000].

Sales tax is commonly differentiated according to gross weight or number of axles, which, although related to fuel consumption, provide no incentive for improving fuel efficiency. The tax is then effectively indexed to damage to infrastructure. With heavy goods vehicles the relationship between vehicle weight and CO_2-emissions is not as clear as with passenger cars, as the fuel efficiency *per tonne transported* is generally higher for vehicles with a high GVW.

4.4.2 Effects of differentiated sales tax

General impact
A differentiated sales tax can play a role in owner/operator decisions to purchase and use better performing vehicles than legally required. As things currently stand, for example, it may serve as an incentive to buy Euro 4 or 5 vehicles before they become mandatory. Since the basic principle of this incentive is that it reduces the purchase cost of these cleaner vehicles, it can be expected to have very similar results to other kinds of incentives for cleaner vehicles (see section 4.6). The main difference between these two policy measures boils down to the question of who pays for the extra costs of the cleaner vehicle: governments (with subsidies) or hauliers buying standard trucks (as in the case of a differentiated sales tax).

A differentiated sales tax will only be effective as long as the financial benefit provided for a cleaner vehicle is large enough to compensate for its additional cost.

As sales tax is imposed once only, when the vehicle is purchased, its only direct influence will be on new vehicles being sold. However, sales tax might be differentiated so as to accelerate fleet renewal, by reducing the tax on new vehicles purchased to replace older, more polluting ones that are being scrapped.

Sales tax differentiation can be implemented without changing total tax revenues, by raising the tax on new vehicles complying with the minimum emission class (currently Euro 3 in the EU) and reducing that on cleaner vehicles. As long as only a minor fraction of new vehicles falls in the lower tariff, the increase of the higher tariff will be limited.

Environment

A differentiated sales tax will improve the environmental performance of the transport sector if it leads to sufficient numbers of better performing vehicles being owned and operated. A calculation of the potential environmental benefit can be found in the text box in section 3.3, where the emissions of a Euro 4 truck are compared with those of a Euro 3 vehicle. Its impact will be restricted to the national vehicle fleet.

If tax differentiation is insufficient to compensate for the additional cost of cleaner vehicles (purchase and operating costs), the incentive will not be effective. In that case it may even have a negative environmental impact: if the sales tax on new vehicles complying with the current Euro class were increased to provide an incentive to buy better performing vehicles, fleet renewal might be hampered. Older, more polluting trucks would then be kept in operation longer, thus worsening the overall environmental performance of the sector.

Obviously, the environmental impact will depend on the precise basis of differentiation. For EU member states, the current system of 'Euro' classes provides an obvious basis, since all new vehicles are tested and categorised according to this classification. This ensures a continuous reduction of polluting emissions such as NO_x and fine particles. However, it would also be possible to differentiate solely on the basis of NO_x-emissions, say. This might be an attractive option in cases where the dynamics of technological advance preclude reduction of all emissions simultaneously.

Similar to the incentives discussed earlier, sales tax differentiation will promote research on cleaner trucks and engines. This may speed up technological developments, which will increase the overall environmental impact of the incentive. This effect will be greatest if incentives to promote the purchase of Euro 4 or 5 vehicles are introduced more widely in the ECMT countries, as there will then be greater pressure on truck manufacturers to design, build and market such vehicles. If there is only modest implementation of such incentives across the ECMT, however, manufacturers are unlikely to respond.

If the intention is to keep the environmental incentive constant over a period of time, the differentiated sales tax system needs to be adapted regularly to changes in the environmental performance of new vehicles. If cost differentials among the various classes of vehicle change, moreover, there may be a need to adjust tariff rates.

Government revenue or costs

Differentiation of the sales tax system can be designed such as to be revenue-neutral for government. Once the system is operational, tariffs need to be adapted to match changes in the environmental performance of new vehicles. As more and more vehicles are sold that can claim the lower tariff, sales tax revenue would otherwise decline.

Road transport sector

As with the previous incentives discussed, a differentiated sales tax will cause some increase in road transport costs compared to an undifferentiated system with the same average tariff, as it encourages use of cleaner vehicles that are more expensive than those complying with the current Euro class. The effects on the sector will be similar to those discussed above in section 3.2. As stated, governments may choose to compensate the sector for these investments.

Since sales tax is imposed on the domestic vehicle fleet only, the ensuing increase in transport costs will be limited to hauliers based in the country where the tax is implemented. As such, it will have a negative impact on competition with foreign carriers. However, we do not expect this effect to be significant, as the tax increase for standard vehicles will be very limited compared to total transport costs.

Haulage firms

The effects on individual transport companies of a differentiated sales tax will be small compared to those of a differentiated road use charge, for the following reasons:

- Taxes on the current vehicle fleet are not affected.
- In general, the sales tax on vehicles complying with the minimum environmental standards will not be much higher than in the case of an undifferentiated sales tax.
- Companies often have the option of waiting a little longer before vehicles are replaced.

Spin-off

Vehicle manufactures will be encouraged to develop technologies to meet the lower emission ceilings embodied in ever-tightening environmental classes, before these are made mandatory. This is likely to have some impact on the technologies used in other, similar vehicles like small trucks, even if the latter are not subject to the differentiated sales tax.

Acceptance by the industry and haulier experience

Since a sales tax on trucks is currently not very common in Europe, the industry can be expected to oppose its introduction unless other taxes are reduced.

4.5 Differentiated vehicle tax

4.5.1 Current policy

Some form of annual vehicle tax (or circulation tax) is levied in just about every EU member state. Although differentiation of this tax according to emission class would provide a clear incentive for hauliers to purchase cleaner trucks, this is currently the case in Germany only. At present, vehicle tax is generally indexed to vehicle weight or engine power [INFRAS, 2000].

Example: differentiated vehicle tax for trucks in Germany

In Germany there are five different vehicle tax rates for trucks, indexed to emission and noise classes. The tax increases progressively in steps of 200 kg authorised laden weight, with the maximum annual charge depending on the emission class, as follows:

Emission class S2[a] and better:	€ 664.68
Emission class S1	€ 1022.58
Noise class G1	€ 1533.88
Neither S1 (or better) nor G1:	€ 1789.52

For trailers a linear tariff of € 7.46 per (part of) 200 kg authorised laden weight applies, with a maximum of € 894.76.

[a] Emission classes S1 and S2 are very similar to Euro 1 and 2.

4.5.2 Effects of differentiated vehicle tax

General impact

Whereas the impact of a differentiated sales tax is limited to the environmental performance of *new* vehicles, a differentiated annual vehicle tax can have an impact on the entire vehicle fleet. As such, vehicle tax is a more versatile policy measure. It can be targeted, for example, at accelerated phase-out of older, more polluting trucks, as well as providing an incentive to purchase new vehicles that are less polluting than legally required. As with the other monetary incentives, this incentive will only be effective if the financial reward for cleaner vehicles is and remains large enough to compensate for their additional cost.

As vehicle tax is imposed on the entire fleet, it can influence the sales of new vehicles as well as affecting which vehicles remain in service. By differentiating vehicle tax it is also possible to reward the retrofit of emission abatement technologies or other technologies enhancing vehicle environmental performance.

Vehicle tax differentiation will be most effective when tariffs are simultaneously decreased for better performing vehicles and increased for those performing worse, thus incrementally reducing costs as environmental performance improves and promoting a shift towards newer, superior vehicles. The exact effect will depend on the basis of differentiation and on the magnitude of the financial reward for cleaner vehicles compared with the additional costs. The incentive will be most effective if different tariffs are assigned to as many

emission classes as possible, ranging from very old vehicles (Euro 0) to future emission classes (currently Euro 4 and 5).

A differentiated vehicle tax can by implemented without affecting total government revenue. However, if the aim is to keep revenue constant as well as the environmental incentive, it also needs to be regularly adapted to the changing environmental performance of the vehicle fleet

From an operator's point of view, for a new vehicle the combined tax gain from vehicle tax (and, where applicable, other incentives) should be equal to or greater than the savings from not selling an older, lower class vehicle and thus not buying a new vehicle, calculated over a period of about 5 years[9], the time a company requires to write off the value of the vehicle.

Environment

A differentiated vehicle tax can encourage replacement of older, dirtier vehicles by newer ones as well as the retrofit of technologies like particle filters. It can than help reduce emissions of fine particles, NO_x and other pollutants. If it is effective in promoting vehicles complying with more stringent emission classes than legally required, moreover, it will promote research on cleaner trucks and engines and thus speed up technological developments. As with the sales tax discussed above, the effect of a differentiated vehicle tax will be restricted to the national vehicle fleet.

Even a small degree of tax differentiation will have some effect, as it directly affects the economics of haulage firms. There will always be some companies with older vehicles for whom replacement becomes financially attractive when vehicle taxes on these vehicles increase relative to newer vehicles. Obviously, the greater the range of tariff differentiation the more significant the environmental impact will be, for renewal will then be attractive for a greater number of vehicles.

The environmental effect therefore depends on the basis of differentiation (Euro classes 0 through to 5, for example), the degree of differentiation and early market introduction of vehicles that are cleaner than required.

Since vehicle tax has to be paid irrespective of the distance driven with the vehicle, it has the (environmental) advantage that it can be used to promote the complete removal of dirtier vehicles from the fleet. With the differentiated road use charge discussed above, hauliers might opt to keep dirtier vehicles in operation, using them for shorter trips or in countries with no such road toll scheme. On the other hand, differentiated vehicle tax is not in accordance with the 'polluter pays' principle, considered the key to fair and efficient pricing, as it is levied irrespective of actual vehicle use, i.e. of the pollution it causes.

[9] T. Pedersen, TB-management, *pers comm.*

Government revenue or costs
As far as government revenues are concerned, a differentiated vehicle tax has very similar characteristics to a differentiated sales tax, as described in section 4.4.

Road transport sector
Like other monetary incentives, if a differentiated vehicle tax is to be effective as an environmental incentive it must enhance fleet renewal and accelerate the market introduction of vehicles that are cleaner than legally required. This will induce a response from the sector (increased efficiency, for example) and an increase in road transport costs, to the extent that governments do not compensate for the additional costs incurred. As vehicle tax must only be paid by hauliers based in the country in question, these extra costs will be incurred by national hauliers only. Inter-country differences in tariffs will then affect the competitiveness of certain hauliers.

