Policy Department B
Structural and Cohesion Policies

PRICING SYSTEMS FOR ROAD FREIGHT TRANSPORT IN EU MEMBER STATES AND SWITZERLAND
Directorate General for Internal Policies of the Union

Policy Department Structural and Cohesion Policies

TRANSPORT AND TOURISM

PRICING SYSTEMS FOR ROAD FREIGHT TRANSPORT
IN EU MEMBER STATES AND SWITZERLAND

STUDY

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Authors: TRT - Trasporti e Territorio, Milan (Italy)*

Responsible Official: Mr Nils Danklefsen
Policy Department B: Structural and Cohesion Policies
European Parliament
B-1047 Brussels
E-mail: ipoldepb@europarl.europa.eu

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* Angelo Martino, Silvia Maffii, Elisa Boscherini, Maurizia Giglio.
Directorate General for Internal Policies of the Union

Policy Department Structural and Cohesion Policies

TRANSPORT AND TOURISM

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IN EU MEMBER STATES AND SWITZERLAND

STUDY

Content:

The aim of this study is to provide an in-depth analysis of the existing charging system for heavy goods vehicles (HGV) in the European Union and in Switzerland. This study therefore, presents an overall picture of the current schemes in operation and their impacts, in light of the proposed development of the "Eurovignette" directive, the debate on climate change and the expected growth in road freight transport.
Executive summary

The object of this study is to provide the Committee on Transport and Tourism with an in-depth analysis of the existing charging system for heavy goods vehicles (HGV) in the European Union and in Switzerland. This study therefore, presents an overall picture of the current schemes in operation and their impacts, in light of the proposed development of the "Eurovignette" directive, the debate on climate change and the expected growth in road freight transport.

The picture of charging systems in the European Union is however quite varied at present. Some countries are still operating with the traditional vignette schemes, others apply tolls only for those parts of the motorway network which are operated by private concessionaries, there are a few countries which have already introduced distance-based charging systems and there is another group of Member States which do not currently have any schemes in place. But the situation is not all static on the policy side as many Member States are in the process of revising their road pricing strategies in anticipation of the new steps to be taken at European level with a view to reviewing the internalisation of external costs.

The results of this study are based on an in-depth review of recent reports, projects, statistics, notes etc., which have already analysed the systems in place and their impacts and which have assessed and recommended various options of improving and developing the present road pricing system.

The review has allowed for the identification of the most promising actions to be developed by the European Union to face the challenge of obtaining an interoperable transport pricing system across Europe which is capable of guaranteeing welfare efficiency, external costs coverage and revenue generation.

Methodology

The study has been divided into three parts: the first part is dedicated to the analysis of the current charging system, the second part is devoted to the analysis of observed and potential impacts of charging schemes and the third part presents the advantages and disadvantages of the identified approaches and suggested recommendations:

▪ The first part, “Overview of Current Charging Systems for Road Freight Transport” reviews the theoretical, legislative and regulatory aspects of the existing charges for infrastructure use and provides a panoramic view of the current situation in Europe.

▪ The second part, “The Impacts of the Different Charging Systems” focuses on the effects of the ongoing practices in the charging of infrastructure use in Switzerland, Germany, Austria and the Czech Republic. For each of these countries, the observed impacts on modal split, reduction in vehicle-kilometres, fleet composition and renewal, use of revenues, traffic diversion and load factor optimisation have been reviewed. The most significant impacts are subjected to a comparison analysis between the four countries concerned and the countries with private distance-based concessionaires and time-based systems. The analysis is complemented by the examination of further potential measures which could be implemented in other countries and in sensitive areas.

▪ The third part “Conclusions and Recommendations” compares the advantages and disadvantages of the time-based (vignette) and the distance-based systems so as to assess the best way forward in obtaining the EU environmental policy objectives and outlines the final suggestions for further development in the HGV charging system in Europe.
Existing charging systems

Four countries have already begun working towards the full application of distance-based charging schemes for HGV proposed by the “Eurovignette” Directive and which are considered as the most suitable way to apply the “user pays” and “polluter pays” principles: these are Austria, the Czech Republic, Germany and Switzerland. The main aims of these systems are the infrastructure financing in favour of more sustainable modes of transport and the protection of the environment.

In France, Spain, Greece, Italy, Portugal and Slovenia, parts of the motorway network have been operated by the private sector for several decades. Private operators have the right to levy tolls for the use of the motorways and toll levels are generally part of the contract with the national authorities. Tolls then cover operating costs, including a surplus as a profit and are differentiated by type of vehicle, motorcycle, cars and light and heavy goods vehicles.

In other countries, there is a different situation:

▪ Belgium, Denmark, Luxembourg, the Netherlands and Sweden have operated a vignette system since 1 January 1995. The vignette fees apply to the motorway network and certain national roads for vehicles over 12 tonnes. The fee is time-based and works on a pre-paid basis. Differentiation is on the basis of the environmental performance of the vehicle (EURO class) and number of axles;

▪ Other Member States apply some kind of user charging on their motorway networks: Bulgaria and Romania operate time-based vignette systems for the use of all inter-urban roads; in Hungary, Lithuania and Slovakia, vignette stickers are compulsory on certain motorway sections, while in Poland there is a toll charge on a few sections.

Several countries do not presently have any charging systems for road infrastructure, but some of them are currently examining the introduction of pricing schemes: for instance, in the UK there are ongoing discussions concerning the introduction of a national distance-based system for all vehicles; also Sweden and the Netherlands have examined the possibilities of implementing an inter-urban kilometre charging system for heavy goods vehicles.

Impacts of charging systems

The impacts of the HGV pricing regimes are quantifiable only in a few cases. The lack of evidence is due to the fact that a longer period of time may be necessary in order for charging reforms to reveal their effects. In addition to the existing difficulties in taking impacts of pricing policies out from other factors and/or long term trends, there are other factors to consider such as increased fuel prices, changed vehicle weights and opening of markets to Eastern Europe, etc.

Starting from the observed impacts analysed in case studies and taking into account the existing difficulties in the road freight transport market, the table below summarises the potential impacts that are important to consider in outlining an optimal pricing policy.
### Effects of HGV pricing policies

<table>
<thead>
<tr>
<th>Potential impact</th>
<th>Description</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet renewal</td>
<td>The pricing schemes might help in accelerating the truck fleets renewal rates: it is important to coordinate the pricing schemes with the emission standards time schedule so that truck operators can plan their investments in advance. In other words, the interplay between a charging regime and the regulation framework in the same policy field is highly relevant.</td>
<td>+++</td>
</tr>
<tr>
<td>Vehicle size/weight</td>
<td>Experience has shown that the market adjusts on the basis of the limits imposed by the pricing policies and therefore care must be paid to possibly include all types of freight vehicles in the schemes. The exemption of light goods vehicles (&lt;3.5t) from the charging regime creates an incentive to switch to such vehicles even if this strategy is not efficient from a purely internal cost point of view (such a switch to light goods vehicles would have been more marked if the borderline had been set at 12t like in the case of the German Maut).</td>
<td>++</td>
</tr>
</tbody>
</table>
| Detours                       | There is evidence that a distance-based pricing system applied to the motorway network implies the possibility of detours. This phenomenon happens where a dense secondary network of good quality adjacent to the motorways exists and where such a secondary network is not already congested. There are two ways to tackle this aspect: either to enforce speed limits and restricted access in the secondary roads, or to extend the pricing system to the whole network (even though, in this case the traffic detour could occur in neighbouring countries). | Small geographic area ++  
Larger geographic area + |
| Road haulage optimisation     | The pricing systems might help in reducing empty trips as well as in increasing load factors, even though it has to be stated that the market is already quite efficient and highly competitive. In order to preserve their own competitiveness, truck companies react quickly putting in place cost reducing measures (in purchase and investment decisions as well as in decisions concerning the use of vehicles), but the improvements are rather marginal. | +               |
| Modal shift                   | HGV pricing might have limited effect: experiences have shown that no significant modal diversion is observed. Problems of capacity of alternative modes should also be considered: where spare capacity on more environment-friendly modes is available, incremental charging might be applied to induce local modal shift. | +/-             |

**Distance-based vs. time-based pricing systems**

The analysis of the existing panorama of pricing systems and of their effects suggests that the two main existing regimes, time-based and distance-based systems, could be considered as steps towards a common European pricing policy characterized by a distance-based system applied to the whole network. The main reason to develop from a time-based to a distance-based approach widely applied can be deduced from the table below, which shows the main advantages and disadvantages of the two existing charging approaches.
Advantages and disadvantages of HGV road pricing approaches

<table>
<thead>
<tr>
<th>Time-Based pricing</th>
<th>Distance-Based Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td><strong>Limited Network</strong></td>
</tr>
<tr>
<td>Low implementation costs</td>
<td>Possibility to internalise external costs</td>
</tr>
<tr>
<td>Simple and easy to understand</td>
<td>Congestion reduction to some extent</td>
</tr>
<tr>
<td></td>
<td>Technological flexibility</td>
</tr>
<tr>
<td></td>
<td>Transparent and user friendly system</td>
</tr>
<tr>
<td></td>
<td>Fair revenue generation</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td><strong>Limited Network</strong></td>
</tr>
<tr>
<td>Low effectiveness for environmental improvements</td>
<td>Traffic diversion on secondary roads</td>
</tr>
<tr>
<td>Unsuitable for fighting congestion</td>
<td>Substantial initial investment</td>
</tr>
<tr>
<td>No influence on traffic management</td>
<td>Low-tech</td>
</tr>
<tr>
<td>Low-tech</td>
<td>Low revenue potential</td>
</tr>
</tbody>
</table>

In light of the analysis illustrated in the table above, the main reasons for choosing the distance-based approach can be summarised as follows:

- To increase the coverage of external costs, reducing negative environmental impacts of HGV transport;
- To reduce the negative impacts of pricing applied only to a limited network, such as detours of traffic to secondary roads;
- To guarantee harmonization with other national pricing systems through an interoperable technology system, progressively less expensive thanks to the developments in technology;
- To increase revenues and assure funds to finance other modes of transport, with a view to a more balanced modal shift.
Recommendations

In view of the expected growth of road freight transport and in order to obtain a sustainable transport policy that ensures that road freight transport pays the price for the costs it is producing, the European Commission, the Parliament and the Council are debating on how best to improve the efficiency of infrastructure use and reduce the negative externalities.

As the theoretical, legislative and regulatory aspects of the study have shown, an efficient pricing system for road freight transport means that the charges should clearly reflect the marginal external and infrastructure costs. This requires differentiation of tariffs for various parameters such as axle load (infrastructure cost), Euro standard emissions, day/night (congestion), and location, and potentially a differentiation with regard to vehicle noise emission class.

In addition, more efficient pricing, the internalisation of external costs and the consequent higher level of charges would probably increase the shift of vehicle travel to unpriced or lower priced infrastructures (traffic diversion) or to alternative modes (modal shift) and could reduce vehicle trip frequency.

The overview of current charging systems has demonstrated that an univocal way to act does not already exist: current charges in different countries are based on different charging principles and include different costs categories. The analysis of the effects of the on-going practices in charging for infrastructure use have shown that strong impacts on reducing emissions and energy consumptions are very difficult to obtain also, when distance-based systems are applied.

In view of these reflections, recommendations have been produced in order to suggest for the revision of the Eurovignette Directive the application of the following progressively compulsory pricing criteria:

- **Highly differentiated tariffs** – Apply charges differentiation through the technological improvements that allow an increasing tariff modulation on the basis of the weight of vehicle, vehicle axles, emission class, time and specific sections of infrastructure in order to reflect environmental, accident and congestion costs.

- **Regulatory charges** – The use of time-variable tolls in sensitive areas, with higher rates during peak periods and lower rates during off-peak periods so as to reduce congestion and environmental impacts. However, the application of high regulatory charges to fight congestion in densely populated areas or in sensitive areas should not have any discriminatory effects on transit traffic.

- **Vehicle target** – Extend tolls to heavy vehicles > of 3.5 tonnes, moving towards a pricing scheme compulsory also for cars.

- **Network** – Extend tolls to encompass the entire network: it is necessary to levy charges for heavy goods vehicles also on secondary and local road networks in order to avoid the traffic diversion phenomenon, support the modal shift and increase the revenue for transport. The setting of regulatory charges on the secondary network should primarily be imposed where HGV traffic causes considerable problems for environment and for the inhabitants’ quality of life (sensitive areas).

- **Interoperability and harmonisation** – Work towards ensuring standardisation of normative framework and interoperability of technology instruments as an important element of convenience and efficiency both at national and international level.

Success factors of a pricing policy characterized by the above-mentioned criteria are:
Pricing systems for road freight transport

- **Acceptability** - Ensure that road pricing decisions are transparent, built on public participation and as predictable as possible so as to increase pricing measure acceptability: clear political objectives related to tolls' introduction or modification have to be defined, and the comparison of tolls with other possible instruments to reach those objectives has to be carried out with great care. Ensure that careful estimation of the impacts of the tolling scheme is carried out, with particular attention given to the environmental impacts of the transit traffic on citizens living in sensitive areas. The engagement of stakeholders should be pursued in a systematic manner, so that acceptance issues may be managed in a sensible way. It is recognised that these processes always take several years to mature in public opinion and that the choices must be made in “political windows of opportunity” of relatively short duration.

- **Policy mix** - Integrate pricing with other strategies that increase haulers' choice and provide additional incentives to use alternative modes in the same area: prices are just one of the types of instruments in support of transport policy (the main other ones being vehicle management, infrastructure management and technological improvements). In pursuit of an optimal intervention on the transport system, policy makers should take into account all of these other types of instruments.

**Complementary measures**

To complete the EU policy framework, complementary measures should boost the effects of pricing systems in order to improve the environmental performance of the transport system, especially regarding the following EU Transport Policy goals:

- A more balanced modal shift particularly towards the rail system by way of: capacity enhancements, better management of the existing system, and increasing quality and services (TRANSCARE 2006).

- Greater efficiency of the logistic performance of road transport through:
  - Co-modality, which requires improving the efficiency, interoperability and inter-connectivity of rail, maritime, inland waterway transport, air and road transport and related hubs to achieve their full integration in a seamless door-to-door service,
  - Intelligent Transport Systems that offer ways to improve transport and cargo management and increase the utilisation of available infrastructure,
  - The development of “green freight transport corridors” (COM(2007) 607), characterised by low impacts on the human and natural environment, which gives further substance to the objective of integrating environmental as well as safety and security concerns in the design and operation of infrastructure in the trans-European transport network,
  - Drivers’ training programmes to ensure that vehicles are driven in a safer and more responsible manner with an increasing involvement of European truck manufacturers and also other road users who have an equal responsibility for road safety.

- A reduction of energy consumption and emissions in the road transport sector by:
  - Promoting energy efficiency through the application of “compulsory agreements” between the European Commission and vehicle manufacturing associations to bring down CO₂ emissions from trucks over 3,5 tonnes,
  - Re-structuring of road registration tax and annual circulation tax by linking taxation to CO₂ emissions and energy consumption (New Directive by 2012).
# Glossary of abbreviations and acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ACE</td>
<td>Alpine Crossing Exchange</td>
</tr>
<tr>
<td>ACP</td>
<td>Alpine Crossing Permit</td>
</tr>
<tr>
<td>ACU</td>
<td>Alpine Crossing Unit</td>
</tr>
<tr>
<td>ANPR</td>
<td>Automatic Number Plate Recognition</td>
</tr>
<tr>
<td>BALT</td>
<td>Bilateral Agreement on Land Transport</td>
</tr>
<tr>
<td>CHF</td>
<td>Swiss Franc</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>CRT</td>
<td>Cost Recovery Theorem</td>
</tr>
<tr>
<td>CZK</td>
<td>Czech koruna</td>
</tr>
<tr>
<td>DG TREN</td>
<td>Directorate-General Energy and Transport</td>
</tr>
<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communications</td>
</tr>
<tr>
<td>EFC</td>
<td>Electronic fee Collection</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EU 15</td>
<td>The 15 Member States of the European Union since 1995</td>
</tr>
<tr>
<td>EU 27</td>
<td>The 27 Member States of the European Union since 2007</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile communications</td>
</tr>
<tr>
<td>GTW</td>
<td>Gross Total Weight</td>
</tr>
<tr>
<td>HGV</td>
<td>Heavy Goods Vehicle</td>
</tr>
<tr>
<td>HVF</td>
<td>Heavy Vehicle Fee</td>
</tr>
<tr>
<td>NARL</td>
<td>New Alpine Rail Link</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrogen Oxide</td>
</tr>
<tr>
<td>OBU</td>
<td>On-Board Unit</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Particulate Matter</td>
</tr>
<tr>
<td>SMC</td>
<td>Social Marginal Cost</td>
</tr>
<tr>
<td>SRMC</td>
<td>Short Run Marginal Costs</td>
</tr>
<tr>
<td>T&amp;E</td>
<td>European Federation for Transport and Environment</td>
</tr>
<tr>
<td>TEN-R</td>
<td>Trans-European Road Network</td>
</tr>
</tbody>
</table>
Pricing systems for road freight transport

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Pricing systems for road freight transport
1. Introduction

In order to provide the Committee on Transport and Tourism with an in-depth analysis of the existing charging system for heavy goods vehicles in the European Union and in Switzerland, this study presents an overall picture of the current schemes and their impacts, in the light of the developments of the Eurovignette directive, the debate on climate change and the expected growth in road freight transport.

The picture of charging systems in the European Union is however quite fragmented. Some countries still operate with traditional vignette schemes, some others apply tolls only for those parts of the motorway network operated by private concessionaries, and while a few countries have already introduced distance-based charging systems, there is another group of Member States which do not have any charging scheme in place. But the situation is not static on the policy side, as many Member States are in the process of revising their road pricing strategies in the light of the new steps which will be taken at European level in the direction of the internalisation of external costs.

This report is divided into three parts:

I. The first part “Overview of Current Charging Systems for Road Freight Transport” reviews the theoretical, legislative and regulatory aspects of the existing charges for infrastructure use, providing a panorama of the current situation in Europe.

II. The second part “The Impacts of the Different Charging Systems” focuses on the effects of the on-going practices in charging for infrastructure use in Switzerland, Germany, Austria and the Czech Republic. For each country, the observed impacts on modal split, reduction in vehicle-kilometres, fleet composition and renewal, use of revenues, traffic diversion and load factor optimisation are discussed. The most significant of these impacts are subject to a comparative analysis between the four countries concerned and countries with distance-based concessionaires and time-based systems. The analysis is complemented by the examination of further potential measures in other countries and in sensitive areas.

III. The third part “Conclusions and recommendations” puts forward final suggestions for the further development for HGV charging systems in Europe.

In addition to this introductory chapter, the three parts of the report are articulated in six chapters which analyse in detail the following themes:

- A brief review of the body of economic theory on charges for infrastructure use and the current legislative framework at European level and in Switzerland concerning the HGV pricing system (chapter 2);
- A review at European level of the implementation of existing HGV charges for infrastructure use, shedding light on characteristics of road networks involved and of tariffs applied (chapter 3);
- The analysis of detailed impacts of implemented distance-based systems' characteristics and the comparison of the effects of distance-based and other charging systems such as distance-based concessionaires and time-based systems (chapter 4);
- The analysis of further studies on expected impacts of potential policy and technological measures in other EU countries and in sensitive areas (chapter 5);
The evaluation of existing pricing systems on the basis of fixed criteria and policy recommendations on the future opportunities for HGV pricing systems. The focus will be on the possible measures to reduce GHG emissions and energy consumption and on the EU's role in the further development of road pricing systems (chapter 6).

With the aim of identifying the key issues for HGV pricing in the European Union, the study is built on policy documents and scientific literature as well as direct contacts with the stakeholders in different Member States. The work has also benefited from research projects developed during the last few years on behalf of the Directorate-General for Transport as part of the Framework Programme for Research. The full list of references can be found in the final chapter of the report (chapter 7).
Part I: Overview of Current Charging Systems for road freight transport

2. Theoretical and legislative framework for road pricing

2.1. Introduction

In view of the expected growth of road freight transport and in order to obtain a sustainable transport policy that does not fail to charge road freight transport for the costs it is causing, the European Commission and Parliament are debating how to introduce efficient road charging to internalise external costs. By internalising external costs, transport prices would give the right signal to transport users and would improve the efficiency of infrastructure use and reduce negative externalities.

According to welfare theory, the primary motif for the internalisation of external costs is for a more efficient economy. This is particularly related to influencing behaviour towards a better use of existing resources by providing optimal incentives, which in the neoclassical model is based on Social Marginal Cost (SMC) pricing scheme.

Efficient pricing means that both external cost and infrastructure cost are taken into account. It does not necessarily mean that the overall charge level of road transport increases. Particularly in countries that have already relatively high tolls (and/or excise duties), making road charging more efficient would result in restructuring of charges rather than in an overall increase.

Efficient pricing for road freight transport means also that charge levels would much better reflect the marginal external and infrastructure cost. This requires differentiation in terms of various parameters such as axle load (infrastructure cost), Euro standard emissions, day/night (congestion), location, and potentially a differentiation with regard to vehicle noise emission class. In practice, however, an univocal way to act does not already exist: current charges in different countries are based on different charging principles and include different categories.

Before starting with the analysis of the existing pricing systems in the EU and Switzerland (taken into consideration in this study due to its innovative pricing policy), this chapter aims to presents the main theoretical and legal constraints to the application of pricing measures, in order to better understand the complex problems and possible solutions to be adopted in a step-by-step pricing process.

This chapter is organized as follows:
- Paragraph 2.2 deals with the policy context at European level;
- Paragraph 2.3 offers a brief review of the legislative framework (Eurovignette Directive, recent developments on internalisation of external costs and Interoperability Directive);
- Paragraph 2.4 concerns the Swiss legal framework related to the HGV pricing system.
2.2. The EU policy context

The efforts aimed at the introduction of pricing instruments towards sounder transport policy, started out from economic theory, which since 1995, has become one of the main goals of the European legislative activity.

During the last years, the Directorate-General for Transport of the European Commission has been active in promoting the implementation of pricing reforms based on marginal cost principles, preparing two groundbreaking policy papers as well as sponsoring numerous research projects.

Box 1 Theoretical framework of transport pricing

Although the theoretical aspects of the transport infrastructure pricing do not appear to suggest univocal information for identifying the optimal transport pricing scheme, the theory represents a valuable instrument to obtain empirical estimations on the alternative pricing solutions, taking into account the diverse objectives to be pursued.

Economic theory provides a contribution along two main lines, that move from a normative approach (how transport charges should be in order to ensure welfare maximization or investment cost recovery) towards a positive approach (how transport charges actually are in order to take account of several constraints). The normative approach describes how price differentiation is affected by the economic efficiency objective, while the positive approach further elaborates on the existing constraints to the SMC pricing application and the impact of policy makers and interest groups on the differentiated price structure. The normative approach concerns the formulation of the optimal framework for transport charges differentiation. It is reached by pursuing economic efficiency, according to which transport charges (prices) should be equal to SMC in order to obtain maximum social welfare.

The rules of SMC pricing assume that all the complements, substitutes and inputs to the transportation service are also priced at marginal cost. However, pricing a service at marginal cost might not be optimal if at least one potential complement, substitute or input is not priced at its marginal cost. In addition, the following conditions should be met to validate the SMC pricing:
- markets should be competitive (firms act as price-takers);
- there must not be any public goods or external effects;
- cost functions should show no increasing return to scale;
- there should not be any information asymmetry.

These “first best” situations in reality are never met completely. Numerous constraints make it necessary to amend the SMC pricing rule, leading to the positive approach. The main constraints that ask for a diversion from the rule of pure and strict SMC pricing are technological and practical constraints: first-best pricing requires charges that vary continuously over time, place, route chosen, type of vehicle, driving style, etc (Verhoef, 2002).

European transport pricing policy development took a major step forward in 1995, with the publication of the Green Paper "Towards fair and efficient pricing in transport" (COM (95) 691), which recognized the importance of pricing to reflect external costs. The objective of this paper was to make infrastructure charging more transparent and fairer based on the same principles and methods; in fact, the paper stresses the need to introduce a charge for heavy vehicles, due to the increase in road freight transport.

The policy was taken further in the White Paper on “Fair payment for infrastructure use” in 1998 (COM (98) 466 final). This document put a clear case for marginal cost pricing, whilst recognizing that the movement towards this target would need to be phased over a number of years, and that second best measures to achieve desired levels of cost recovery would continue to be necessary.

Shortly before the publication of this White Paper, the European Commission created a High Level Group on Transport Infrastructure Charging for advice on the development of a comprehensive set of charging principles. This group presented a series of reports in that direction, with strong recommendations towards adoption of social marginal cost pricing, and specific recommendations for the systematic application of this principle.
Complementing these policy initiatives, the European Union's fourth (1994-1998), fifth (1998-2002) and sixth (2002-2006) Framework Programmes for Research and Technological Development included a significant number of projects directed at the various issues relevant for application of prices for the use of infrastructure (see Annex I – The Transport Pricing Research Programme).