Haulage firms
A differentiated vehicle tax will increase the cost of operating vehicles of older emission class but reduce the cost of cleaner vehicles. Some transport companies will therefore benefit from this incentive, while others will be faced with a competitive disadvantage compared to an undifferentiated vehicle tax system. If, for the latter group, vehicle renewal is not a cost-effective option, this incentive will have a negative impact on their business. The severity of the impact will depend on the exact tariffs imposed and on the additional costs of the cleaner vehicles promoted. Part of the additional costs will then be passed on to customers.

Spin-off
Newer trucks are generally better equipped from a safety point of view than older vehicles and enhanced fleet renewal will therefore have some positive effect on safety.

If vehicle tax differentiation is extended to include future emission classes, vehicle manufactures will be encouraged to develop technologies satisfying these lower emission criteria. This is likely to have some effect on the technology used in other, similar vehicles like small trucks, even if these are not subject to the differentiated tax system.

Acceptance by the industry and haulier experience
By and large, considering that vehicle tax is already well established in many countries, differentiation of this tax seems to be a fairly minor change. However, since hauliers with relatively old vehicles may be faced with a significant increase in their vehicle tax bill, it seems likely they will reject such differentiation.

4.6 Financial incentives for clean vehicles or technologies, fleet renewal schemes

4.6.1 Current policy

Many ECMT countries use financial incentives to encourage investments in specific technologies that improve the environmental performance of their road vehicle fleet. These may be incentives for:

- Engines that comply with future emission classes.
- Retrofitting of particle filters on existing vehicles.
- Use of cleaner fuels.
- Equipment that reduces the amount of water used to clean vehicles.
- Equipment that reduces emissions of dust or other pollutants during loading and unloading.
- Installation of econometres and other systems providing information on fuel efficiency.
- Scrapping of old, very polluting vehicles.

These incentives may cover some or all of the investments in the cleaner technologies. Many countries have programmes under which hauliers receive a fixed sum on each investment, while others have also introduced tax reduction schemes. An example of the latter is the VAMIL scheme in the Netherlands; under which investments in clean technology can be deducted from the tax on profits over a shorter period (see following text box). Fuel tax reductions for low-sulphur fuels or biofuels are examples of financial incentives for fuels that are environmentally friendlier than fossil fuels.

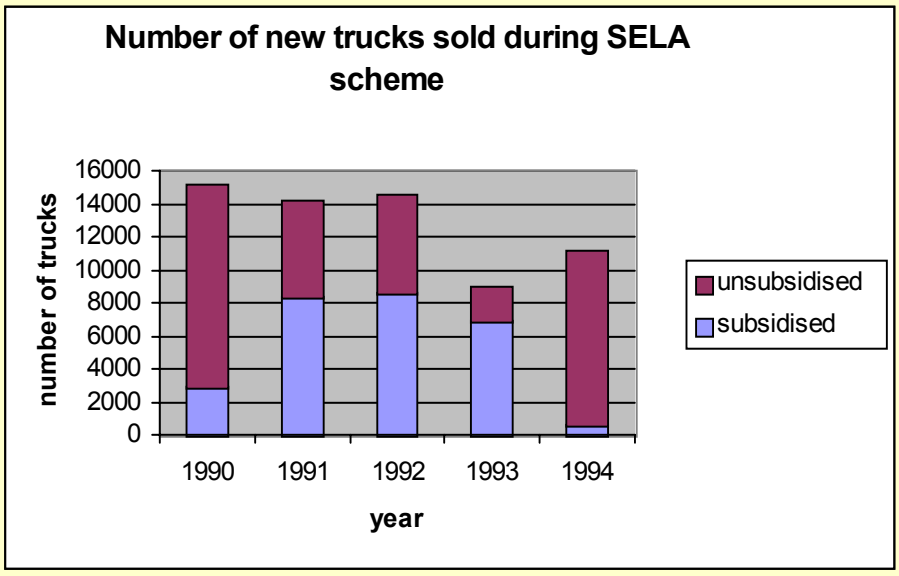
Financial incentives are often temporary measures to promote a specific technology for a period of one or several years.

A Dutch example: incentives to promote the sales of Euro 2 trucks

Under the SELA scheme in place in the Netherlands from 1990 to 1994 the purchase of quieter and cleaner trucks and buses was promoted by means of government subsidies. This was in advance of the obligatory Euro 1 and Euro 2 class, introduced on October 1st of 1993 and 1996, respectively, the aim being to encourage earlier introduction of low-emission technologies.

The subsidies were paid for by an increase of excise duty on diesel fuel. The subsidy per truck depended on the noise and emissions generated and covered the additional cost of the cleaner, quieter motor. Over the 4 years it was in force, over 28,000 applications resulted in a total of € 100 million in subsidies being granted.

From 1993 to 1994, when the regulation had to be discontinued because of its considerable success, a total of 7,568 trucks with a Euro 2 engine were sold under the scheme, receiving a total of € 28.6 million in subsidies. Unfortunately, the environmental benefits of the subsidy were disappointing, because, as it turned out later, Euro 2 trucks were found to emit more NO_x than expected (and, according to the most recent emission factors, even more than Euro 1 trucks do, as discussed in section 3.3.1). However, this was not known during the period the scheme was in place.



4.6.2 Effects of financial incentives for clean vehicles or technologies

General impact

Financial incentives may be a very effective means of promoting purchase and implementation of a specific technology. Obviously, their effectiveness will depend on whether or not the incentive level is sufficient to encourage hauliers to make the investment in question. The effectiveness will also depend on the effort hauliers must make to apply for the incentive.

Financial incentives can be used to promote technologies or other best practices that involve costs to operators and benefits to society. The incentive then gives operators a chance to improve their environmental performance without seeing profits fall or competitiveness threatened.

One general disadvantage of these incentives is that they are often valid for a limited period only. This may make manufacturers hesitant to invest in research

and development in the new technologies promoted by the subsidy in question. If the technology is already available, however, an incentive targeted at creating demand ('market pull') may help get the new product out on the market and increase demand and production, eventually reducing its cost price. This is illustrated by the Dutch example described in the text box on the previous page.

When designing financial incentives, it is important to set environmental goals rather than lay down the particular technology to be supported. For example, it is better be steer towards 'reducing emissions of fine particles by a certain amount' than installation of specific particle filters. Such incentives will then also encourage other technologies that may usefully be employed to the same end.

Environment
Financial incentives can be created for technologies and best practices that reduce polluting emissions, CO_2-emissions, water use, etc. Their effect will depend on the technologies promoted and on whether or not the incentive provides sufficient financial benefit to compensate for the additional cost.

An incentive that encourages market introduction of trucks complying with future emission classes, will achieve a lifetime reduction of emissions of the trucks in question. A lower tax on biofuels will lead to a reduction of CO_2-emissions, while fleet renewal schemes may be an effective means of getting very old and polluting trucks off the road.

Government revenue or costs
This category of incentives is paid for by governments, usually in the form of a fixed annual budget set aside in order to set a cap on maximum expenditure.

One potential drawback of these financial incentives is the so-called 'free-rider' effect, free riders being companies that would have invested in the best practice or technology even without the incentive, but now eligible for financial support. The environmental gains attributable to these companies will then not be due to the incentive, a fact for which governments should make due allowance when assessing the effectiveness of this type of incentive.

As an example, consider the effect of a fleet renewal scheme in which a financial incentive is paid for every truck older than 15 years that is scrapped. This can be a very effective means of getting rid of these very polluting vehicles in a relatively short time. However, the government cannot distinguish between trucks that are being scrapped solely on the grounds of the incentive (i.e. that would not have been scrapped otherwise) and those that would have been scrapped anyway. Only the first category will yield environmental benefits attributable to the incentive, but both categories of truck owner will receive the reward.

Road transport sector
Since financial incentives are paid for by governments, there will be no negative impact on the road transport sector. In real terms, there may even be a positive economic effect. This will be the case if governments provide an incentive for an

investment that some hauliers would have chosen to make even in its absence. These free-riders will then benefit financially from the incentive.

Haulage firms
As these financial incentives are voluntary, hauliers will only make use of them if they stand to gain from the associated investment. If the subsidy in question covers all additional costs, there will be no financial burden on individual firms. If it covers only part of the additional costs, its effect will generally be far smaller. However, hauliers may still opt to apply for it if they consider other benefits large enough (for example, PR or driver satisfaction).

As mentioned previously, there may be a group of hauliers that benefits from the incentive financially, the 'free-riders'.

Spin-off
Incentives for cleaner, quieter or safer technology may encourage development of technologies that can also be used in other sectors or for other modes of transport, for example emission abatement technologies that can also be used in vans or passenger cars, or in engines for diesel trains.

Acceptance by the industry and haulier experience
Although voluntary financial incentives are generally appreciated by the industry, if there is a lot of bureaucracy involved in applying for a subsidy, firms may opt to ignore them.

4.7 Multilateral ECMT quota system

4.7.1 Current policy

The multilateral ECMT quota of transport licences was introduced in 1974 to facilitate the liberalisation of road freight transport throughout the EU. This objective required the harmonisation of the terms of competition between road hauliers from different countries, as well as between modes of transport. The quota system is essentially an instrument regulating market access between EU- and non-EU-countries within the ECMT region and is therefore not of great relevance or importance for freight transport within the EU under the terms of the Single Market.

It may be of far greater relevance for Central and Eastern European countries (CEC) that are not yet members of the EU and must still cross controlled borders. As there are a large number of bilateral agreements in place, however, the multilateral quota accounts for only about 5-6% of the international transport between the countries to which the system applies [ECMT, 2003].

By introducing safety, noise and emissions standards into the quota, the system was broadened to take into account the need for moving towards transport sustainability. As such it contributes to the modernisation of vehicle fleets, especially in CEC countries. There, the quota system serves as a powerful

incentive, as only those trucks complying with the quota classes are able to cross into the EU. Furthermore, conventional quota can be converted tot 'greener' quota (for vehicles that comply with certain emission standards), in a ratio of 1 to 2, to 'greener and safer' (same as greener, bus also with safety standards) quota in a ratio of 1 to 4, and to 'Euro 3 safe' in a ratio of 1 to 6.

As the EU represents the most lucrative market for CEC operators, the quota induces them to use the best available vehicles, unless they wish to operate only in other CEC countries.

4.7.2 Effects of the multilateral ECMT quota

General impact

As only 5-6% of international (i.e. inter-ECMT) freight is subject to the quota system, its potential for improving the safety and environmental performance of the entire European vehicle fleet is correspondingly small. In CEC countries, however, its impact appears to be far higher, as hauliers in these countries are keen to access the Single Market. It therefore seems likely that the quota system to which the CEC fleet is subject helps improve the overall performance of trucks registered in CEC.

With the recent enlargement of the EU, the effect of the ECMT quota system can be expected to decline in the coming years.