However, politicians have other objectives to follow besides maximum economic efficiency, so that on the political front – namely in the European Council and Parliament – the principle of defining user prices based on social marginal cost was not adopted, as the following policy and normative steps show.

**Box 2 The objectives of road pricing**

Clarifying the objectives of a road pricing strategy is arguably the most important prerequisite for determining the design of any charging system.

The aims of the agents involved in a pricing policy can range from the very general (e.g. economic efficiency which comes down to welfare maximisation) to the very case-specific (e.g. profit maximisation). The following pricing objectives have been distinguished by economic theory:

- economic efficiency: the objective of economic efficiency is usually important to governments as it reflects the aim to maximise welfare of all inhabitants. In a first-best world, optimal charges, reflecting SMC (Button, 1993), will be very complex with a very high level of differentiation;

- profit maximisation: profitability reflects the traditional economic assumption that firms set prices to maximise profits. Studies analysing the consequences of private involvement in transport have shown that private tolls are different from optimal tolls based on SMC theory, leading to other welfare levels (see Verhoef et al., 1996). Variations on these theories suggest that many undertakings adopt prices that maximise sales revenues (Baumol, 1962) when in an expansive phase, or simply price to ensure that certain satisfactory levels of profit or market domination are achieved (Simon, 1959). In any case, profit maximisation leads to a mark-up on marginal costs;

- cost coverage: a third possible objective is that of cost coverage. Most publicly owned firms are not so much focused on making profits but rather aim to stay in business and recoup their costs, often induced to do so for political or fiscal reasons. Cost coverage leads to the issue of determining a mark-up on marginal costs. Ramsey pricing is often suggested to be a solution in order not to deviate too much from efficient pricing. Ramsey pricing minimises the distorting effect of charging more than marginal cost by increasing prices more in those markets where demand is least sensitive to price (Nash, 2001);

- environmental sustainability: protection of the environment has become an important objective for governments in recent years. Transport in general, and road transport in particular, are widely recognised as an important source of pollution which threatens environmental sustainability. Pricing measures have been suggested or introduced to deal with these problems. In an increasing number of countries, freight traffic is confronted with charges that are differentiated according to vehicle type and emissions category. Road damage costs and environmental costs are the basic motivations for this type of differentiation.

The most recent transport policy documents, the 2001 White Paper “European transport policy for 2010: time to decide” (COM (2001) 370) and the 2006 mid-term revision “Keep Europe Moving” (COM (2006) 314), reaffirm the commitment to more efficient pricing of transport in order to internalise externalities, but the expression “marginal cost” no longer appears.

In parallel to the publication of these policy documents, the Commission has tried to develop a comprehensive approach to road transport taxes and charges, due to the variety among existing different pricing systems in EU, which distort competition. A number of mode-specific pricing directives have been published, including the ”Eurovignette” Directive (2006/38/EC) that deals with road freight transport pricing and tries to find a solution between the principle of defining user prices based on SMC and the political objectives. The Directive is illustrated in the following section.
2.3. The European legislative framework

2.3.1. The “Eurovignette” Directive

Rules for road infrastructure charges for heavy goods vehicles are specified in Directive 2006/38/EC, which amends the 1999 “Eurovignette” Directive 1999/62/EC and has the objective of reducing obstacles to the free movement of goods and guaranteeing fair competition between road haulage operators. The revision of the Eurovignette Directive has been prepared over a two-year negotiation process.

The 1999 directive was updated with the twofold aim of creating a uniform platform for motorway tolling in the EU and giving further incentives to improve capacity use and environmental performance in the road transport sector. The new regime allows (but not obliges) the Member States to levy user charges or tolls on the entire road network and set the pricing rule for vehicles on the TEN-T network.

It is useful to illustrate the main features of the directive making reference to the following relevant themes:

- **Network extension**: the Directive applies to the whole Trans-European Transport Network (TEN-T). Although not obliging them to do so, the Directive also allows Member States to levy tolls and user charges on all other roads as well;
- **Vehicles involved**: the Directive applies to vehicles over 3.5 tonnes, Member States are thus free to implement charging schemes for all such vehicles, or alternatively may choose to continue existing schemes or introduce new ones for vehicles over 12 tonnes, but only until 2012;
- **“Polluter pays” principle**: a fairer system of charging for use of the road infrastructure is provided on the basis of the “user pays” principle. Member States may charge different tolls depending on the day of the week and time of day and even vary fees on the basis of the EURO emission classes or PM/NOx emissions as of 2010;
- **“Regulatory charges”**: the Directive allows Member States to levy additional so-called “regulatory charges” that are specifically designed to combat time- and place-related congestion or environmental impacts, for example in urban areas. These charges can be levied on top of the “weighted average fee”, but the Directive does not define “time- and place-related congestion” or “environmental impacts”;
- **“Mark-ups”**: this is a new instrument allowing Member States to add 15% or 25% to the average toll on roads in mountainous areas, subject to certain conditions:
  - the road section must be subject to acute congestion or the vehicle using these road sections must cause significant environmental damage
  - the revenues must be invested in priority projects of the TEN-T networks;
  - the maximum level for mark-ups is 15% (25% in case of cross-border projects);
  - discounts may be given to frequent users, but not exceeding 13% of the standard tolls.

The Directive lists the conditions to be met by Member States wishing to introduce and/or maintain tolls or introduce user charges. These conditions are as follows:

- Tolls and user charges may not discriminate, directly or indirectly, on the grounds of nationality of the haulier, the country or place of establishment of the haulier or of registration of the vehicle, or the origin or destination of the transport operation, not resulting
in distortions of competition between operators. Fees should be transparent and proportionate
to the objective pursued, and their collection should not involve excessive formalities or
create barriers at internal borders;

- Revenues from tolls or user charges should be used for the maintenance of the infrastructure
  concerned and for the transport sector as a whole, in the interest of the balanced and
  sustainable development of transport networks. The Directive recommends that the revenues
  should be used to benefit the transport sector and optimise the entire transport system (not
  just for roads). As recommendations are not legally binding, Member States may also use the
  revenues for non-transport purposes. Tolls will still be based on the principle of recovery of
  infrastructure costs although environmental considerations will also play a key role in
determining the rate charged. The revenues of user charges or tolls may not exceed the
infrastructure costs, but the Directive specifies that the weighted average toll shall in principle
not exceed construction costs and operating costs, maintaining and developing the
infrastructure network concerned. The weighted average toll may also include a return on
capital or profit margin based on market conditions. In the absence of a Community
framework for tolled motorway concessions, the notion of weighted average tolls is quite a
broad umbrella for the variety of approaches used in different Member States to determine
tolls;

- Member States have to ensure that systems are properly implemented; to achieve this, they
  may take all necessary measures and establish penalties which are effective, proportionate
  and dissuasive.

2.3.2. The EU action towards internalisation of external costs

The current approach followed by the Commission initiative on road freight pricing policy is to
propose a strategy to consider the need of internalising external costs generated by Heavy Goods
Vehicles in the definition of tariffs, according to the principle of "polluter pays\(^2\)", as has been
requested by the European Parliament (TREN.A2/EM/cc D(2007)).

With regard to the **internalisation of the external costs**, the Eurovignette Directive states that:
“\textit{No later than 10 June 2008, the Commission shall present, after examining all options including
environment, noise, congestion and health-related costs, a generally applicable, transparent and
comprehensible model for the assessment of all external costs to serve as the basis for future
calculations of infrastructure charges}”. Moreover, it adds that: “\textit{This model shall be accompanied
by an impact analysis of the internalisation of external costs for all modes of transport and a
strategy for a stepwise implementation of the model for all modes of transport}”.

\(^2\) The “polluter pays” principle is defined as a political/economic principle which stipulates that the user should pay
the full social cost (including environmental costs) of his/her activity (CE Delft, 2007).
Box 3 External costs in the IMPACT study

The monetary evaluation of external costs, and their allocation to individual modes, is complex and the results of current studies on this subject vary widely, depending on how included costs are differentiated and the methodology used. Costs also vary as a function of place, time, vehicle characteristics, and vehicle and route capacity utilisation. The IMPACT study (CE Delft, 2007), carried out on behalf of the Directorate-General for Transport, has provided an overview of the range of the unit values recommended by different studies for the different cost categories of road transport. Despite substantial differences in methodologies and results, the existing studies demonstrate that:

- external costs arising from road freight transport are substantially higher than those from road passenger transport,
- external marginal costs of road freight transport vary greatly according to vehicle type, route and traffic situation,
- external costs of road freight transport are on average higher than its infrastructure costs.
- the overall costs from road freight transport exceed the contribution it makes to government revenue via payment of taxes and charges.

The table below summarises the values for heavy duty vehicles, compared with the passenger cars, calculated by the IMPACT study team for Germany.

**External costs caused by road freight transport**

<table>
<thead>
<tr>
<th>Cost component</th>
<th>Passenger car</th>
<th>Heavy duty vehicle (HGV)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit costs</td>
<td>Unit costs</td>
</tr>
<tr>
<td></td>
<td>(€/vehicle/km)</td>
<td>(€/vehicle/km)</td>
</tr>
<tr>
<td><strong>Emissions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>Urban, day</td>
<td>0.76 (0.79-1.35)</td>
</tr>
<tr>
<td></td>
<td>Urban, night</td>
<td>0.35 (0.13-3.37)</td>
</tr>
<tr>
<td></td>
<td>Interurban, day</td>
<td>0.12 (0.04-0.17)</td>
</tr>
<tr>
<td></td>
<td>Interurban, night</td>
<td>0.22 (0.09-0.22)</td>
</tr>
<tr>
<td>Congestion</td>
<td>Urban, peak</td>
<td>30.0 (5.0-56.5)</td>
</tr>
<tr>
<td></td>
<td>Urban, off-peak</td>
<td>0 (±)</td>
</tr>
<tr>
<td></td>
<td>Interurban, peak</td>
<td>10 (0-20)</td>
</tr>
<tr>
<td></td>
<td>Interurban, off-peak</td>
<td>0 (±)</td>
</tr>
<tr>
<td>Accidents</td>
<td>Urban</td>
<td>4.12 (0.0-4.47)</td>
</tr>
<tr>
<td></td>
<td>Interurban</td>
<td>1.67 (0.0-2.55)</td>
</tr>
<tr>
<td>Air pollution</td>
<td>Urban, petrol</td>
<td>0.17 (0.07-0.24)</td>
</tr>
<tr>
<td></td>
<td>Urban, diesel</td>
<td>0.52 (0.01-2.05)</td>
</tr>
<tr>
<td></td>
<td>Interurban, petrol</td>
<td>0.00 (±)</td>
</tr>
<tr>
<td></td>
<td>Interurban, diesel</td>
<td>0.02 (±)</td>
</tr>
<tr>
<td>Climate change</td>
<td>Urban, petrol</td>
<td>0.37 (0.97-1.52)</td>
</tr>
<tr>
<td></td>
<td>Urban, diesel</td>
<td>0.81 (0.61-2.16)</td>
</tr>
<tr>
<td></td>
<td>Interurban, petrol</td>
<td>0.05 (±)</td>
</tr>
<tr>
<td></td>
<td>Interurban, diesel</td>
<td>0.45 (0.05-0.95)</td>
</tr>
<tr>
<td>Up- and downstream processes</td>
<td>Urban, petrol</td>
<td>0.37 (0.97-1.52)</td>
</tr>
<tr>
<td></td>
<td>Urban, diesel</td>
<td>0.81 (0.61-2.16)</td>
</tr>
<tr>
<td></td>
<td>Interurban, petrol</td>
<td>0.05 (±)</td>
</tr>
<tr>
<td></td>
<td>Interurban, diesel</td>
<td>0.45 (0.05-0.95)</td>
</tr>
<tr>
<td>Nature &amp; landscape</td>
<td>Urban</td>
<td>3.0 (0-0)</td>
</tr>
<tr>
<td></td>
<td>Interurban</td>
<td>2.4 (0-0.8)</td>
</tr>
<tr>
<td>Soil &amp; water pollution</td>
<td>Urban/Interurban</td>
<td>0.96 (0.95-3.56)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Urban, peak</td>
<td>39.4 (3.4-53.9)</td>
</tr>
<tr>
<td></td>
<td>Day, off-peak</td>
<td>7.0 (3.5-13.0)</td>
</tr>
<tr>
<td></td>
<td>Night, off-peak</td>
<td>8.6 (4.1-14.3)</td>
</tr>
<tr>
<td></td>
<td>Interurban, peak</td>
<td>14.1 (1.7-20.7)</td>
</tr>
<tr>
<td></td>
<td>Day, off-peak</td>
<td>4.7 (1.7-6.7)</td>
</tr>
<tr>
<td></td>
<td>Night, off-peak</td>
<td>4.2 (1.9-6.3)</td>
</tr>
</tbody>
</table>

Source: CE Delft, 2007

In the second half of the year 2007, the Directorate-General for Transport launched a public consultation on the proposed approach to internalisation of external costs. Besides the public consultation, the Commission has commissioned the IMPACT study (IMPACT, 2008) aiming at reviewing and modelling the existing estimates of external costs in Europe in order to carry out an impact assessment of the internalisation of external costs for all modes of transport, with a view to preparing a European strategy on this subject by June 2008. The Commission is entitled to produce
Pricing systems for road freight transport

2.3.3. The Interoperability Directive

The Directive “On interoperability of electronic road toll systems in the Community” (Directive 2004/52/EC) laid down the conditions necessary to ensure a European electronic toll service that is interoperable at the technical, contractual and procedural levels. The aim is to have a single contract between the user and all operators and provide a set of technical standards that allow the industry to provide the required equipment on a competitive market.