Environment

For those countries where the quota applies as well as for the countries through which the trucks drive, there will be environmental gains. Unfortunately, no data are available to quantify this effect. As only a few percent of international freight is subject to the quota, however, the overall impact will be small. For those countries participating in the scheme, the quota will generally enhance fleet environmental performance. However, if the number of best-class vehicle exceeds the number of licences available, it could be said that unless the number of licences is also increased, the value of the incentive will decline.

The impact of the quota system on the EU and particularly on the border regions (between the EU and the CEC) is likely to be significant in terms of preventing high-emission vehicles entering the EU. As such, it reduces pollutant emissions in these countries.

Government revenue or costs

The costs of implementing and operating the system are inherent in distribution of the quota among ECMT countries, enforcement at borders, control and verification of truck compliance with the various quota classes and so on. There is no government revenue from the system.

Road transport sector

The quota system impacts on the transport sector because it effectively limits the access of hauliers from non-EU countries to the European single market.

The quota itself does not depend on time or distance travelled and therefore should not affect transport performance in terms of kilometres driven. From the perspective of market access, the quota could be considered essential for those operators seeking to penetrate the EU market.

Haulage firms
The ECMT quota are essentially instruments regulating market access and those hauliers taking advantage of the quota (in particular the bonuses) indeed have a clear advantage in terms of market opportunity. However, given the small scale of the international freight market affected by this quota, effects on individual hauliers are also likely to be restricted to a small segment.

Spin-off
Given the small segment of the inter-ECMT (and further) market affected by the quota and the fact that it provides no incentives for technological development beyond Euro 3, there is likely to be little spin-off.

Acceptance by the industry and haulier experience
The ECMT quota system has been in operation for some 30 years now, since 1974, and can therefore be said to be well accepted by the industry. However, there is an ongoing debate about its effects and possible improvements. Nonetheless, it has not succeeded in replacing the large number of bilateral agreements with a multilateral quota system.

4.8 The ecopoint system

4.8.1 Current policy

In 1992, before Austria joined the EU, a Transit Agreement was concluded between the EU and Austria to limit and reduce air pollution (NO_x) by 60% by 2003, by regulating the volume of transit heavy goods vehicles. The agreement came into force on 1 January 1993 and was originally due to expire at the end of 2003. The principal motives for the scheme were, first, Austria's geographical position at the crossroads between the north-south route (Germany-Italy) and east-west route and the steady growth of road transport and, second, the particularly fragile alpine environment.

The basic aim of the scheme is to reduce pollution, in particular the NO_x-emissions of goods vehicles of over 7.5 tonne laden weight. Each EU member state is allocated a number of 'ecopoints', for issue to its transport operators, based on an agreed figure for the number of transit trips in 1991. For each single-leg transit journey, a haulier is required to have a number of ecopoint stamps corresponding to the vehicle's NO_x-emission, with one ecopoint per unit NO_x. Each heavy goods vehicle is then charged proportionally for the ecopoints equivalent to its emission level, with a 'greener' vehicle with a lower NO_x rating requiring fewer ecopoints and thus paying less. Each EU Member State has a strictly limited quota of ecopoints, which is reduced each year until the 60% cut envisaged for 2003 is achieved.

For hauliers what this means, in effect, is either a reduction in the number of transit journeys or, alternatively, constant upgrading of the vehicles used in order to achieve the same number of transits using less ecopoints.

The ecopoint protocol also includes a provision stating that if the total number of transit journeys in any given year exceeds 108% of the total in the reference year (1991), the number of ecopoints for the following year is reduced (= the 108% limitation clause). However, amongst other criticisms of the clause, the European Commission has stated that it is difficult to justify having a penalty that applies to trucks that are too clean and is therefore proposing to abolish the clause.

By the end of 2003, the Commission had reached agreement on extending the ecopoint system, though in modified form. Vehicles complying with Euro 4 require no ecopoints, while transit of Euro 0 vehicles is now essentially prohibited (though with some exceptions). The NO_x-emissions of Euro 4 vehicles are, however, still included in calculating the total NO_x-emissions of transit traffic.

4.8.2 Effects of the ecopoint system

General impact

For transit traffic through the sensitive alpine regions of Austria, the ecopoint system clearly promotes the use of lower NO_x-emitting trucks. Given that the steadily rising noise, safety and pollution standards embodied in each new Euro class generally spur technological development, there is a wider net environmental gain. Although the ecopoints are indexed only to NO_x, technological improvements to meet the NO_x-emission ceilings bring with them other environmental benefits, too. This does not extend to CO_2-emissions, however.

According to a European Commission report on the transit of road freight through Austria, the ecopoint system has been very effective in encouraging hauliers with EU-registered trucks to use cleaner vehicles on transit through Austria. However, the system has not achieved its key goal: a sustainable 60% reduction of NO_x-emissions in 2003, compared to 1992 [EC, 2000].

Since the ecopoint system applies only to transit traffic, most of the heavy goods traffic in Austria is actually excluded, viz. bilateral traffic, national and local traffic, as well as tractors and buses. In addition, trucks registered in most non-EU countries and trucks using ECMT permits are exempted. However, if total cuts in the NO_x-emissions of heavy goods traffic are compared with those of transit traffic, the latter are found to have fallen more, a clear indication of the positive environmental impact of the ecopoint system.

The ecopoint system has not been differentiated according to distance travelled or the sensitivity of the area through which a truck is driving. It therefore seems likely that the environmental gains as well as support for the system could be increased if it were differentiated more and targeted specifically at

environmentally sensitive areas. A differentiated road user charge system could provide this kind of flexibility.

The ecopoint system was established not only to promote the use of cleaner trucks for transit through Austria, by requiring less points per trip for cleaner trucks; it also limits the number of transit trips per year. Although this limit may effectively reduce total NO_x-emissions, in itself it provides no incentive for using cleaner trucks. Instead, it may reduce the potential benefits of the system, as it provides no further incentive to use cleaner trucks once the limit has been reached.

Environment

Considering the relatively limited share of road haulage in Austria affected by the ecopoints scheme, the total environmental effects are also limited. At a local level, on the mountain passes, though, the benefits are considerable, for this is where a substantial share of transit traffic takes place. Even though the 60% NO_x-reduction is not achieved, the NO_x-emissions of transit trucks have declined far more than those of other Austrian traffic. It is unclear, however, how much of this reduction is actually due to the ecopoint system. Part of this difference will also be follow from the fact that transit trucks drive more kilometres per year and are thus replaced more often by new, and (because of the Euro classification system) cleaner trucks.

The recent changes to the system, whereby Euro 4 trucks have been completely exempted and Euro 0 trucks banned altogether, are likely to result in further environmental gains as long as the market share of Euro 4 trucks remains (very) limited. In the current situation it gives hauliers a positive incentive to purchase these cleaner trucks. Once Euro 4 trucks become more common, though, the revised system has no means of setting a cap on the total NO_x-emissions of transit transport.

The ecopoint system probably has an impact on emissions in other European countries, too, although it is unclear whether this is positive or negative. On the one hand, encouraging road hauliers to use cleaner trucks for their Alpine transit will also reduce polluting emissions in the other countries through which these trucks drive. On the other hand, the relatively dirtier trucks will be assigned to other routes, increasing emissions elsewhere. It is also likely that hauliers (especially those with polluting trucks) will make detours through other countries in order to save on ecopoints. Clearly, this will increase the environmental impact of the trip, as illustrated in the following text box. These negative effects can only be reduced by means of effective environmental incentives in these other countries.

The effect of detours

In Austria the ecopoint system limits the number of transit trips through the country, which may cause hauliers to make a detour through neighbouring countries. What is the effect of such a detour for a typical Euro 2 truck?

For a truck avoiding Austria on a trip from Hamburg to Rome the extra distance amounts to about 40 kilometres (on top of a total distance of 1,700 km), adding about 30 minutes to journey time. The extra cost of the detour will lie not so much in the extra mileage, but in toll payments and the time costs associated with any traffic jams.

For a truck going from Rome to München, however, the detour will be over 250 kilometres and the trip will take about 4 hours longer. The extra costs will then be considerable. A study by HCG [HCG, 1992] has shown that the value of travel time depends on the type of product being transported. Counter-intuitively, travel time has a higher value for raw materials and semifinished products than for end products. The rationale might be that delays in the transport of semi-manufactures can cause delays in the production process. In the HCG report travel time was valued at an estimated 70 guilders (32 Euro) and 60 guilders (27 Euro) an hour for raw materials and end products, respectively. Obviously, the figure will be highest for perishable goods.

Government revenue or costs

The ecopoint system involves operational and management costs that are paid for by the Austrian government.

Road transport sector

The ecopoint system affects all hauliers involved in trans-Austrian road freight transport. Additionally, as it is discriminatory it places a greater burden on transit traffic than on domestic and bilateral traffic.

Theoretically, the system can be made more effective and non-discriminatory by extending it to all heavy goods vehicles operating in alpine and sensitive regions, regardless of the country. Politically, however, this is not a viable option. A more general distance-based road toll differentiated according to environmental performance will yield similar benefits.

Haulage firms

Hauliers affected by the ecopoint scheme can respond in two ways:

- They may invest in 'greener' vehicles (lower NO_x-emissions) to reduce the number of ecopoints required.
- They may also increase the efficiency of individual transit journeys to reduce the number that need to be made.

At the same time, though, there may also be other effects:

- Hauliers may use their 'greenest' vehicles on Austrian transit routes.
- There may be a higher proportion of more polluting vehicles on other routes on which no penalty is payable.
- Hauliers can also be expected to use other, longer routes to avoid payment, thus increasing their cost, fuel consumption and associated emissions.
- A certain proportion of goods will be transferred to other modes, especially rail and short sea shipping.

As the system discriminates between transit travel on the one hand and national and bilateral transport on the other, Austrian transport firms may benefit considerably from the system, at the expense of foreign operators.

Spin-off

The main spin-off of the current ecopoint system is likely to be the push it provides to further development of the emission abatement technology required to comply with Euro 4. This technology can then be launched on the truck market (not limited to Austrian transit traffic) and can also be used in light-duty vehicles (such as vans and passenger cars), coaches and other transport modes.

Acceptance by the industry and haulier experience

The ecopoint scheme has been in operation since Austria joined the EU in 1992 and can therefore be said to be well established. However, because of its discriminatory nature and because it hampers the free European market, the road transport industry has argued against the system. Meanwhile, though, the IRU has expressed its appreciation of the environmental incentive provided in the new (2004) system.

4.9 Exemptions from driving bans

In various countries, driving bans for heavy-duty vehicles are used to reduce local noise or pollution levels. These bans may be imposed during specific hours, as with night-time bans, or be limited to the transport of specific goods, as discussed in the next section.

By providing exemptions for cleaner or quieter trucks, governments can use driving bans as a means of encouraging use of such vehicles. Indeed, this would be in line with the stated aim of most such bans: to cut noise and pollution. As yet, however, this form of incentive has not been introduced on any significant scale in Europe.

4.9.1 Current policy

Driving bans for heavy-duty vehicles as such are fairly common throughout Europe. In Germany, for example, there is a driving ban for trucks > 7.5 tonne on Sundays and public holidays between 00.00 and 22.00 hours[10]. There are exemptions, for example for trucks transporting perishable goods and those serving as a link in intermodal transport. A similar regulation is in force in Italy (though over a different period and with different exemptions) and, on several days a year, on various motorways in Austria. Since these driving bans have no exemptions on ecological grounds, they provide no incentive to hauliers to implement best environmental practices.

[10] Source: http://www.polizei.bayern.de/ppmuc/verkehr/text67.htm.

At the moment, exemptions from driving bans for cleaner or quieter vehicles are limited to several fairly local or regional regulations. Two examples:

- In the Netherlands, some parts of the inner city of Amsterdam are off limits to trucks > 7.5 tonne that are older than 8 years or do not comply with Euro 2 or higher emission classes.
- In France, the Montblanc Tunnel is prohibited for Euro 0 vehicles.

4.9.2 Effects of exemptions from driving bans

General impact

A driving ban may have the following general effects on hauliers and shippers:

- If the ban is limited to a specific time span, goods will be transported either earlier or later. If it is limited to a certain vehicle category (for example, only trucks with a GVW > 7,5 tonnes are banned), some goods will be transferred to vehicles that are not banned.
- Trucks will make a detour.
- Goods will be transported by another mode, such as ship or rail, or not be transported at all.

All three effects can be expected to have a negative economic impact on the road transport sector.

Combining the driving ban with an exemption for cleaner or quieter trucks will generate the following, *additional* effects:

- The share of trucks exempted from the ban will rise, with a corresponding decline in the number not exempted.
- If the ban is in force for a specific period of the day or week only, traffic will increase during that period, relative to the present situation, while at other times (mainly just before and just after the ban) it will decrease.

In addition, the total volume of traffic can be expected to increase slightly, as transport costs on the routes affected by such bans will decrease.

This will have no negative economic impact on hauliers owning exempted trucks, as they will have a competitive advantage on the routes concerned. However, others may need to invest in such cleaner and/or quieter vehicles. Individual hauliers will need to make a cost-benefit analysis to decide whether or not such investments are justified.

Environment

The environmental and social consequences of a driving ban (without exemptions for cleaner or quieter trucks) may be either positive or negative and depend on which of the first three effects cited above is strongest. The first effect, viz. goods being transported before or after the ban, will mean that emissions occur at a different time, with no reduction in overall emissions. It may also increase traffic jams at times without a ban, which may lead to a rise in emissions. The second effect, truck detours, will increase emissions (see the example in the previous section on ecopoints). The environmental impact of the

third effect, a modal shift, will depend on the environmental performance of the alternative mode (including transport to and from ship or train) and the detour factor, as explained above in section 3.4.

If exemptions are introduced for cleaner or quieter trucks, this will provide a business incentive to invest in such vehicles or the technology required for the exemption. Obviously, the greater this business advantage (which is highly dependent on the goods involved and local circumstances), the more hauliers it will encourage to improve their environmental performance.

This may have a significant positive environmental impact if the system really encourages the use of technology that would otherwise not be used. If, for example, there is an exemption of the driving ban for Euro 3 and cleaner trucks, all trips now made with Euro 3 trucks that would have otherwise been made with a Euro 2 or 1 truck will reduce emissions.

However, there will also be negative environmental effects: even though the exempted trucks are cleaner or quieter than average, their emissions will not be zero. The negative environmental impact of these exemptions may be reduced by lowering speed limits during the night, which will reduce both noise and pollution levels. In some cases, additional noise abatement measures may be necessary.

A specific analysis of the expected effects should therefore be carried out before this policy measure is used, in order to determine its net impact. Negative environmental effects are likely to occur in the Alps and other mountainous regions, where pollution is known to be aggravated by the frequent temperature inversions in winter and at night [EEA, 2001]. In these areas the benefits of significantly lower nocturnal emissions due to a full night-time ban may well be greater than the environmental benefits of cleaner trucks as such.

Government revenue or costs

The government costs of issuing exemptions to driving bans will be limited to enforcement costs and, where necessary, the cost of additional noise abatement measures. As there are already exemptions in place that require enforcement, the additional costs of the former will be low.

Road transport sector

As already mentioned, driving bans have a negative economic impact on the haulage sector. If cleaner or quieter trucks are exempted, this impact can be reduced: the trips for which the costs of the ban are higher than the additional cost of the exempted vehicle will then be performed using these cleaner or quieter vehicles.

Haulage firms

The economic effect of the exemptions on individual hauliers will obviously depend on whether or not it is financially attractive for them to sign up forexemption. This will depend on the balance between the required additional costs and the profitability of driving during the ban.

Clearly, hauliers that already have trucks that are exempt from the ban will benefit most from the exemption, as they incur no additional costs. Hauliers that cannot afford to invest in cleaner or quieter trucks (i.e. those for whom the costs outweigh the benefits) will be hit hardest financially, as competitors with trucks exempt from the ban will have the edge.

Spin-off
The spin-off of this incentive will be very similar to that of the ecopoint system.

Acceptance by the industry and haulier experience
The road transport industry is obviously not keen on driving bans, which restrict operations and push up costs. Exemptions are therefore likely to be welcomed.

4.10 Promotion of eco-driving

4.10.1 Current policy

Finland, Switzerland, Germany and the Netherlands actively promote 'eco-driving', a driving style aimed at improving fuel efficiency, at the same time enhancing safety and reducing operating costs by cutting expenditures on fuel and maintenance.

The aim of this incentive is essentially to educate truck drivers and increase their awareness of the consequences of different driving styles. Eco-driving programmes are national-level actions. Even though this is a non-monetary incentive, there is still the question of who pays for the educational programmes and the time of those attending them. In most cases governments provide some form of financial incentive for drivers attending such courses. Nonetheless, operators will need to cover any remaining costs of employee attendance, lost vehicle availability, and so on.

In table 8 the objectives and results of eco-driving programmes in Finland, Switzerland and the Netherlands are reviewed.

table 8 Eco-driving: objectives and results in Finland, Switzerland and the Netherlands

Country	Objective and results
Finland	Objective: mainly to reduce CO_2-emissions, but also other environmental and safety objectives. Since 1997 eco-driving has been integrated into general driver education. Target group: private and professional drivers. Result: reducted CO_2 and other emissions, improved safety and other unspecified benefits. A positive non-monetary incentive.
Switzerland	Activities to foster fuel-efficient driving. Eco-driving leads to 10-20% less fuel consumption. Leads to environmental and economic gains. Is voluntary Should stabilise energy consumption and CO_2-emissions.
Netherlands	Subsidies on driver training. Main objectives: improved fuel efficiency and safety, reduced fuel and maintenance costs.

Overall, the main objective is to reduce fuel consumption and improve safety by means of a better driving style.

4.10.2 Effects of eco-driving promotion

General effects

Although the aim of eco-driving programmes is to improve safety as well as fuel efficiency, little is currently known about their precise effects. While reports of up to 15-20% improvements in fuel consumption suggest eco-driving has great potential with few up-front costs, a more modest 5% is considered to be a more realistic estimate of the average result in the longer term. Nonetheless, promotion of eco-driving is a low-cost, long-term endeavour that has discernible social, environmental and economic benefits.

It is to be expected, however, that the benefits will decline as old habits resurface. Eco-driving programmes will therefore have greatest impact if repeated regularly, or if hauliers maintain a focus on driving style and fuel consumption. At the moment, though, eco-driving programmes are generally conducted as a short-term or temporary exercise in most countries.

Environment

Eco-driving will yield environmental gains by reducing CO_2-emissions. More moderate driving habits are also likely to reduce noise and pollutant emissions as well as accident rates.

Environmental and economic benefits of eco-driving

If 1,000 truck drivers, each driving 120,000 km a year, take an eco-driving course and thereby reduce their fuel consumption by 5%, total annual fuel savings of 2 million litres diesel will be achieved, equivalent to savings of € 1.4 million a year (€ 1,400 per truck) and almost 6 ktonne of CO_2 a year. From the former figure the cost of the course (mainly driver and vehicle time) must be deducted.

Government revenue or cost

Costs fall into three basic categories: the course itself and any instruction materials, lost man-hours while employees attend courses, and costs relating to vehicles required during the course. Governments can provide financial incentives for the courses themselves, while the transport sector usually shoulders the costs associated with manpower, vehicle usage and time lost. In addition, governments will need to promote eco-driving, for example through advertisements.

Road transport sector

The road transport sector will benefit from eco-driving as a result of reduced fuel costs, lower accident rates and decreased maintenance costs, although (part of) this benefit will be cancelled out by the additional costs incurred. As already stated, the benefits vary and are not precisely known. However, a 5% reduction of fuel consumption (and thus fuel cost) seems to be a realistic average.

Haulage firms

Hauliers benefit from eco-driving through cost reductions with respect to fuel, insurance payments, loss of vehicles and manpower through fewer accidents, lower fines and infringement notices (speed-related, careless and reckless driving). The main benefit is likely to come from fuel savings, amounting to about 5%. Furthermore, fewer accidents will lead to lower insurance premiums. In Finland, moreover, one insurance company (Pohjantähti) gives a 10% discount on insurance premiums to car owners who have passed an eco-driving course.

In most countries, the government incentive is limited to reimbursing the cost of the course itself, with hauliers having to pay for driver and vehicle time themselves.

Spin-off

Eco-driving has positive spin-off with regard to safety and vehicle maintenance costs. It has also been reported that drivers experience eco-driving as being less stressful that their usual driving style.

Acceptance by the industry and haulier experience

Eco-driving is not yet widespread practice, even though claimed fuel savings are significant. This may be due to inadequate acceptance of eco-driving in itself or to lack of awareness of the benefits as compared with the costs. Where policies in this area have been implemented, eco-driving has found considerable acceptance. Perhaps cultural differences with respect to driving style play a role here.