The Directive covers all types of infrastructure over the entire Community road network (urban and interurban, motorways, major and minor roads, and various structures such as tunnels, bridges and ferries) and all types of vehicle (heavy and light vehicles, motorcycles, etc.). It defines different technologies of the new electronic toll systems and necessary measures that Member States shall take to increase the use of electronic toll systems.

The Directive does not deal with road-charging policy as such; however, by ensuring the interoperability of toll systems in the internal market it will facilitate the implementation of a Europe wide infrastructure-charging policy.

Electronic Fee Collection systems offer the possibility of charging road vehicles in a more flexible way and allow infrastructure charging policies to be implemented. It is vital for such systems to be interoperable across national borders to avoid creating new obstacles to traffic flow in Europe. Interoperability should therefore enable users to travel throughout the Union without charging procedures changing from one country to another and without having to install extra equipment to access other charging zones. This does not mean there would be one single supplier but that there should be sufficient technical compatibility between different systems so that paying charges on different stretches of road in the Union would be a seamless operation.

The electronic toll service shall be independent of the fundamental decisions taken by Member States to levy tolls on particular types of vehicles, of the level of charges and of the purpose for which such charges are levied. It shall be concerned only with the method of collecting tolls or fees; however, the system shall allow intermodality to develop without creating disadvantages for other modes of transport.

2.4. The Swiss legal framework

Switzerland’s transport policy is characterized by its role as a non-member state of the EU. Transport agreements with the surrounding countries and later with the EU have always had a major impact on the national policy. With the Bilateral Agreement on Land Transport (BALT), two main pillars of Swiss transport policy were coordinated and agreed upon with the EU. These pillars are the construction of a New Alpine Rail Link (NARL) and the introduction of the (mileage-related) Swiss Heavy Vehicles Fee.

In particular, the Agreement defined the frame for specific pricing schemes and disciplines in these main areas:

- free access to the road transport market in order to bring new market opportunities to the transport companies;
- harmonisation of the rules and conditions of admission for road transport, for example, the increase of weight limit for trucks from 28 to 34 tonnes in 2001, and to 40 tonnes in 2005;
- liberalization of the access to rail transport market between EU and Switzerland.
Furthermore, rail freight traffic was deregulated, unattended transalpine combined traffic and piggyback traffic (rolling motorway) received additional compensations, and train paths were subsidised. All these measures have contributed to a strong increase in transalpine rail freight traffic. Nevertheless, the goal of relocating transalpine road freight traffic down to 650,000 journeys per year will not be achieved within the near future. Subsequently, Switzerland launched several studies on future traffic management systems (reservation systems, Alpine Crossing Exchange).

**Box 4  Road transport in the Transalpine area**

Since the “Declaration of Zurich concerning the improvement of road safety, in particular in tunnels in the Alpine zone”, signed on 30 November 2001, the Ministers of Transport of Germany, Austria, France, Italy, Switzerland, and more recently Slovenia, have broadened the objectives of their cooperation. Indeed, “the implementation of the declaration has now proceeded to the stage of identifying measures to be coordinated between the signatory Alpine countries for regulating road traffic and encouraging a shift to an alternative mode of transport with four main areas of work, one of them being the management and regulation of transalpine road freight transport”.

The mandate of the Lyon Conference on 20 October 2006 was inter alia to commission a study on “…the preconditions for the implementation of new systems for the regulation of Transalpine road freight transport…”, making explicit reference to reservation system mechanisms or “tradable transit permits” which have been developed in sectors like environment or energy.

The study is part of the process that leads to the identification of appropriate traffic management systems for transalpine road freight transport and will have to provide the relevant information to enable the Ministers’ decision in autumn 2008 and, consequently, to give input for an in-depth study aimed at the operational implementation of the models selected by Ministers.

The coordination of the study has been assigned to the Advisory Board under the chairmanship of Austria, which has been entrusted with the Presidency of the Alpine countries’ Steering Committee for the period 2007/2008.
3. The Current Types of Charging Systems in the EU and in Switzerland

3.1 Overview

The geographical scope of the review covers the 27 EU countries and Switzerland. There is an intrinsic difficulty in providing a summary of charging practices at country level, because charges may differ internally according to specific site characteristics, e.g. a given type of area, or specific stretch of network etc. In order to avoid an excessive level of detail, the focus is on the “representative” charging practice in any given country. Member States are grouped according to the following categories: distance-based system; distance-based concessionaires; time-based systems; no charging systems.

Fig. 3.1  Overview of motorways charging systems in the EU

In Table 3.1, the road networks of the 27 + 1 countries are classified into three types of infrastructure: motorways; trunk roads; local roads. Total length and length of tolled sections are provided for each country together with figures for the overall volume of traffic.
## 3.1 Main characteristics of the European road network

<table>
<thead>
<tr>
<th>Country</th>
<th>Motorways</th>
<th></th>
<th></th>
<th>Trunk roads</th>
<th></th>
<th></th>
<th>Traffic 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total km</td>
<td>Tolled km</td>
<td>%</td>
<td>Total km</td>
<td>Tolled km</td>
<td>%</td>
<td>1000 mio t/km</td>
</tr>
<tr>
<td><strong>Distance-based system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>1,677</td>
<td>1,677</td>
<td>100%</td>
<td>33,366</td>
<td>467</td>
<td>1.4%</td>
<td>71,059</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>546</td>
<td>546</td>
<td>100%</td>
<td>54,946</td>
<td>426</td>
<td>0.8%</td>
<td>72,300</td>
</tr>
<tr>
<td>Germany</td>
<td>12,174</td>
<td>12,174</td>
<td>100%</td>
<td>219,267</td>
<td>233</td>
<td>0.1%</td>
<td>413,000</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1,358</td>
<td>1,358</td>
<td>100%</td>
<td>18,492</td>
<td>18,492</td>
<td>100%</td>
<td>51,446 **</td>
</tr>
<tr>
<td><strong>Distance-based concessionaires</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>10,383</td>
<td>8330</td>
<td>80.2%</td>
<td>386,269</td>
<td></td>
<td></td>
<td>604,308</td>
</tr>
<tr>
<td>Greece</td>
<td>916</td>
<td>916</td>
<td>100%</td>
<td>37,414</td>
<td></td>
<td></td>
<td>75,600</td>
</tr>
<tr>
<td>Italy</td>
<td>6,532</td>
<td>5,649</td>
<td>86.5%</td>
<td>165,340</td>
<td></td>
<td></td>
<td>496,904</td>
</tr>
<tr>
<td>Portugal</td>
<td>1,836</td>
<td>1,434</td>
<td>78.1%</td>
<td>15,064</td>
<td></td>
<td></td>
<td>62,528</td>
</tr>
<tr>
<td>Slovenia</td>
<td>465</td>
<td>381</td>
<td>82%</td>
<td>19,628</td>
<td></td>
<td></td>
<td>11,628</td>
</tr>
<tr>
<td>Spain</td>
<td>10,747</td>
<td>3,099</td>
<td>28.8%</td>
<td>85,782</td>
<td></td>
<td></td>
<td>68,623</td>
</tr>
<tr>
<td><strong>Time-based system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>1,747</td>
<td>1,747</td>
<td>100%</td>
<td>13,88</td>
<td></td>
<td></td>
<td>134,940</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>331</td>
<td>331</td>
<td>100%</td>
<td>6,981</td>
<td>6,981</td>
<td>100%</td>
<td>11,976</td>
</tr>
<tr>
<td>Denmark</td>
<td>1,032</td>
<td>1,032</td>
<td>100%</td>
<td>10,331</td>
<td></td>
<td></td>
<td>60,894</td>
</tr>
<tr>
<td>Hungary</td>
<td>677</td>
<td>644</td>
<td>95.1%</td>
<td>84,825</td>
<td></td>
<td></td>
<td>75,930</td>
</tr>
<tr>
<td>Lithuania</td>
<td>417</td>
<td>417</td>
<td>100%</td>
<td>20,98</td>
<td>20,98</td>
<td>100%</td>
<td>57,986</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>147</td>
<td>147</td>
<td>100%</td>
<td>2,747</td>
<td></td>
<td></td>
<td>14,470</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2,342</td>
<td>2,342</td>
<td>100%</td>
<td>64,150</td>
<td></td>
<td></td>
<td>59,400</td>
</tr>
<tr>
<td>Poland</td>
<td>405</td>
<td>405</td>
<td>100%</td>
<td>175,297</td>
<td>175,297</td>
<td>100%</td>
<td>201,992</td>
</tr>
<tr>
<td>Romania</td>
<td>113</td>
<td>113</td>
<td>100%</td>
<td>44,944</td>
<td>44,944</td>
<td>100%</td>
<td>27,817</td>
</tr>
<tr>
<td>Slovakia</td>
<td>313</td>
<td>313</td>
<td>100%</td>
<td>7,064</td>
<td></td>
<td></td>
<td>10,396</td>
</tr>
<tr>
<td>Sweden</td>
<td>1,591</td>
<td>1,591</td>
<td>100%</td>
<td>98,526</td>
<td></td>
<td></td>
<td>40,000</td>
</tr>
<tr>
<td><strong>No charging system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>268</td>
<td></td>
<td></td>
<td>5,021</td>
<td></td>
<td></td>
<td>3,577</td>
</tr>
<tr>
<td>Estonia</td>
<td>98</td>
<td></td>
<td></td>
<td>16,442</td>
<td></td>
<td></td>
<td>36,441</td>
</tr>
<tr>
<td>Finland</td>
<td>653</td>
<td></td>
<td></td>
<td>78,197</td>
<td></td>
<td></td>
<td>25,000</td>
</tr>
<tr>
<td>Ireland</td>
<td>176</td>
<td>83</td>
<td>47.2%</td>
<td>16,862</td>
<td></td>
<td></td>
<td>78,773</td>
</tr>
<tr>
<td>Latvia</td>
<td>0</td>
<td></td>
<td></td>
<td>52,096</td>
<td></td>
<td></td>
<td>7,338</td>
</tr>
<tr>
<td>Malta</td>
<td>0</td>
<td></td>
<td></td>
<td>1,439</td>
<td></td>
<td></td>
<td>647</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>3,609</td>
<td>42</td>
<td>1.2%</td>
<td>47,928</td>
<td></td>
<td></td>
<td>364,689</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>60,553</td>
<td>44,771</td>
<td>74%</td>
<td>1,783,328</td>
<td>267,870</td>
<td>15%</td>
<td>3,168,246</td>
</tr>
</tbody>
</table>

* 83 km of local roads are tolled
** All local roads are tolled

Source: TRT elaboration: the road network lengths for the latest available year per country (2002 to 2005) are taken from EU (DGTREN, 2006); the length of toll roads has been estimated for motorways, trunk and local roads starting from ASECAP data (2007); data on national and international road freight traffic in 2005 are taken from EU (DGTREN, 2006).
3.2 Existing Pricing Schemes

Four countries are already in line with the application of distance-based charging schemes, suggested by the “Eurovignette” Directive and have considered as the most suitable way to apply the “user pay” and “polluter pays” principles: Austria, the Czech Republic, Germany and Switzerland. In addition to these principles, the main aims of these systems are the protection of the environment and infrastructure financing in favour of more sustainable modes of transport.