As the countries that have implemented eco-driving incentives compensate part of the cost by means of a subsidy and participation is entirely voluntary, there is no reason for hauliers to oppose this kind of incentive.

5 Conclusions and recommendations

5.1 Introduction

As implementation of best environmental practices generally requires an investment on the part of hauliers, most will only consider doing so if they can expect a satisfactory return on their investment. This may be in any of several forms: financial compensation, a permit to drive through environmentally sensitive areas, an improved image (public relations), driver satisfaction and so on.

The same applies to vehicle manufacturers. Research and development on cleaner vehicles and engines and their eventual market introduction involve very significant investments, which must be justified on economic grounds.

In the previous chapter we reviewed a variety of government incentives that may encourage hauliers and vehicle and engine manufacturers to make these investments. The effectiveness of these incentives will be greatest if:

a The financial or other business benefits are sufficiently large compared with the additional investments required.
b The incentives are stable, i.e. with little risk of early termination due to a change of government or budget cuts, for example.
c They are established in a timely fashion.
d They are valid for a large section of the transport market.

5.2 Monetary incentives

Direct financial compensation for investments in best environmental practices can be of two basic forms: differentiated taxes, tolls and ‘vignettes’, and direct incentives for purchasing cleaner trucks or technologies. The environmental and economic effects of the two options differ and depend very much on the specific design of the incentive, in particular the level of compensation provided.

All these incentives can effectively promote the use of cleaner vehicles as long as the financial benefits are large enough compared with the additional investments required. However, their specific effects may vary, for example in terms of area of impact (e.g. national or international) or whether they affect the existing vehicle fleet or only new vehicles sold.

An overview of the main characteristics of the various monetary incentives can be found in table 9.

table 9 Main characteristics of the monetary incentives reviewed

	National/ international effect	Incentive to improve environmental performance of…	Impact on government expenditure	Other characteristics
Differentiated road charge according to Euro class[1].	International.	Existing fleet and new vehicles.	Possibly neutral[2].	• Greatest impact on vehicles driving most, especially when distance-based (‘polluter pays’ principle). • Incentive level depends on duration of vignette or kilometres driven.
Differentiated sales tax according to current and future Euro classes.	National.	New vehicles.	Possibly neutral[2].	• Only budget-neutral for government if sales tax for current Euro classes is increased.
Differentiated vehicle tax according to all existing and future Euro classes or fuel consumption.	National.	Existing fleet and new vehicles.	Possibly neutral[2].	• Higher costs for older vehicles.
Subsidies on clean vehicles (future Euro classes).	National.	New vehicles.	Increases expenditure.	• No direct impact on hauliers.
Subsidies for retrofit (for older or current Euro classes).	National.	Existing fleet.	Increases expenditure.	• No direct impact on hauliers.

[1] Either distance-based or time-based charging.
[2] Needs careful design if it is to be neutral with respect to government budgets.

Environmental effects

The environmental effects of these monetary incentives depend on their specific design, especially on the degree of differentiation and the financial incentives relative to investments. If there is too little financial reward for switching to cleaner or more fuel-efficient technologies or logistics, the effectiveness of the incentive will be negligible.

However, a number of more general conclusions can be drawn regarding the effects and effectiveness and the pros and cons of the various forms of monetary incentive:

- Policies applying to all hauliers using the roads of a particular country are potentially more effective than those affecting only domestic carriers. Differentiated road charging is therefore likely to be more effective than differentiated sales or vehicle tax or other financial incentives for cleaner vehicles.
- Incentives that target the entire vehicle fleet, i.e. both old and new vehicles, have a potentially greater environmental effect than those applying to newly purchased trucks only, as in the case of a differentiated sales tax. Road use charging can be differentiated according to both old and future Euro classes (from Euro 0 to Euro 5), as can vehicle tax. In current road toll or vignette systems, however, this potential is often not utilised.
- Differentiated, distance-based road charging is the most effective means of implementing the ‘polluter pays' principle. It creates the greatest incentive to reduce the emissions of the vehicles used most, which is an effective means of optimising the environmental impact of the incentive.
- Differentiation of sales tax and financial incentives for clean vehicles are designed to influence sales of new vehicles. These can be used to promote the sale either of (more than averagely) fuel-efficient trucks or of vehicles emitting less pollutants than legally required (in the current situation Euro 4 instead of Euro 3, for example). This can accelerate the development and market introduction of new technologies and thus promote the technological development necessary for future emission classes.
- A differentiated road use charge can target both the existing vehicle fleet and new vehicles. It can therefore provide an incentive to remove vehicles of lower Euro class from the fleet and at the same time promote sales of the least polluting vehicles available.
- As these incentives depend on the duration of the vignette (time-based) or the kilometres driven (distance-based), the financial gains will be largest for those driving most. This increases the environmental effectiveness of the incentive, as it promotes best practices most where gains are likely to be greatest. Another advantage of road toll differentiation is that it provides a kilometre-indexed financial incentive that can cover kilometre-dependent costs, such as urea use in vehicles with an SCR.
- If monetary incentives increase the cost of road transport, some freight carriage is likely to be shifted from road to rail, water or air. The environmental effect of this modal shift depends on the environmental performance of those transport modes competing on the same route, including any detours and combined transport that may be required.
- Road use charging and differentiated sales and vehicle taxes are all aimed at promoting environmental upgrading of the vehicles themselves. However, financial incentives can also be directed towards best practices in other areas, for example reducing the amount of water used for vehicle cleaning.
- Financial incentives can be a very powerful tool for promoting market introduction of new technologies. However, they are often valid for a limited period only.

In conclusion, a differentiated road use charge has a potentially greater environmental impact than the other monetary incentives cited in table 9, provided it is sufficiently differentiated. In countries with no road toll system in place or where, for political or other reasons, the existing charging system is not differentiated, sales or vehicle tax differentiation and other financial incentives can be effective means of promoting best practices. However, the latter incentives are restricted in scope to the national vehicle fleet. Vehicle tax differentiation is potentially more effective in promoting best environmental practices than sales tax differentiation, because it can target the entire vehicle fleet. It can therefore be used both to promote clean vehicles and to encourage early replacement of old, polluting vehicles.
To provide an ongoing incentive for continual improvement of the environmental performance of road transport, the differentiation schemes and financial incentives should be adjusted to keep track of developments vis-à-vis introduction of new Euro emission classes and the ongoing shift towards a less polluting and more fuel-efficient vehicle fleet.

Economic effects
These monetary incentives can vary significantly in their economic effects. Like the environmental effects, they will depend very much on the specific design of the measure in question. Again, though, a number of general conclusions can be drawn:

- For governments as well as haulage firms, a differentiated tax regime will have very a different financial impact from a direct subsidy. Differentiated taxes provide scope for implementing an incentive without increasing government expenditure (or reducing revenues), whereas subsidies always increase government expenditure. Under a differentiated system of road charging or taxation, tariffs for cleaner vehicles can be set lower than those for dirtier ones, effectively inducing hauliers operating more polluting trucks to pay for the cleaner vehicles.
- Such incentives will therefore have a negative financial impact on hauliers operating vehicles for which higher tariffs must be paid. This may obviously have a significant impact on these specific businesses.
- Furthermore, if an incentive promotes purchase and/or use of cleaner or more fuel-efficient vehicles that are more expensive than standard vehicles, total transport costs will rise. If subsidies are used as an incentive, these additional costs will be paid by governments. If differentiated taxes or road charges are used and differentiation is designed such that government revenue remain constant, the transport sector will effectively pay the additional costs.
- In order to keep the revenues of a differentiated tax system constant over time, differentiation needs to be continually adapted to account for ongoing improvements in fleet environmental performance.
- Subsidies are paid by governments and have no negative economic impact on haulage firms. Indeed, as they are voluntary and operators declining to make use of them are unaffected, they are generally welcomed by the transport industry. In political terms, though, they are often more unstable: subsidies cost governments money and if there is a need for budget cuts they may be all too readily terminated.

5.3 Non-monetary incentives

Non-financial incentives, such as a permit or quota scheme differentiated according to Euro emission class, can provide an incentive to invest in cleaner technologies by reducing transport time and providing additional business opportunities for hauliers. It can therefore be a very effective policy instrument for promoting best practices. However, some of these incentives also impact negatively on the transport sector and consequently meet with significant resistance from the industry. In some cases, moreover, their design is such as to discriminate between hauliers from different countries, which is in conflict with the objective of a liberalised transport market and is generally considered unfair by the haulage sector.

The main features of the non-financial incentives reviewed here are shown in table 10.

table 10 Main characteristics of the non-monetary incentives reviewed

	National/ international effect	Incentive to improve environmental performance of…	Government costs	Other advantages or disadvantages
Multilateral ECMT quota system.	International, but only effects in ECMT countries that are not members of the EU.	Existing fleet and new vehicles.	Administrative costs.	• directly targets trucks more polluting than EU average. • effects diminish when accession countries become EU members.
Ecopoints.	International[1].	Existing fleet and new vehicles.	Administrative costs.	• system now implemented in Austria provides competitive advantages for Austrian hauliers. • limits transit traffic, which is not in line with the EU free market.
Exemptions from driving bans.	National and international (if on a transit route).	Existing fleet and new vehicles.	Cost of enforcement and (possibly) of additional noise abatement measures.	• more pollution and noise during the hours of the ban, reduction at other times. • provides competitive advantages to hauliers with cleaner or quieter vehicles.
Promoting eco-driving.	National.	Existing fleet.	Costs of driver training (may be shared with hauliers).	• may have financial benefits for hauliers, through lower fuel consumption. • effects likely to

	National/ international effect	Incentive to improve environmental performance of…	Government costs	Other advantages or disadvantages
				diminish after several months unless repeat courses are given.

[1] This is true in the case of Austria, where national and bilateral transport are exempt. However, the incentive can be designed such as to include national transport as well.

Environmental effects

In general it can be said that the environmental gains of any incentive will increase in step with the financial gain to hauliers who implement the best practices in question. Incentives that give hauliers a tangible return (more trip permits, for example) are thus potentially effective.

- As with the monetary incentives, the environmental effects of quota systems such as the ECMT and ecopoint system depend on the degree of differentiation adopted. The effect can be maximised by differentiating between both old and new Euro classes.
- Environmental benefits will also depend on the amount of (international) transport influenced by the scheme in question. For example, the multilateral ECMT quota system affects only 5-6% of the international transport in the ECMT region.
- Both the ECMT quota and the ecopoint system are essentially permit systems designed to allow more vehicles to enter the EU or Austria, respectively, as they comply with a higher Euro class. This provides a clear business incentive that is widely acknowledged to be an effective environmental measure: the average Euro class of the foreign transit vehicles driving through Austria has improved more than that of non-transit vehicles. As the ecopoint system also sets a cap on the number of transit trips per year, it also provides an incentive to increase transport efficiency, which has an additional positive environmental impact.
- However, a system like the Austrian ecopoints may have negative environmental side-effects, especially in neighbouring countries, for it may en-courage hauliers with polluting vehicles to opt for a detour round Austria or use their cleaner trucks for transit through Austria and their older vehicles for other trips. The severity of these effects depends on the environmental policies in place in the other countries. In addition, this kind of policy instrument has economic disadvantages, as discussed below.
- As with the monetary incentives, the quota and ecopoint system may cause a shift to other transport modes. The environmental impact of this shift may be positive, but depends on the environmental performance of the alternative mode and any detours that may be necessary.
- If cleaner or quieter vehicles are exempted from driving bans, a clear business incentive is provided to invest and use these trucks on these routes. If these replace more polluting or noisy trucks, the environment will benefit. However, it also means more trucks driving through the area in question, leading to more emissions and noise. In the case of a night-time ban, the

result will be a reduction of emissions and noise during the daytime but an increase at night. Whether the net environmental result is positive or negative will depend on the specific situation.

- Promotion of 'eco-driving', essentially training in a more fuel-efficient and safer driving style, is estimated to reduce fuel consumption (and thus CO_2-emissions) by about 5%. However, it is generally considered that these effects decline with time as drivers tend to return to their old driving habits, unless repeated attention to the correct driving style is given.

Economic effects

- Since permit systems set volume limits on road transport, they will have a negative economic impact on the haulage sector. If there is a modal shift, other modes may benefit.
- Non-monetary incentives such as the multilateral ECMT quota and the ecopoint system provide a clear business opportunity for hauliers operating cleaner trucks, but will have a negative impact on hauliers with dirtier vehicles.
- Both the ECMT quota and ecopoint system discriminate between hauliers from different countries. With the first, it is non-EU hauliers who are adversely affected, with the second, international transit traffic through Austria.
- Exemptions from driving bans will have a positive economic effect on the transport sector, but only those hauliers operating exempted trucks will benefit.
- As it results in improved fuel efficiency, eco-driving will have a positive economic impact on the road transport sector.

5.4 The effectiveness of environmental incentives

As we have seen, there are a variety of government incentives at hand to promote best environmental practices in the road transport sector. Some of them are potentially more effective than others, and some have positive, others negative economic effects on the sector.

In all cases the effectiveness of an incentive as a policy measure to promote best practices depends on its precise design. In this study we have identified several options for improving existing schemes, most of them related to the generally only limited degree of differentiation according to Euro class. Whether we are dealing with road use charges, vehicle tax, ecopoints or multilateral quota, differentiation according to as many Euro classes as there currently exist will always provide an additional incentive to use or purchase cleaner vehicles.

The key factor determining effectiveness is always whether the benefit accruing to a haulier investing in better environmental performance outweighs the associated cost. Whether the benefit is financial, for example a lower tax, or non-financial, such as a permit to drive through a given country or environmentally sensitive area, is not important in this respect.

In addition, it can be concluded that some incentives are potentially far more effective than others, because of their wider, international scope. For example, a differentiated vehicle tax affects national hauliers only, whereas a differentiated road use charge can improve the environmental performance of all the transport occurring in a country, including foreign vehicles.

We have also seen that there is a huge range of incentives in place in the various ECMT countries and even within the EU. Harmonisation of taxes, including environmental incentives, would create a much more powerful operating environment: first, by increasing pressure on vehicle manufacturers to develop and market cleaner trucks (which would reduce their cost) and second, by creating a non-discriminatory and transparent situation for road hauliers. In section 5.5 we shall discuss this issue further.

A combination of incentives all geared to the same environmental goals can also increase the benefit to hauliers and thus increase their overall effectiveness. For example, if purchase of a Euro 4 truck means the owner a) is exempted from the Austrian ecopoint system, b) pays lower road use charges in certain other European countries, and c) pays less vehicle tax in his home country, then more hauliers will opt for these cleaner trucks than if only one of these incentives were in place.

5.5 Level playing field

As the road transport sector and the truck market are both largely international, there are significant weaknesses in individual countries introducing measures to promote best practices in the sector, for measures taken in isolation are generally far less effective. Conversely, the wider the geographical validity, the more impact a given measure is likely to have.

The value of a level playing field, i.e. a harmonised and coordinated approach to transport prices and pricing, has moreover been stressed by a wide range of actors and authorities. Purely fiscal, nationally based taxes impact more on competitiveness in the road haulage sector than territorial charges. Distortion of competition can thus be avoided by partially replacing vehicle charges with territorial charges.

However, even though harmonisation of incentives has clear advantages, countries may well choose to implement national policies. They may do so to address specific environmental problems, in the conviction that it is the right policy for their country, or to set an example to other countries. Examples of the latter two reasons are the road use charges (being) implemented in Switzerland, Austria and Germany.

5.6 Regional incentives for environmental bottlenecks

The various incentives discussed all have their own specific characteristics and impacts. Governments considering their introduction are therefore well-advised to first identify the specific, most pressing environmental problems attributable to road transport and then design and optimise the incentives best suited to alleviate them. This kind of analysis can also help generate political and public support for particular measures.

As an illustration, consider the specific problems arising in mountainous areas within the ECMT countries. These areas suffer more than others from road transport pollution. Specifically, mountainous areas in the alpine region and the Pyrenees are more prone to high concentrations of pollutants and high noise levels than other regions, because of the large volume of transit freight traffic on a limited number of routes and the specific morphological and meteorological conditions in their valleys[11].

Non-discriminatory infrastructure charging on transit routes, differentiated according to vehicle pollutant and noise emissions, seems to be a very suitable means of promoting the use of cleaner and quieter vehicles on these routes. This would also improve the efficiency of transport (thereby reducing the traffic volume) in these regions. Differentiation of road use tariffs according to the sensitivity of the specific area (in terms of environmental and health damage) would be a flexible and efficient way of maximising the effect of this incentive.

5.7 Other modes of transport

Road transport is the main mode of transport in the ECMT countries. However, on some routes and for some types of goods it competes with other modes, viz. rail, waterway or air. Many of the incentives examined in this report potentially increase the cost of road transport, thereby potentially reducing its competitiveness with other modes. However, various studies have shown that an increase in the cost of road transport leads to only a very limited modal shift, because the various modes serve quite separate markets (see for example [UBA, 2001]).

The effect of a modal shift on the environment depends on the specific route and type of goods being transported and may be either positive or negative, depending on the environmental performance of the other modes and the detour the goods need to make (see for example [CE/RIVM, 2003]).

Any anticipated changes to a level playing field can be counteracted by designing incentives such that governments pay for (part of) the additional costs, for example by lowering taxes or other road transport charges.
A second option would be to provide parallel incentives to other modes of transport. This could create a level playing field and at the same time improve the

[11] Road freight transport and the environment in mountainous areas, EEA, Technical Report No. 68, Copenhagen, 2001.

environmental performance of the overall transport sector. If this is done by applying the ‘user pays’ principle to all transport modes, the result would be a fair and efficient pricing system across the board.

5.8 Monitor effects and evaluate incentives

In the course of this study we discovered how difficult it was to find concrete data on the effects of the various incentives examined. In some cases anticipated effects had been estimated during the decision-making process, but there were only very few studies available in which the effects were actually monitored and evaluated once the policy had been put into practice. Even then, analysis was often limited to comparing data before and after implementation, without properly accounting for changes that would have occurred anyway. In the case of the ecopoint system, for example, not all of the higher share of Euro 2 and 3 trucks in transit traffic through Austria is due to the ecopoints, as this share would also have risen without the system.

Without proper knowledge and understanding of the costs and effects of the various incentives arising in actual practice, it is difficult to properly evaluate and compare them on relevant aspects. More thorough monitoring of the policy measures in question would, moreover, help government justify decisions in this area and generate support within the road transport sector as well as among the general public, especially in cases where there may be adverse economic effects.

Sources

CE/NEA, 1999
CE and NEA, *Prijselasticiteiten in het goederenwegvervoer,* Hoofdrapport, Rotterdam/Delft 1999

CE/RIVM, 2003
CE and RIVM, *To shift of not to shift, that is the question - The environmental performance of the principal modes of freight and passenger transport in the policy-making context*, Delft, 2003

EC, 1995
Commission of the European Communities, *Towards fair and efficient pricing in transport: policy options for internalising the external costs of transport in the European Union:* green paper, COM(95)691 final, Luxembourg, 20.12.1995

EC, 2000
Commission of the European Communities, *Report from the Commission to the Council on the Transit of Goods by Road through Austria,* COM(2000) 862 final, Brussels, 2000

EC, 2001
Commission of the European Communities, *White Paper, European transport policy for 2010: time to decide*, COM(2001) 370, Brussels, 12.9.2001

EC, 2003a
Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels for transport

EC, 2003b
Commission of the European Communities, *Proposal for a Directive of the European Parliament and of the Council amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures,* COM(2003) 448 final, Brussels, 23.7.2003

EC, 2003c
Directive of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, 2001/0245 (COD), Brussels, 16.9.2003

ECMT, 1998
European Conference of Ministers of Transport, *Resolution No. 98/1 on the Policy Approach to internalising the external costs of transport*, CEMT/CM(98)5/FINAL

ECMT, 1999
European Conference of Ministers of Transport, *Efficient transport taxes: International comparison of the taxation of freight and passenger transport by road and rail,* Ad hoc group on fiscal and financial aspects of transport markets, CEMT/CS/FiFi/(99)1/REV1, 1999

ECMT, 2000a
European Conference of Ministers of Transport, *Resolution No. 00/3 on charges and taxes in transport particularly in international road haulage*, CM(2000)13/FINAL, Prague, 2000

ECMT, 2000b
European Conference of Ministers of Transport, *Efficient Transport Taxes and Charges,* CEMT/CM(2003)8, 2003

ECMT, 2001a
European Conference of Ministers of Transport, *Taxation and Competitiveness in the European Road Haulage Market*, Group on Fiscal and Financial Aspects of Transport, CEMT/CS/FiFi(2001)2, 2001

ECMT, 2001b
European Conference of Ministers of Transport, *Road Transport, Report on Regulatory Reform in Road Freight Transport*, CEMT/CM(2001)8, 2001

ECMT, 2001c
European Conference of Ministers of Transport, *Sulphur free fuels*. CEMT/CM(2001)11/Final, 2001