In France, Spain, Greece, Italy, Slovenia and Portugal, parts of the motorway network have been operated by the private sector for several decades. These operators have right to levy tolls for use of the motorways. Toll levels are generally part of the contract between the national authorities and the motorway operator. The toll level covers operating costs, including a surplus as a profit. The toll level schemes are differentiated by type of vehicle, motorcycle, cars and light and heavy goods vehicles.

In other countries there is a different situation:

- Belgium, Denmark, Luxembourg, the Netherlands and Sweden have operated a vignette system since 1 January 1995. The vignette fees apply to the motorway network and certain national roads for vehicles over 12 tonnes. The fee is time-based and works on a pre-paid basis. Differentiation is on the basis of the environmental performance of the vehicle (EURO class) and number of axles;

- other Member States apply some kind of user charging on their motorway networks: Bulgaria and Romania operate time-based vignette systems for the use of all inter-urban roads. In Hungary, Lithuania and Slovakia vignette stickers are compulsory on certain motorway sections, while in Poland, a toll is charged on a few sections.

Several countries do not presently have any charging systems for road infrastructure, but some of these are currently examining the introduction of pricing schemes: for example, Ireland has three motorway links tolled according to vehicle class; and the UK has charging schemes according to vehicle class on the M6 and certain infrastructure sections (for example, tunnels and bridges).

Table 3.2 illustrates the different existing pricing schemes in the EU Member States and in Switzerland: date of coming into force, vehicles involved, the level of differentiation, the way the revenues are used and the technological system used for the implementation.

Levels of charges according to the adopted criteria, axles and/or EURO categories are summarised in Table 3.3. The nationwide systems and the motorway concessionaires apply distance-based tariffs calculated in €/km, called kilometre charges. On the contrary, vignette systems apply time-dependent charges, reported as annual fee. It is important to observe that in Switzerland tariffs are calculated per tonne/km and not only per km, so that charges for trucks are higher than in other countries with distance-based systems, as shown in Table 3.4.
Tab. 3.2 Pricing Systems in EU Member States and Switzerland

<table>
<thead>
<tr>
<th>Country</th>
<th>Pricing scheme</th>
<th>Tollored vehicles</th>
<th>Differentiation</th>
<th>Use of revenues</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Distance based system since 2004</td>
<td>&gt; 3.5 tonnes</td>
<td>Vehicle class (axles)</td>
<td>Road construction and maintenance; 58 % for for underground construction</td>
<td>DSRC</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Distance based system since 2007</td>
<td>&gt; 3.5 tonnes</td>
<td>Axes and emission class</td>
<td>Regions for transport projects</td>
<td>EFC/DSRC</td>
</tr>
<tr>
<td>Germany</td>
<td>Distance based system since 2005</td>
<td>&gt; 12 tonnes</td>
<td>Vehicle class (axles), emissions (Euro class)</td>
<td>20% to toll operators, 80% to federal transport network **</td>
<td>GPS/DSRC</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Distance based system since 2001</td>
<td>&gt; 3.5 tonnes</td>
<td>Maximum laden weight and emission classes</td>
<td>2/3 to the Finov Fund, 1/3 to regions for infrastructure projects</td>
<td>Tachograph, DSRC, GPS for checks</td>
</tr>
<tr>
<td>France</td>
<td>Toll All vehicles</td>
<td>-</td>
<td>Vehicle class (axles)</td>
<td>Motorways operators; high-speed railways</td>
<td>DSRC</td>
</tr>
<tr>
<td>Greece</td>
<td>Toll All vehicles</td>
<td>-</td>
<td>Vehicle class (axles)</td>
<td>Motorways operators</td>
<td>DSRC</td>
</tr>
<tr>
<td>Italy</td>
<td>Toll All vehicles</td>
<td>-</td>
<td>Vehicle class (axles)</td>
<td>Motorways operators</td>
<td>DSRC</td>
</tr>
<tr>
<td>Portugal</td>
<td>Toll All vehicles</td>
<td>-</td>
<td>Vehicle class (axles)</td>
<td>Motorways operators</td>
<td>DSRC</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Toll All vehicles</td>
<td>-</td>
<td>Weight, vehicle height, axles</td>
<td>Motorways construction and maintenance, loan repayment</td>
<td>DSRC</td>
</tr>
<tr>
<td>Spain</td>
<td>Toll All vehicles</td>
<td>-</td>
<td>Vehicle class (axles)</td>
<td>Motorways operators</td>
<td>DSRC</td>
</tr>
<tr>
<td>Belgium</td>
<td>Time based vignette systems since 1995</td>
<td>&gt; 12 tonnes</td>
<td>EURO 0 - EURO IV+, 3/4 axles</td>
<td>Regions for transport projects</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Time based vignette systems since 2004</td>
<td>All vehicles</td>
<td>3 categories: bus, trucks, light vehicles</td>
<td>Road infrastructure fund</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Denmark</td>
<td>Time based vignette systems since 1995</td>
<td>&gt; 12 tonnes</td>
<td>EURO 0 - EURO IV+, 3/4 axles</td>
<td>Other transport or no transport use</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Hungary</td>
<td>Time based vignette system since 2000</td>
<td>All vehicles</td>
<td>Weight</td>
<td>Motorways</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Lithuania</td>
<td>Time based vignette system</td>
<td>Good vehicles, buses, agricultural vehicles</td>
<td>Weight/length</td>
<td>Road construction and maintenance</td>
<td>Card/sticker</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Time based vignette systems since 1995</td>
<td>&gt; 12 tonnes</td>
<td>EURO 0 - EURO IV+, 3/4 axles</td>
<td>-</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Time based vignette systems since 1995</td>
<td>&gt; 12 tonnes</td>
<td>EURO 0 - EURO IV+, 3/4 axles</td>
<td>-</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Poland</td>
<td>Time based system since 2002</td>
<td>&gt; 3.5 tonnes (+ motorway toll for all motorised vehicles)</td>
<td>Weight, Axles, emissions (EURO 0- EURO II+)</td>
<td>Motorways and national roads</td>
<td>Road user card</td>
</tr>
<tr>
<td>Romania</td>
<td>Time based vignette system</td>
<td>All vehicles</td>
<td>Axles, weight, emission class</td>
<td>Road infrastructure fund</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Time based vignette system</td>
<td>All vehicles</td>
<td>Weight</td>
<td>Motorways</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Sweden</td>
<td>Time based vignette systems since 1995</td>
<td>&gt; 12 tonnes</td>
<td>EURO 0 - EURO IV+, 3/4 axles</td>
<td>-</td>
<td>Manual/sticker</td>
</tr>
<tr>
<td>Cyprus</td>
<td>None</td>
<td>-</td>
<td>None</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Estonia</td>
<td>None</td>
<td>-</td>
<td>None</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Finland</td>
<td>None</td>
<td>-</td>
<td>None</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ireland</td>
<td>None except for 3 motorway links</td>
<td>None but all vehicles on 3 tolled motorway</td>
<td>None but vehicle class on 3 tolled motorway</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Latvia</td>
<td>None</td>
<td>-</td>
<td>None</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Malta</td>
<td>None</td>
<td>-</td>
<td>None</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>None except for 42 km motorways</td>
<td>None but all vehicles on 42 km motorways</td>
<td>None but vehicle class on 42 km motorways</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: TRT elaboration on (T&E, 2007) and (REVENUE D3, 2005);
Data for Austria are referred to the year 2007 (OECD 2007)

** Data for Germany refer to REVENUE D4, 2006: 80% of revenues are allocated to the federal transport networks: 50% for the federal road network, mainly motorways, 38% for the federal rail network, 12% for inland waterways.
### Tab. 3.3 Differentiation criteria and level of charges in EU Member States and Switzerland in 2008

<table>
<thead>
<tr>
<th>Country</th>
<th>Km charge (€/km except for Switzerland)</th>
<th>Annual fee (€ per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 axles</td>
<td>3 axles</td>
</tr>
<tr>
<td><strong>Distance-based system</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>0,158</td>
<td>0,2212</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>EURO 0: 0,0805</td>
<td>EURO 0-II: 0,1295</td>
</tr>
<tr>
<td>Germany</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>0,15</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>0,071</td>
<td>0,092</td>
</tr>
<tr>
<td>Italy</td>
<td>0,127</td>
<td>0,162</td>
</tr>
<tr>
<td>Portugal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Time-based system</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulgaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: TRT Elaboration on T&E (T&E, 2007), HOP! Project (HOP!, 2007) and DATEC (ARE, 2008)
Tab. 3.4 Examples of distance-based tariff in Austria, Switzerland, the Czech Republic and Germany (cost in Euro for a 300 km trip)

<table>
<thead>
<tr>
<th>Type of heavy goods vehicle</th>
<th>Axles/tonnes</th>
<th>Euro 0-1-II</th>
<th>Euro III</th>
<th>Euro IV</th>
<th>Euro V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>CH</td>
<td>CZ</td>
<td>DE</td>
<td>A</td>
</tr>
<tr>
<td>2 axles/18 tonnes</td>
<td>47.4</td>
<td>102.6</td>
<td>24.2</td>
<td></td>
<td>47.4</td>
</tr>
<tr>
<td>3 axles/24 tonnes</td>
<td>66.36</td>
<td>136.8</td>
<td>38.9</td>
<td></td>
<td>66.36</td>
</tr>
<tr>
<td>4 axles/34 tonnes</td>
<td>193.8</td>
<td></td>
<td></td>
<td></td>
<td>173.4</td>
</tr>
<tr>
<td>4 axles/38 tonnes</td>
<td>99.54</td>
<td>216.0</td>
<td>56.7</td>
<td>46.5</td>
<td>99.5</td>
</tr>
<tr>
<td>4 axles/40 tonnes</td>
<td>228</td>
<td></td>
<td></td>
<td></td>
<td>204</td>
</tr>
</tbody>
</table>

Source: TRT elaboration on DATEC (ARE, 2008) and T&E (T&E, 2007).

Note: In Switzerland tariffs are differentiated per weight (Gross Total Weight of the drawing vehicle and trailer) and calculated per tonne/km; in other countries tariffs are differentiated per axles and calculated per km.
Part II: The Impacts of the Different Charging Systems

4. Analysis of detailed impacts of implemented measures

4.1. Introduction

The main purpose of this chapter is to investigate the main characteristics and the observed impacts (where possible) of the distance-based charging systems for heavy goods vehicles in four European countries, namely Austria, the Czech Republic, Germany and Switzerland. The impacts of these systems, which have different characteristics and have been in place for varying numbers of years, are analysed paying particular attention to the following items: the modal split, the reduction of vehicle kilometres, the traffic diversion, the fleet composition (size of vehicles), the fleet renewal (Euro emission standards of vehicles), the load factor optimisation and the use of revenues. Before the impact analysis a description of the case studies, completed by implementation aspects and acceptability issues (see Box 5), is briefly reported.

<table>
<thead>
<tr>
<th>Box 5</th>
<th>HGV Pricing Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Perspective</td>
<td></td>
</tr>
<tr>
<td>- Easy for users to understand.</td>
<td></td>
</tr>
<tr>
<td>- Convenient – does not require vehicles to stop at toll booths.</td>
<td></td>
</tr>
<tr>
<td>- Transport options – consumers have viable travel options available (i.e., alternative modes, travel times, routes, destinations).</td>
<td></td>
</tr>
<tr>
<td>- Payment options – easy to use with multiple payment options (cash, prepaid card, credit card, etc.)</td>
<td></td>
</tr>
<tr>
<td>- Transparent – charges evident before trip is undertaken.</td>
<td></td>
</tr>
<tr>
<td>- Anonymous – privacy of users is assured.</td>
<td></td>
</tr>
<tr>
<td>Traffic Authority Perspective</td>
<td></td>
</tr>
<tr>
<td>- Traffic impacts – does not require each vehicle to stop at toll booths or in other ways delay traffic.</td>
<td></td>
</tr>
<tr>
<td>- Efficient and equitable – charges reflect true user costs.</td>
<td></td>
</tr>
<tr>
<td>- Effective – reduces traffic congestion and other transportation problems by changing travel behaviour.</td>
<td></td>
</tr>
<tr>
<td>- Flexible – easily accommodates occasional users and different vehicle types.</td>
<td></td>
</tr>
<tr>
<td>- Reliable – minimal incorrect charges.</td>
<td></td>
</tr>
<tr>
<td>- Secure and enforceable – minimal fraud or non-compliance.</td>
<td></td>
</tr>
<tr>
<td>- Cost effective – positive return on investments.</td>
<td></td>
</tr>
<tr>
<td>- Implementation – minimum disruption during development phase. Can be expanded as needed.</td>
<td></td>
</tr>
<tr>
<td>Society’s Perspective</td>
<td></td>
</tr>
<tr>
<td>- Benefit/cost – positive net benefits (when all impacts are considered).</td>
<td></td>
</tr>
<tr>
<td>- Political acceptability – public perception of fairness and value.</td>
<td></td>
</tr>
<tr>
<td>- Environment – positive environmental impacts.</td>
<td></td>
</tr>
<tr>
<td>- Quality of life - Integrating health objectives into transportation pricing may be a cost-effective way to improve public health(^3)</td>
<td></td>
</tr>
<tr>
<td>- Integrated – same charging system can be used to pay other public service fees (parking, public transit, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

Source: TDM Encyclopedia - Victoria Transport Policy Institute

The chapter also includes - for selected themes - the comparison with other European countries where tolls are collected by other pricing systems.

\(^3\) Transportation decisions have impacts on public health through impacts on crash risk, pollution emissions and physical fitness. All three health risks tend to increase with motor vehicle use. Pricing, as a mitigation strategies that can reduce motorized travel, can give a contribution in reducing negative impacts on public health (T. Litman, 2003).
Figures and data presented below come from a desk analysis of policy documents, research projects and scientific literature. Most of the studies offer plenty of information on the technicalities of the pricing schemes, while evidence of impacts is more difficult to locate. This is also due to the fact that some of the distance-based charging systems are very recent and that some of the observed effects (such as the optimisation of load factors or the renewal of the fleet) are part of general trends of the road haulage system.

In particular, many difficulties were met in finding information about impacts of motorway concessionaires and vignette schemes due the lack of studies and their long-term period of application, which makes it difficult to distinguish their impacts from other policy measures.

4.2. Austria

4.2.1. General description

The heavy vehicle toll, known as *LKW-Maut*, was introduced on 1 January 2004 by the Austrian government. It is a distance-related fee, levied on motorways and a few express roads\(^4\), for all passenger and freight vehicles over 3.5 tonnes.

Higher fees characterised by added mark-ups are applied on some alpine links, due to the special environmental characteristics of the areas crossed by the motorways; these so-called ‘Sondermauten’, or ‘exceptional tolls’, are levied on the Brenner, Tauern, Pyhrn, Karawanken and Arlberg links. On the Brenner Pass (A13 motorway), there is also a night-time tariff for vehicles with 4 axles or more, which is double the day-time fee.

The *LKW-Maut* is designed to cover the infrastructure costs, including the debts of the state-owned road infrastructure company ASFINAG, owed for earlier construction work. The kilometre charge is differentiated according to the number of axles, type of road (exceptional tolls in mountainous areas) and time (Brenner motorway day/night), with no differentiation by emission class (which will enter into force in 2010). The average fee level for 40 tonnes vehicles has been increased from the 1\(^{st}\) of July 2007 by 0.042 EUR/km (from 0.227 to 0.269 EUR/km) with the approval of the European Commission. The fee level by vehicle category is shown in table 4. Recently, the Austrian Ministry of Transport has announced that starting from the 1\(^{st}\) of May *LKW-Maut* tariffs will increase by 2.2% to in line with inflation. ASFINAG estimates that revenue generation from toll increase will be equal to 21,1 million €.

![Box 6 The Ecopoints system](image)

A licensing system of Ecopoints was introduced in 1994 as a part of the transit agreement between Austria and the EU (Protocol 9 to the Act of Accession of the Republic of Austria to EU, 1994). The main goal was to reduce NOx emissions from transit transport through Austria by 60% over the period between the years 1991 and 2003 and limit the number of transit journeys to a maximum of 8% above the level of 1991. Goods vehicles over 7.5 tonnes on a transit journey through Austria must carry an Ecocard, which is a standard form with a number of Ecopoints stamps attached, showing that prior payment has been made. The value of NOx emissions shall be set according to Ecopoints distributed and the number of Ecopoints depends on the pollution rating of the vehicle being used (lorries emitting more NOx need more ecopoints to pass through Austria). In 2004 the Ecopoints system was extended until 2006 and its operations stopped in 2007. Part of the revenues from Ecopoints were used to finance the Brenner railway tunnel.

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\(^4\) For future extension of the *LKW-Maut* to the rest of the road network, see table 5.1.
4.2.2. Technology, enforcement and implementation costs

The *LKW-Maut* is based on a microwave technology (DSRC) with a simple tag (Go-Box) in the vehicles and gantries on the motorways. All vehicles must be equipped with this on-board unit. It is a so-called open system, in contrast to a closed system whereby the gantries are located at motorway entries and exits.

Public inspection officers must monitor the correct payment of tolls: toll enforcement officers are authorised, among other things, to use clearly visible and audible signals to request drivers to stop and to inspect the attachment of the toll sticker. Moreover, toll enforcement officers are authorised to divert traffic to the toll inspection areas, which are currently located at particular points. For enforcement, the authorities rely on about 100 gantries equipped with Automatic Number Plate Recognition (ANPR) and about 30 mobile units.

The operating costs of the system are about 4% of revenues, while total enforcement costs are about 12% of revenues.

<table>
<thead>
<tr>
<th>Tab. 4.1 Implementation costs (€)</th>
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</thead>
<tbody>
<tr>
<td>Total implementation costs (€)</td>
</tr>
<tr>
<td>Investment</td>
</tr>
<tr>
<td>Investment per user</td>
</tr>
<tr>
<td>Annual operation costs</td>
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<tr>
<td>Annual operation costs per user</td>
</tr>
</tbody>
</table>


4.2.3. Acceptability

The perception of the Austrian *LKW-Maut* scheme by the public is fairly positive. Despite strong opposition at the outset by the Austrian Federal Economic Chamber over the possibility to introducing a dual system (manual and electronic control), a survey in Austria found that 94% of users of the HGV toll and light vehicle vignette declared themselves either satisfied or very satisfied with the toll collection system (ASFINAG, 2005).

Liechti and Renshaw (T&E, 2006) points out the following experiences:
- the *LKW-Maut* was successfully implemented despite strong opposition at the outset;
- the scheme now has high acceptance among users;
- the scheme is based on well-known and simple technology which makes it reliable (99,9% correct transactions);
- the technology is also simple and readily understandable for users and causes them only low equipment costs (5 € for a “Go-Box, to install in one’s vehicle).

4.2.4. Impacts analysis

The difficulty in detecting part of the required impacts is linked to the fact that, at least for transit traffic (which plays a major role in this country), the *Ecopoints* system was already operating before the introduction of the *LKW-Maut* and therefore the new system did not imply a significant change for the road haulage market.

- **Modal split.** Nowadays there is no evidence that significant changes in the modal split can be attributed to road charging schemes (East West TC, 2007). However, Austria is expecting a
further 70% growth in freight transport over the coming years and the transit traffic is estimated to constitute a third of heavy vehicle traffic in Austria (T&E, 2007)\(^5\). These forecasts ask for a policy that intervenes for a more balanced modal share, today completely in favour of road transport. As a matter of fact, the Austrian road traffic through the Alps amounts to 77%, leaving the remaining part to the rail sector (DATEC, 2005).

- **Reduction of vehicle kilometres.** Since the increase of toll level in 2007, the vehicle kilometres in road freight transport have slightly increased on the North-South routes and dramatically on the East-West routes (more than 10% in one year, according to ICCR International, 2008). The main explanation seems to be the transition to a market economy of the Central and Eastern Europe (CEECs) countries combined with an obsolescent rail system that increased the level of the European East-West road traffic, in addition to the introduction of road tolls in the Czech Republic that provoked a detour towards the Austrian network.

- **Traffic diversion.** The diversion of traffic from the tolled parts of the network to the toll-free roads is a significant phenomenon, as increased traffic on secondary roads leads to higher maintenance costs as well as to disturbances to the local citizens. During the second and the third quarter of the year 2004, an increase in traffic was observed on roads close to the tolled network, with marked differences according to the region. The average diversion of trucks from highways and express roads was about 2.8 % of the total freight transport of highway and express roads. The effect of this average diversion is very diverse from one road to another: some roads have experienced an increase of 100% in lorries! The diversion has taken place only where alternative roads with high capacity were available. After a peak of traffic diversion in May 2004, some Regions decided to ban freight transport on some of the toll-free roads. From September 2004, the amount of trucks diverted from highways and express road to toll-free roads has become stable. According to ASFINAG (ASFINAG, 2004), the estimated average diversion from highway and express roads to non-tolled roads in 2004 is about 2.3% of the freight transport of highway and express roads; this data is confirmed also by Nagel (Kummer und Nagel, 2005) in an observation in 2004 that an increase in heavy goods transport on parts of the secondary road network totalled around 2-3%.

- **Fleet composition.** No data is available for the impact on Austrian fleet composition. In June 2008 there will be available a study on the Austrian traffic forecast for 2025 that will contain information on this item.

- **Fleet renewal.** The fee is differentiated only according to number of axles, with no higher charges for more polluting lorries and thus there are no incentives to use cleaner vehicles. Austria, like the other EU Member States, will anyway have to differentiate the charging systems according to emission classes or PM10 or NO\(_x\) emissions by 2010.

- **Load factor optimisation.** Statistics on the Alpine traffic show that the number of empty lorries crossing the Alps has been reduced from 25% to 16% between 1994 and 2004, this is mainly caused by the ecopoints system and partly by the Austrian *LKW-Maut* (East West TC, 2007)\(^6\).

- **Use of revenues.** Revenues in 2005 were €775 million (REVENUE, 2005). The fee increase as of 2007 is expected to raise a further €115 million. It is important to take into account that the heavy vehicle toll aims at full cost recovery and in fact is determined so as to cover the costs of construction, operation and maintenance of roads. All revenues levied by the state-

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\(^5\) The growth of road traffic in last years can be attributed also to the traffic diversion coming from Switzerland due to the Swiss HGV weight limit and the higher Swiss fee level. For more details see paragraph 4.5.4 on traffic diversion.

\(^6\) More recent data on load factor optimisation related to the entrance into force of the *LKW Maut* are not available.
owned road infrastructure company ASFINAG – vignette, federal truck toll, and special tolls – are earmarked for the construction and maintenance of roads. 58% of the revenues from charges on lorries are used for tunnel construction (OECD, 2007). The projects in the investment programme were determined jointly with the Länder and the major public transport companies.

4.3. Czech Republic

4.3.1. General description

Within the Czech Republic, the use of motorways and express roads by motor vehicles with at least four wheels or vehicles plus trailers has been, from 1995, subjected to a time-based vignette. Since 1st January 2007, the distance-based toll system has replaced the time-based user charge for heavy vehicles on the 970 km of the state-managed motorways and dual carriageways. The vignette system however, still applies to vehicles under 12 tonnes.

The new toll affects 60,000 to 65,000 domestic and 30,000 to 35,000 foreign vehicles over 12 tonnes (T&E, 2007) and this reflects the growing role of the Czech Republic as a transit country for HGVs: according to Ministry of Transport figures, 20-30% of vehicles over 12 tonnes merely transit through the country.

The charge is differentiated by the number of axles and Euro emissions classes. The average toll rate for 40 t vehicles is CZK 4.05 (€ 0.14) per km for motorways and dual carriageways. When the toll is extended in 2008 to first class roads (express roads), their average level will be CZK 1.90/km (€ 0.07)\(^7\) (T&E, 2007).

4.3.2. Technology, enforcement and implementation costs

Similar to the Austrian case, the Czech scheme makes use of gantries over key roads and is based on a microwave technology (DSRC); it requires a simple on-board unit in the vehicles and motorways gantries. There are currently about 190,000 active OBUs, 73,000 of these are Czech carriers and 117,000 foreign ones, with Polish and Slovak fleet on top positions\(^8\).

4.3.3. Acceptability

As for all the newly associated states, motorway charging has generally found a high public resistance in the Czech Republic; this is due to a combination of factors:

- Road charging is a quite new concept;
- The public has a lower income level compared to the EU15;
- Motorised mobility costs (fuel, insurance, registration, maintenance) are generally perceived to be high already compared with current GDP per capita.

Users often feel they are “taxed double” when road charges are added on top of the already existing taxation. This low acceptability is also endangered by the fact that, as shown by quality of service indicators, the “value for money” is very poor.

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\(^7\) Source: Czech Ministry of Transport, February 2007.
\(^8\) Source: Czech Ministry of Transport, June 2007.
4.3.4. Impact analysis

Due to the short time that the policy has been in place, for most of the impacts listed here below there have been some difficulties in collecting the relevant data.

- **Modal split.** It is probably too early to attribute any significant modal shift to the new road charging scheme.