EEA, 2001
European Environmental Agency, *Road freight transport and the environment in mountainous areas, Case studies in the Alpine region and the Perenees,* Technical report No. 68, Copenhagen 2001

GUT, 2003
Graz University of Technology, *Emission Functions for Heavy Duty Vehicles, Update of the Emission Functions for Heavy Duty Vehicles in the Handbook Emission Factors for Road Traffic,* commissioned by the Federal Environment Agency, Austria, Vienna, 2003

HCG, 1992
HCG, *De reistijdwaardering in het goederenvervoer;* 1992

IFEU, 2002
IFEU Heidelberg and SGKV, *Comparative Analysis of Energy Consumption and CO_2 Emissions of Road Transport and Combined Transport Road/Rail*, Report commissioned by the IRU and BGL, 2002

INFRAS, 2000
INFRAS, *Variabilisation and Differentiation Strategies in Road Taxation*, for the ECMT, Group on transport and environment, Zürich, 2000

IRU, 1996
International Road Transport Union, *Driving Towards Sustainable Development: A road transport industry initiative for achieving a better economic, social and environmental future,* Geneva, 1996

IRU, 2000
International Road Transport Union, *IRU Guide to Sustainable Development,* Geneva, 2000

IRU, 2002
International Road Transport Union, *Report on Road Transport, Best Industry Practices,* Geneva, 2002

Rapp, 2003
M.H. Rapp and U. Balmer, *The Swiss distance related Heavy Vehicle Fee (LSVA) – a novel approach to area-wide road charging*, AIPCR/PIARC World Road Congress 2003, Durban, South Africa

TIS, 2002
TIS, INFRAS, Erasmus University Rotterdam, DIW, *Study on Vehicle Taxation in the Member States of the European Union*, 2002

TLN, 2002
Transport en Logistiek Nederland, *Licht op Groen*, *Visie van Transport en Logistiek Nederland op een effectief en efficiënt milieubeleid in het wegvervoer*, Zoetermeer, 2002

TNO, 2003
Emissiefactoren heavy duty wegvoertuigen ten behoeve van EmissieRegistratie 2003, Delft, 2003.

UBA, 2003
Umweltbundesamt, *Stickstoffoxid-Emissionen von Schweren Nutzfahr-zeugen*, Berlin, 2003

UBA, 2001
Umweltbundesamt, *Anforderungen an eine umweltorientierte Schwer-verkehrsabgabe für den Straßengüterverkehr*, Rothengatter, W. and Doll, K., UBA project nr. 57/2001, Berlin, 2001

Incentives in Action

Analysis of the role of incentives in road transport

Annexes

CE Delft

International Road Transport Union

A Monetary incentives

Fiscal Incentives		
System	Country	Description
CTP Pricing restructuring	EU	Under the Common Transport Policy there is ongoing discussion on charging for the use of infrastructure, price structures reflecting true costs to the Community (marginal social costs), harmonisation of fuel taxes and the need for a Community pricing framework. Ref: European Commission White Paper. 2001. *European transport policy for 2010: time to decide*. COM(2001) 370.
Directive 98/69		Regulating the emissions of CO_2, HC, and PM from diesel cars
Directive 98/70		Regulating diesel fuels, including sulphur content
Eurovignette Directive 1999/62/EC		In force from 1 July 2000. Applies to vehicle taxes, tolls and charges for use payable by heavy goods vehicles. Also regulates minimum levels of annual vehicle tax. Differentiated according to gross vehicle weight and number of driving axles. Reducted tariff for driving axles with air suspension. New min. rate for 40 tonne trucks with 3+2 axles and air suspension is € 628 per year. Ref: Council Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructure. http://Europa.eu.int/comm/transport/infr-charging/library/directive1999-62.pdf. Kågeson, P. 2000. *Bringing the Eurovignette into the electronic age*. T&E, Brussels, Belgium.
Electronic km charging	ECMT	Recommendations of a 2000 report on efficient transport taxes and charges include: • Harmonisation of the tax *basis*, e.g.: methodologies to determine marginal social costs. • Fuel taxation to better incorporate external environmental costs. Better for CO_2 than most social transport costs. Shift from national tax to fuel tax. • Shift from national (e.g. vehicle) charges to territorial, e.g. electronic kilometre charging or tolls. • Replacing Eurovignette with electronic km charging (to increase efficiency). • Electronic km charges for trucks, permitting internalisation of marginal social costs (allowing fuel tax to be reduced). Ref: ECMT. 2000. *Harmonisation in road transport – efficient transport taxes and charges.* CEMT/CM(2000)14/Final.

Eurovignette	Belgium, Denmark, Germany, Luxembourg, Netherlands, Sweden	A time-based charge for use of motorways in participating countries. Minimum charge: € 750 and € 1,250 for 3 and 4 axle trucks, respectively. Rates are scaled according to the damage caused to the environment and road infrastructure and vehicle emission class. The higher the Euro class, the lower the payments, e.g. Euro 2 is charged less than Euro 1. There is no additional rebate for Euro 3 or Euro 4 class vehicles. Introduced in 1995, with Sweden joining in 1998. For trucks with a GVW of 12 tonnes or more. Ref: Kågeson, P. 2000. *Bringing the Eurovignette into the electronic age*. T&E, Brussels, Belgium.

Distance-based charge	Austria	From 2004 over the entire road network, based on new German system. Applies to trucks > 3.5 tonne. Payment by electronic means; compatible with German, Italian, Swiss & Slovenian systems. Price varies, based on axles: 2 axle = 0.13 €/km to 4 or more axles = 0.27 €/km. Undifferentiated with respect to Euro class or environmental performance. Set-up costs estimated at € 290 m, operating costs at 55 m €/year. Revenues estimated at 250m €/year. *Transport en logistiek Nederland*. 2002. Issue 33/34. Zoetermeer, the Netherlands. Transport & Environment. 2000. *Comparative information on transport prices and taxation across Europe*. Brussels, Belgium.

CO_2-differentiation of road and sales tax	Finland. All measures except biofuels and CO_2 agreement initiated and implemented at national level. Reference: see footnote[12].	Not yet implemented, but under investigation.
Road / km / congestion pricing		Not yet implemented. Unknown whether under investigation.
Tradable CO_2 permits		Not yet implemented. Unknown whether under investigation.
Bio Fuels		Objective: to encourage use of biofuels in line with EU Biofuels Directive. Biofuels (ethanol) added to diesel. Pilot project beginning Autumn 2002. Target group: unspecified, but transport-related. Likely to target freight transport and heavy users of diesel. Result: none specified, but likely to be in line with sustainable energy programmes and development of renewables.
Vehicle tax		The Finnish tax system does not currently consider the vehicle environmental performance in any sophisticated or systematic manner, nor does it embody any strong environmental incentives. Fuel and vehicle taxation are aimed at maintaining a high level of public transport, i.e. are passenger transport oriented. Noise and emissions are subject to standards, with no charges levied at point of use. Annual vehicle tax is based on vehicle age and is lower for older and therefore dirtier vehicles – a reverse incentive to pollute! Annual vehicle tax is levied on environmentally more harmful diesel vehicles is according to weight, correlated to fuel consumption. The carbon tax is the only true environmental tax as an excise on fuel and energy. Ref (all): Kuitunen, H; Risto, S; Mäkelä, K. 2002. *Personal communications*.

[12] Mäkelä, K. 2002. *Personal communications*. VTT - Technical Research Center of Finland, Building and Transport.
Saari, R, 2002. *Personal communications*. Ministry of Transport and Communications, Finland.

Distance-based charge	Germany	Distance-based charge for trucks over 12 tonne on motorways, levied on distance travelled, number of axles and vehicle emission class; to be introduced Jan. 2005. Estimated cost of system: € 550-600 million/year. Estimated revenue generated: € 3.4 billion/year. Truck charge of € 0.12 - 0.17 per km, depending on Euro class. Ref: http://bulktransporter.com/ar/transportation_update_german_truck/; *Transport en logistiek Nederland.* 2002. Issues 27/28, 29/30, 31/32, 35, 37 & 40. Zoetermeer, the Netherlands. Transport & Environment. 2000. *Comparative information on transport prices and taxation across Europe*. Brussels, Belgium.
Stimulation of clean diesel		Lower excise tax on 'clean' diesel, i.e. lower sulphur content, etc. Ref: Poppink, P. 2002. *Personal communications.* Transport en Logistiek Nederland.
Stimulation of bio-diesel		Lower excise tax on bio-fuels, such as bio-diesel. Ref: Poppink, P. 2002. *Personal communications.* Transport en Logistiek Nederland.

Distance-based charge	Netherlands	Distance-based charge, all roads, all users. Announced in 2001; introduction: 2004 to 2006.
Stimulation of clean diesel		Lower excise duty on 'clean' diesel, i.e. lower sulphur content, etc. Ref: Poppink, P. 2002. *Personal communications*. Transport en Logistiek Nederland.
Stimulation of Euro class		During the '90s: Subsidies and stimulation of Euro classes 1 to 3. Plans to provide financial incentives for Euro 4 and Euro 5 in 2005. Ref: Poppink, P. 2002. *Personal communications.* Transport en Logistiek Nederland. Beleidsnota Verkeersemissies, Ministry of Housing, Spatial Planning and the Environment, 2004.

No specific incentives for freight transport. Incentives being considered	Sweden	Financial incentive for purchase of low-emission trucks (over 3.5 tonne) is 'unsuitable'. Incentives for purchase of environmentally friendly technology are 'urgent'. Vehicle and fuel tax changes are both being considered, differentiated according to environmental class. Ref: Linberg, G. 2002. *Personal communications*.
Proposal for differentiated vehicle tax		There is a proposal for a vehicle tax scale differentiated according to environmental class, to improve competitiveness and increase use of clean vehicles. Three-tier strategy related to Euro class implementation dates: first stage: requires environmental class 2000 or higher to get tax breaks; second stage: requires environmental class 2005 or higher; third stage: requires environmental class 2008 or higher. Incentive seeks to encourage use of clean vehicles already available and purchase of new vehicles. Measure financed by increasing taxes on buses and light trucks (<3.5 t) to same rate as for private cars. Light trucks are often used as if they are private cars and should therefore be subject to the same tax burden. First incremental tax rise to be just over 50%. If linkage can be established between pneumatic suspension and lower road wear, possibility of tax differentiation based on suspension. Start date of proposal: 1 April 2003, implemented over 3½ years. Overall impact of proposal to be budget-neutral.
Possible differentiated fuel tax		Fuel tax differentiated according to Euro class, preferential for 'clean' diesel. Ref (all): Ministry of Finance of Sweden. 2002. *Vissa vägtrafisskatterfrågor.* SOU 2002. Stockholm, Sweden. Report in Swedish with English summary.

Heavy-duty vehicle tax LSVA charge	Switzerland	From 1 Jan 2001, distance-based fee for heavy vehicles over 3.5 tonne. Calculated on 3 parameters: 1) kilometres driven; 2) max. permitted total weight; 3) differentiated according to Euro class. Implemented in conjunction with strategies to provide cross-Swiss rail-freight alternatives. Revenues go to funding rail infrastructure.
Vehicle registration fee		Vehicle registration fee levied by the 26 Cantons. Possible 26 different solutions, but mostly dependent on vehicle weight and/or engine size.
Low/zero emission subsidies		Subsidies / tax exemptions for low and/or zero emission vehicles. Determined at Cantonal level and therefore possibly a variety of solutions. Ref (all): Stefan Suter. 2000. *Personal communications*. Infras, Switzerland. Swiss Customs Authority. 2000. *HGF - in concrete terms*. Brochure in English, Bern, Switzerland. Transport & Environment. 2000. *Comparative information on transport prices and taxation across Europe.* Brussels, Belgium.

VED	UK	Changes to truck VED will differentiate according to how clean and/or damaging to the environment a vehicle is. This should result in a shift to cleaner, less damaging trucks.
Road user charge for trucks		Either time- or distance-based. Under development, with preference for distance-based. To be implemented 2005 or 2006. Irrespective of nationality. Key objective is for users to contribute more equally towards costs they impose in the UK. Under consideration: road coverage to include all roads; charges to vary based on vehicle type: emissions, axle number, weight, etc; possible congestion-charging component. Ref: SMMT Policy & economics. 2002. *Truck charging scheme - progress report for HM treasury.* London, Britain.
Fuel tax escalator		Introduced 1993; increases fuel taxes 6 percentage points above inflation per year. Aim: to generate government revenue and improve environmental performance of transport by reducing fuel consumption and CO_2-emissions. Should discourage driving, promote better driving and fuel efficiency, and lead to faster fleet turnover and newer, cleaner technology. Ref: BBC news, 21 September, 2000 *UK fuel tax: The facts.* http://news.bbc.co.uk/1/hi/in_depth/world/2000/world_fuel_crisis/933648.stm.
Other		Other initiatives include: • No VED on electric vehicles. • Purchase grants will be made available for electric vehicles. • Zero duty demonstration pilots for bringing forward new 'friendly fuels' put in place by the Green Fuels Challenge.

B Non-monetary incentives

Regulatory Incentives per country		
System	Country	Description
DIVINE Advanced suspension	OECD	Study on the effects of heavy traffic on transport infrastructure. Key conclusion: advanced suspension design for heavy vehicles can reduce road wear and therefore achieve substantial maintenance savings and lead indirectly to improved environmental performance. Example includes 'road-friendly' air or equivalent suspensions. The European Commission has introduced preferential weight limits for vehicles fitted with such suspension. Benefits: substantial savings on maintenance and rehabilitation; increased pavement life between 15% and 60% (depending on type of pavement). Additionally allows increase in vehicle weight, improving transport efficiency and (technically) also environmental performance (i.e. less fuel per unit cargo) and possibly fewer trucks on the road. A positive, non monetary incentive. Ref: www.oecdobserver.org/news/fullstory.php/aid/236/ Trucks:_the_road_to_ruin_or_increased_efficiency_.html - 25k - 22 Oct. 2002 NRTC Publications. Date unknown. *Increased Mass Limits: Compliance and Enforcement Issues - Discussion Paper Certification Of Suspension Systems*. Melbourne, Australia. See: http://www.nrtc.gov.au/publications/report-15_2.asp?lo=public.

CTP *Freight modal shifts, multi-modal corridors*	EU	The EU's common transport policy (CTP) promotes a twofold priority objective to shift the balance (of freight) between modes, viz. from road to rail or shipping: i) regulated competition between modes; ii) link-up of modes (intermodality). Measures to contain road freight and promote a 'genuine' internal market in rail (goods) transport. Also to link road, rail and sea transport routes, as well as develop 'motorways of the sea'. The creation of 'favourable' technical conditions is emphasised: innovative services and so on. Ref: European Commission White Paper, 2001. *European transport policy for 2010: time to decide*. COM(2001) 370.
Air suspension		In Dir 96/53/EC mention is made of 'preference (to be) given to pneumatic or equivalent suspension' to 'prevent excessive road damage' and 'standards (that) reflect a balance between the rational and economic use of commercial road vehicles and the requirements of infrastructure maintenance, road safety and the protection of the environment and the fabric of life'. This is embodied in a positive non-monetary technical incentive. Ref: *Council Directive 96/53/EC laying down for certain road vehicles circulating within the Community the maximum authorized dimensions in national and international traffic and the maximum authorized weights in international traffic*.
Traffic bans - Directive on restrictions on trucks		Night-time bans between 2200 & 0500 only on those vehicles not complying with noise emission classes of Dir 96/20/EC. Based on *per vehicle* noise, not overall noise. Weekend bans possible only from Sat 0700 to Sun 2200 (summer) and Sat 22.00 to Sun 22.00 (winter). Exemptions for combined transport, perishable and exceptional loads.

Multilateral quota	ECMT	Quota evolving to take into account Euro 3 trucks: 'Euro 3 safe' trucks. Member states can choose quota for: 'green', 'greener & safe' and 'Euro 3 safe' lorries. Priority for Euro 3 safe. From 01 Jan 2002 only 'green', 'greener & safe' and 'Euro 3 safe' will benefit from ECMT licences. No more quota for 'traditional' trucks. Reward to countries with high environmental and safety standards, in the form of a bonus (yet to be defined). Oct 2000: Euro 3 class in force but only few countries can deliver appropriate diesel. Bonuses: • x2 - 'green' with bonus of 10% max. if all a country's vehicles with ECMT licence are 'green' • x4 - 'greener & safe'; bonus = 20% max. if all a country's vehicles with ECMT licence are 'greener & safe' • x6 - 'Euro 3 safe'; bonus = 40% if all are 'Euro 3 & safe'. Bonus for 'Euro 3 safe' is high, to provide adequate incentive. Special quota for vehicles meeting Euro 3 introduced 01 Jan 2002, in line with sustainable development and to improve environmental and safety standards. Euro 1 = 'green' NO_x ~9g/kWh; Euro 2 = NO_x ~7g/kWh; Euro 3 = NO_x 5g/kWh. Traditional truck = NO_x 15g/kWh. ECMT, 2001. *Agreement on the evolution of the quota as at 1st January 2002.* CEMT/CM(2001)7/final. Paris, France.

Ecopoint	Austria	Objective: to regulate heavy goods transit traffic through Austria and limit and reduce the air pollution caused by such vehicles. Member States are allocated ecopoints for issue to its transport operators, based on an agreed figure for the number of transits carried out in 1991. The number of ecopoints required per journey depends on the NO_x-emission rating of the vehicle used. Vehicles registered before October 1990 require the maximum 16 ecopoints per journey, newer, environmentally friendlier vehicles fewer. Vehicles first registered later than 1993 generally need only 8 points per journey, some newer trucks require as few as 6 or 7. To qualify for the lower rating, however, a COP (conformity of production) document must be obtained for the vehicle, certifying its lower pollution rating. EU Parliament and (several) Ministers want domestic freight transport to be treated the same as international transit freight transport; otherwise the Ecopoint system should be abolished.

Telematics improved freight logistics	Finland All measures except biofuels and CO_2 agreement initiated and implemented at national level See Annex 3 for CO_2-reduction potential per instrument Reference: see footnote[13]	Objective: to increase the cost-effectiveness of transport and reduce 'all adverse environ-mental effects' including CO_2-emissions. Target group: freight transport operators. Result: lower transport costs for 'more sustainable' modes: rail, shipping. A negative non-monetary incentive.
CO_2-emission standards		Objective: to increase energy efficiency and reduce CO_2-emissions. A voluntary energy saving agreement with the Truck Drivers Association and Bus Drivers Association. Specifics concerning actions not specified. Target group: 'especially' professional drivers. Result: increased energy efficiency and reduced CO_2 and other emissions.
Ecodriving Including on-board devices		Objective: principally to reduce CO_2 emissions, but also other environmental and safety objectives. Since 1997 eco-driving has been integrated into general driver education. Target group: individual and professional drivers. Result: reduction of CO_2 and other emissions, improved safety and other unspecified benefits. A positive non-monetary incentive.
Modal shift for freight		Objective: to promote 'environmentally friendly' freight transport modes, particularly rail and shipping (see telematics initiative). Initiatives being developed to promote use of Baltic Sea shipping potential. Target group: freight transport operators, handlers, shippers, etc. Result: increased logistical efficiency (port functions, loading/unloading, traffic flow systems); rail and shipping maintain strong market share (rail ~25%). A negative non-monetary incentive.
Speed limits		Objective: primarily increased safety, but increasingly seen as a measure to improve environmental performance via reduced speed (noise) and fuel consumption (emissions). Target group: principally car drivers (who cause most accidents) but also other road users. Results: lower accident rate, reduced noise and emissions.

No specific incentives for freight transport. Incentives being considered	Sweden	Incentive to promote purchase of environmentally friendly technology described as 'urgent'. Ministry of Finance of Sweden. 2002. *Vissa vägtrafisskatterfrågor.* SOU 2002. Stockholm, Sweden. Report in Swedish with English summary.

[13] Mäkelä, K. 2002. *Personal communications*. VTT - Technical Research Center of Finland, Building and Transport.
Saari, R. 2002. *Personal communications*. Ministry of Transport and Communications, Finland.

Energy 2000	Switzerland	Activities to foster fuel-efficient driving. Eco-driving leads to 10-20% reduction of fuel consumption. Leads to environmental and economic gains. Is voluntary, leading to behavioural change. Should stabilise energy consumption and CO_2-emissions.
Other		Other initiatives: • Technical standards. • Regular obligatory exhaust emission tests. • Infrastructure project appraisals (national and cantonal level). Ref (all): Stefan Suter. 2000. *Personal communications*. Infras, Switzerland.

'Powering future vehicles'	UK	UK's 'Powering Future Vehicles' strategy aims to shift to clean, low-carbon transport. Regulatory (non-fiscal) incentives possibly relevant to trucks include: • MOTs now include emissions tests. • Local authorities will soon be introducing emissions spot checks.