- **Reduction of vehicle kilometres.** The introduction of the toll did not reduce the vehicle kilometres travelled in the country. On the contrary, the traffic flows are constantly increasing due to the transit traffic (20-30% of vehicles over 12 tonnes, according to Ministry of Transport, and 10% of vehicles over 3.5 tonnes, according to T&E, 2007), as is also happening in the whole CEEC region.\(^9\)

- **Traffic diversion.** In order to avoid traffic diversion to secondary roads, the Czech Government’s intention is to extend the toll system to more express roads in the year 2008 and to the whole road network later on. In fact, there are plans to levy the toll on first, second and third class roads, also differentiated by emissions class and number of axles from 2009. The regions are keen to include minor roads in the scheme to put an end to toll avoidance by heavy traffic diverting from motorways (T&E, 2007).

- **Fleet composition.** No data has been found about the impact on size of vehicles in the domestic fleet.

- **Fleet renewal.** Heavy goods vehicles of EURO 0-II emission classes on motorways and dual carriageways currently pay on average 30% more than the cleaner EURO III-IV vehicles. This is a relevant factor in a country like the Czech Republic with a high proportion of older vehicles in the fleet.\(^10\)

- **Load factor optimisation.** No data has been found.

- **Use of revenues.** The main goal of introducing the heavy vehicle fee is to acquire funds to speed up the completion of the motorway network. The planned revenue from the fee in 2007 is CZK 5 billion (€175 million). For comparison, coupon revenue was CZK 2.2 billion in 2005. All revenues from highway and motorway tolls are received by the State Infrastructure Fund, which also collects revenue from the vignette for lighter vehicles. Revenues from toll collection on minor roads are planned for use by the regions to improve the quality of the road network.

4.4. Germany

4.4.1. General description

Germany introduced the HGV motorway toll system after a debating time of about 30 years. In 2003, on the basis of a law adopted by the German parliament in 2002, the time-dependent vignette was replaced by a distance-related fee called *LKW-Maut*. The new tolling system was planned to come into operation at the beginning of August 2003. However due to very serious technical difficulties the system could not start until January 2005.

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\(^9\) Central and Eastern European Countries, including Poland, the Czech Republic, Slovakia, Hungary and Slovenia

\(^10\) The Eurovignette Directive gives additional scope to vary the toll by 100% between the highest and lowest emissions classes. An increased differentiation on the basis of environmental characteristics could be used to stimulate fleet renewal and promote cleaner vehicles (T&E, 2007).
The strategic objectives of the introduction of the distance-related user charge are that it allows a more rigorous application of the *user pays* principle, a more efficient use of transport capacities, additional revenues for transport infrastructure financing and a greater environmental protection due to the emission-related toll differentiation. The fee is calculated on the basis of infrastructure costs and differentiated according to number of axles and emission categories, subjected to a time-based modification plan, as shown in the following table.

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>EURO -4, -5, EEV (Enhanced Environmentally Friendly Vehicle)</td>
<td>EURO -5, EEV</td>
<td>EEV</td>
</tr>
<tr>
<td>B</td>
<td>EURO -2, -3</td>
<td>EURO -3, -4</td>
<td>EURO -5</td>
</tr>
<tr>
<td>C</td>
<td>EURO -0, -1</td>
<td>EURO -0, -1, -2</td>
<td>EURO -0, -1, -2, -3</td>
</tr>
</tbody>
</table>

Source: MautHV

The fee is currently levied only on vehicles over 12 tonnes for the use of motorways and since January 2007, also on three federal highways. The average toll level has increased from 0.124 EUR/km to 0.135 €/km per 40 tonne vehicles since September 2007. The increase was justified by the need to compensate the loss of revenues arising from the reduction of the vehicle tax rate for heavy goods vehicles to the EU minimum permitted rate and the activation of financial incentives for the purchase of vehicles with lower emissions.

### 4.4.2. Technology, enforcement and implementation costs

The German system is technically the highest developed system in Europe. It is based on GPS/GSM technology: satellite navigation (GPS) locates the vehicles via an on-board unit, i.e. checks whether it is on a motorway or on another road; a cellular network (GSM) communicates the fees to be paid to the central office, which then invoices users.

All motorways are divided into logical segments, with the on-board unit storing the geographical coordinates of these segments. GPS is then used to verify what segments the vehicle has travelled on, with the digital tachograph as a back up. On exit from the motorway network, the OBU transmits details of which segments have been travelled on to the toll operator over an encrypted cellular GSM link.

Regarding the form of payment users can choose from a wide range of methods: using a fuel card, with a credit account, participating in the so-called LogPay plan, for the users taking part in the automatic logon system and using a fuel card, with credit card, with EC card and cash payments for the unregistered users. The fuel card and the LogPay methods have the advantage that the payment occurs once a month, which means the date of payment is usually delayed by an average of two weeks compared to the date of the trip.

The Federal Office for Goods Transport supervises the heavy goods vehicle fee operations, while a private consortium (Toll Collect) built and operates the system, and, furthermore, is responsible for toll enforcement and the punishment of violations with the aid of a microwave technology (DSRC). 90% of fees are calculated and debited electronically due to increasing use of on-board units (compared to 75% in 2005). This reduces the operating costs of the scheme and will facilitate any future plans for further fee differentiation.
### Tab. 4.3 Implementation costs (€)

<table>
<thead>
<tr>
<th></th>
<th>Total implementation costs (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>700 – 1200 million</td>
</tr>
<tr>
<td>Investment per user</td>
<td>500 – 1000</td>
</tr>
<tr>
<td>Annual operation costs</td>
<td>550 - 610 million</td>
</tr>
<tr>
<td>Annual operation costs per user</td>
<td>393 - 508</td>
</tr>
</tbody>
</table>


#### 4.4.3. Acceptability

With regard to the toll, public opinion is divided. On the one hand, the high density of HGV on German motorways leads to a relatively high acceptance of the HGV toll by private users. On the other hand, private consumers fear a negative impact on overall price levels.

The German Federal Office for Goods Transport states that the new system (apart from some expected teething troubles) has been accepted by the industry. The most convincing evidence is the constantly increasing number of OBUs. Six months after the toll's introduction there were around 450,000 OBUs installed. Up to April 2006, installed OBUs exceeded the figure of 500,000 and their number continues to grow at regular pace. By earmarking the revenues generated by the toll for improving transport infrastructure (especially road infrastructure), the acceptance of the charging scheme has increased.

#### 4.4.3. Impact analysis

The German Federal Office for Goods Transport (BAG) is responsible for market observation. To that aim, BAG makes annual surveys representatives of the transport industry concerning the effects of the German toll system.

It must be noted that most of the following effects are general effects resulting from the toll's existence, rather than its differentiation with respect to the number of axles and the emission classes, which has not been large enough to have made any significant impact (DIFFERENT, 2007).

**Modal split**

One of the main aims of the German *LKW-Maut* was a modal shift in favour of the railways. During the first months of the introduction, the Ministry of Transport claimed that there had been considerable shifts from road to rail. This was denied by the BAG, as the results of its survey show that no considerable modal shifts had occurred. Even though no direct elasticity estimation has been made since the toll introduction, diverse studies confirm the fact that demand is quite inelastic: i.e. much higher fees would be needed to shift traffic toward the rail model\(^{11}\).

In the 2005 industrial survey (BAG, 2005), there are some estimations of a modal shift as a result of the introduction of the charging scheme:

- 3.1% of the companies in the survey answered that they use rail to a larger degree than earlier (mostly larger companies;)
- 76.4% have not changed anything;

\(^{11}\) Rothengatter and Doll (2001) estimate on this point that an average charge of 20 ct/km as well as a surcharge of 5 Ct/km for vehicles over 18t would bring a modal shift of 3 %. In a further scenario, they calculated that modal shifts of 15 % correspond to a price level of 1.05 € per km combined with a 69 Ct per km charge for smaller vehicles.
19.3% have consolidated their use of road transport, thereby increasing utilisation. Some minor changes in terms of increased use of inland waterways (0.6%) and air freight (0.6%) have also been registered.

In different earlier studies, modal shift effects have been estimated indicating a reduction of road transport volumes by 1.4% and an increase of rail transport volumes by 4.4% (Gernot, 2006). Other studies have shown more limited effects.

Looking at the observed data on the freight transport market in Germany, road transport increased by 9% between 2003 and 2005 whereas rail transport increased by 17% (East West TC, 2007).

The most recent data on the development of modal split in freight transport refer to 2006 and 2007 (BAG 2007) and consider the foreign trucks as well. Between 2006 and 2007, the percentage of freight transport on road and rail increased. In 2007 road transport reached the rate of 71.92% (+27.25 millions tonnes/km with respect to the year 2006) and rail transport reached about 17.95% (+7.61 millions tonnes/km with respect to the year 2006). The BAG assumes that without the engine drivers’ strike in the last six months of 2007 rail transport would have reached a higher share.

Increases in the intermodal transport market could be also seen as a result of the toll: such an impact was registered in 2005 (BAG, 2005), soon after the introduction of the LKW-Maut, and confirmed by the last market assessment study (BAG 2007), which shows that intermodal transport increased by 13% between 2006 and 2007 as a consequence of the increased costs of road transport from door to door (especially due to higher fuel costs).

The reduction in vehicle kilometres

One of the consequences of the introduction of the tolling system, as observed by BAG, was a modification in kilometres travelled according to the emission standards. The table below shows clearly that over 95% of the total kilometres travelled have been made by lorries of the emission class EURO 2 or better. The long-term trend to use environmentally friendly lorries has intensified since the toll’s introduction. For the first midyear of 2006, the use of lorries of class EURO 3 or better for domestic trips reached a share of 74.4% of the total use. One of the reasons for that seems to be the scheduled reordering of the differentiation classes effective from October 1st 2006 onwards. However, it is very likely that there are additional reasons affecting this development. In particular, the natural process of replacing older vehicles with newer ones of superior technology certainly plays a decisive role in the decrease of EURO 2 vehicles.

Also, the increase of vehicle use of the EURO 5 emission class is considerable and this trend is expected to continue and intensify. The most important reasons for this are the new emission classes since October 2006 and the intention of the Federal Government to subsidise environmentally friendly vehicles as well as the authorities’ intention to spread the charges according to the emission classes more strongly. Indeed, with respect to decisions on investment in new lorries, hauliers showed less willingness to invest in new lorries of the EURO 4 class and instead were more in favour of EURO 5 vehicles or EURO 3 vehicles.
### Pricing systems for road freight transport

#### Tab. 4.4 Kilometres travelled: breakdown by the emission classes

<table>
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<tr>
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<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>A</td>
<td>0.9</td>
<td>1.5</td>
<td>2.5</td>
</tr>
<tr>
<td>EURO 4</td>
<td>0.2</td>
<td>1.3</td>
<td>3.9</td>
</tr>
<tr>
<td>EURO 5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>EEV</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>B</td>
<td>32.8</td>
<td>28.1</td>
<td>23.2</td>
</tr>
<tr>
<td>EURO 2</td>
<td>62.4</td>
<td>65.9</td>
<td>68.0</td>
</tr>
<tr>
<td>EURO 3</td>
<td>3.7</td>
<td>3.1</td>
<td>2.4</td>
</tr>
<tr>
<td>C</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: DIFFERENT, 2007

### Traffic diversion

Deviations from the motorway network in order to avoid the charges are the subject of controversy within Germany. The BAG stated on the basis of the survey, that there is no considerable toll avoidance effect to be expected. At the same time, a lot of municipalities complained about increased traffic in the secondary network.

The Federal Government asked the States to identify roads where a large increase of over-regional lorry traffic could be recognised. Despite the large public discussion, only 20 routes were identified, of which only 3 have been included in the network for fee collection from January 2007. These routes are: B-75 between the motorways A-261 and A-253 (Hamburg), B4 north of A-23 (Schleswig-Holstein), B9 between to the German-French border and A-65 (Rheinland-Pfalz). In addition, the municipalities obtained the freedom to impose administrative measures such as detours or speed limits.

Traffic caused by the _LKW-Maut_ is not evident for the whole of Germany: surveys show that effects were only evident where there are national roads with a good design standard, running parallel to the motorway and not causing major delays, indeed sometimes even shortening distances.

In the second quarter of 2005, the average traffic growth on secondary roads was 7.6% compared to 2004 and the main part of this increase was caused by the _LKW-Maut_ (6.6%) (East West TC, 2007).

Also in 2006, the Ministry of the Environment reported an average increase of traffic in the secondary network at 7.6 % (about 57 lorries per day) whose 6.6% (49 lorries per day) due to the toll (DIFFERENT, 2007).

Diversion of lorry traffic has been registered to the west of Bremen towards the Dutch border, to the south-east of Hamburg, and along the German-French border, especially in Alsace, where motorways run along either side of the Rhine, which forms the frontier. A modification of the French transport law allows the Alsace region to introduce a charge between 0.1-0.15 €/km on sections of the motorway not already subject to a toll for vehicles over 12 tonnes for an experimental period of 5 years (East West TC, 2007). Also, hauliers from the neighbouring eastern countries are often willing to undertake longer deviations in order to pay no toll.
Fig. 4.1 Deviations from motorway network after the introduction of the HGV toll

Source: IWW, 2005
Fleet composition

As a result of the toll's introduction, it can be clearly seen (see next graph) that the number of new registered lorries between 10 and 12 tonnes has increased rapidly. This trend stabilized at a high level in the first six months of 2006 compared to the same period in 2005; new registrations of the lorries between 10 and 12 tonnes declined marginally at about 1.3%. The main reason given by the surveyed firms (BAG, 2005), was that they could not pass the additional costs caused by the toll onto their clients. This effect was mainly observable in close-up range. As a result of this awareness, there are a lot of politicians and experts as well as special interest groups who now demand an extension of the charging system for all lorries over 3.5 tons.

Fig. 4. 2 New registration of lorries between 10 and 12 tonnes before the entry into force of the Maut system in 2005

Source: BAG, 2005

Fleet renewal

The LKW-Maut has an effect on choice of vehicle emission class. With respect to decisions on investment in new lorries, the hauliers prefer to invest in EURO 5 vehicles, or in EURO 3 vehicles, as shown in the BAG survey. The downgrading of EURO 4 vehicles from the beginning of 2006 resulted in a stronger interest in EURO 5 vehicles. This awareness, in association with the decision of the government to subsidize ecologically friendly vehicles, leads to the conclusion that in the future the hauliers will prefer to invest in EURO 5 vehicles rather than in EURO 4 (DIFFERENT, 2007)\(^\text{12}\).

On 24 January 2007 the European Commission approved a German state aid scheme that aims to help transport operators acquire heavy vehicles with better emission performance. The Commission found the aid scheme to be in line with Community rules on environmental protection within the permitted thresholds. The scheme will make 100 million € available annually for six years. The aid will be in the form of investment grants or interest allowances to transport operators investing in lorries which comply with stricter environmental standards than those in force. The scheme is designed to stimulate acquisition of vehicles of EURO 5 emissions standards (until

\(^{12}\) However, such steering effects are also already caused by taxation of vehicles according to their emission class (East West TC, 2007).
October 2008) or better. German hauliers will, in part, be compensated by reduced vehicle tax and financial incentives for the purchase of vehicles with lower emissions.

**Load factor optimisation**

While in principle, the increased freight rates for full lorry loads are paid by the cargo owners, the empty runs have to be paid by the hauliers themselves. One of the aims of the German tolling scheme was a better utilisation of the existing fleet through the reduction of empty trips, leading to higher load factors, and therefore to enhanced welfare.

With respect to this effect, BAG considered long-term trends concerning the load factor for the vehicles, observing that the ratio load kilometre to total kilometre had increased within the ten-year period prior to 2004 at a yearly average of one percent, reaching 79.2% in the year 2004 (BAG, 2005). According to the hauliers, the most important reason for that was the increasing costs, particularly the increase in petrol prices. In other words, cost pressures forced the hauliers to improve trip planning. This trend continued also in 2005 and the ratio load kilometre to total kilometre reached 80.3% in 2005. Up until May 2006, the ratio had increased to 80.8%. The surveyed firms gave the HGV toll as well as the very high fuel costs, as the main reasons. This trend is confirmed also by other studies that show that in 2007, the number of loaded runs reached 82.1% (East West TC, 2007) and the number of empty trips decreased by 6% (DIFFERENT, 2007).

![Fig. 4. 3 Load and empty run kilometres in Germany from 2000 to 2007 in billions tonnes/km](source: BAG, 2007)

Looking at the run kilometres, the last BAG survey (BAG 2007) shows that in the year 2007 German trucks travelled for 4.7% kilometres more than in 2006 (both for inland transport and cross-border transport), reaching 31.3 billions of tonnes/km. According to the same survey, the growth of run kilometres has led to an increase of both load and empty kilometres, as shown in the following figure. The slight growth of empty kilometres during 2007 is explicable in the light of two different trends: if on the one hand some firms could lower the rate of empty kilometres thanks to the higher transport demand, on the other hand other firms, in order to fulfil increasing demand from a few important clients, had to give up to looking for loads for the empty return trips.
Use of revenues

Toll revenues met the government’s expectations. According to the latest data published by the German Ministry\textsuperscript{13}, the trend of toll revenues is as follow:

- 2nd midyear 2006: 1.5 billion €
- 1st midyear 2007: 1.6 billion €
- 2nd midyear 2007: 1.7 billion €

In the first 8 months of the year 2007 (January to August), charged traffic reached a total figure of 18.26 billion vehicle/km, i.e. 8% more than the corresponding value for the year 2006 (16.95 Billion vehicle/km). 66% of the 2007 vehicle/km is domestic traffic, while the rest is considered as foreign traffic (the share of domestic traffic was a bit smaller - 62% - one year before)\textsuperscript{14}. At the end of the year 2005, the net revenues from the heavy vehicle fee reached approximately 2.4 billion € and were earmarked as follows: 20% are granted to the toll operator for operating the charging technology, the remaining 80% are allocated to the federal transport networks, of which: 50% for the federal road network, mainly motorways, 38% for the federal rail network, and 12% for inland waterways (REVENUE, D4, 2006).\textsuperscript{15}

4.5. Switzerland

4.5.1. General description

The Heavy Vehicle Fee (HVF) was introduced in Switzerland in January 2001, as the final step of a long political debate that had started in 1978. The HVF is levied on the whole Swiss road network and the reasons for it are to internalise external costs of transport, finance new railway infrastructures and obtain structural changes in the transport industry and in fleet composition in order to limit heavy goods vehicle traffic growth.

All domestic and foreign heavy vehicles and trailers for goods transport with a gross total weight of more than 3.5 tonnes are subject to the distance-related heavy vehicle fee (HVF). The HVF calculation depends on the kilometres driven within the borders of Switzerland (on any road), the permissible Gross Total Weight (GTW) according to the registration documents of the vehicle\textsuperscript{16} and the emission standard of the vehicle.

\textsuperscript{13} http://www.bmvbs.de/Verkehr/Strasse,-1436/LKW-Maut.htm (visited February 2008)
\textsuperscript{14} One and a half years after the toll introduction, in its second survey BAG recognized no significant differences between the tolls paid by domestic and foreign hauliers. According to BAG calculations, domestic hauliers paid in average 11.8 € Ct./kilometre whereas foreign hauliers paid 11.9 Ct./kilometre. However, this calculation concerns tolls paid until the 30th of June 2006.
\textsuperscript{15} This includes investment in railway infrastructure (3.2 billion € from 2004 to 2007), road construction (1.1 billion € in 2004), and national waterways (0.25 billion € in 2004). Data from Revenue – Deliverable 3, March 2005
\textsuperscript{16} Trailers are not separate fee objects but are assessed together with the pulling vehicle.
The HVF rate has increased over time in coordination with the increase of the permissible gross total weight (GTW) of heavy vehicles using the Swiss road network (from 28 to 34 tonnes in 2001 and to 40 tonnes in 2005). However, the rate level is not the only feature of the HVF that has adjusted over time. The same applies to the way the more or less environmentally harmful HGV are attributed to the three vehicle categories (classes 1 – 3), as shown in table 4.5.

The dynamics in the HVF rate was designed to take into account the development in the emission abatement technologies of diesel engines. The distance-dependent fee, with its differentiation between more or less polluting trucks, thus meets the principle of internalisation (polluter-pays principle) stated in the Swiss constitution. This principle inspired a charge that includes in its calculation the external costs, such as health costs and damage to buildings caused by air pollution and costs of noise and accidents, nevertheless excluding congestion costs.

4.5.2. Technology, enforcement and implementation costs

The vehicles are fitted with an electronic recording device, the on-board unit (OBU). This appliance is coupled to the tachograph and records the kilometres travelled. For domestic vehicles, the OBU is given for free but the owner has to pay the installation costs. This on-board unit is fixed at the windscreen and connected to the tachograph. As soon as the engine is started, the on-board unit starts as well and counts the electronic impulses it gets from the tachograph. In this way, it registers the kilometres driven. The admissible weight and the emission category are stored in the OBU as well as in the background system. At the beginning of each calendar month, the data stored in the OBU has to be transmitted, physically by chip card or electronically to the Swiss Customs Authority, which is, within the Department of Finances, responsible for the administration and the collection of the HVF. The checked and, if necessary, corrected data then form the basis for the calculation of the fee and the billing.

For foreign vehicles, the installation of an OBU is not mandatory, though owners can acquire them for free as well, if they request it. If the vehicle is not equipped, the fee is registered by using an identification card at the special terminals for HVF clearance. This identification card is provided upon entering Switzerland for the first time and contains the relevant data, especially the admissible weight and the emission class. To get the distance relevant for calculating the fee, the driver has to insert on a form the actual mileage on the tachograph when entering and when leaving the country. To avoid fraud, the distance driven is checked occasionally by comparing the
mileage declared with the tachograph and the papers the driver has concerning the destination of his goods. The fee has to be paid when leaving the country.

The functioning of the OBU can be checked by 12 control stations spread throughout Switzerland (GPS and DRSC technology). The Swiss Customs Administration is responsible for the implementation of the heavy vehicle fee collection system and its continued operation.

According to the Swiss Customs Authority, the implementation Costs for the HVF amount to about 65 Mio CHF per year. Included in this amount are the costs for research, investment, constructions, replacement, operation and personal. In the short term, these 65 Mio correspond to about 8% of the gross revenue. In the long term, the cost-performance ratio will even improve. The costs should be in the range of 5-6% of revenue.

<table>
<thead>
<tr>
<th>Tab. 4.5</th>
<th>Implementation costs (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total implementation costs (€)</td>
<td>160 – 200 million</td>
</tr>
<tr>
<td>per use</td>
<td>450 – 565</td>
</tr>
<tr>
<td>ration costs</td>
<td>35 million</td>
</tr>
<tr>
<td>ration costs per user</td>
<td>100</td>
</tr>
</tbody>
</table>


4.5.3. Acceptability

The Swiss heavy vehicle charging system was introduced after a national referendum. The HVF had a good level of acceptability thanks to a specific situation where environmental considerations were combined with transport and regional considerations and economic and political arguments (avoiding opposition to the agreements between Switzerland and the EU). The HVF could be considered an instrument for “getting the prices right”, making the users and polluters pay for the costs they have caused. The user and polluter pays principle is generally well accepted by the public and in environmental politics.

Balmer states that three reasons have been decisive for the political implementation of the charge system (Balmer, 2003):

- the HGV charge system was introduced simultaneously with a raise in the weight limit of trucks, as a consequence of which the competitiveness of road transport remains stable;
- the HGV charge system was linked to the polluter pays principle;
- the revenue from the system has been reinvested in the improvement of road transport, the extension of the railway network and the strengthening of public transport.

4.5.4. Impact analysis

Modal split

The HVF is considered an important instrument to encourage transport of goods to shift from road to rail, but the choice of transport mode – especially in international transport – depends on various factors, with elements such as reliability and ease of transportation being regarded as at least as important as the price. Not surprisingly, the first positive reports of a modal shift in overland traffic have been observed in domestic transport. However, the increase observed in the rail sector’s share of freight transport in the first half of 2004 did not represent the beginning of a real trend (ARE, 2004). As matter of fact, despite the higher costs of transport by road haulage, there were no significant changes in the modal split. A substantial shift of tonne-kilometres to the railways will need more time and more factors:
to reach a higher market share, railways have to improve their productivity (Nash, 2004): in terms of competition between road and rail, the better competitiveness of rail due to the HVF (HVF cost increasing effect of 19%) was outbalanced by increased productivity in road transport due to the higher weight limit (road transport's average gain in productivity was 18%) (IMPRINT, 2003).

once the new trans-Alpine rail tunnels, which are largely funded by HVF revenues, have been opened, between 2007 and 2014/15, rail might capture a larger share of the freight market. However, due to the infrastructure fragmentation, the rail system is still disadvantaged in comparison to the road system, especially between Italy and Germany. The existing patchwork of different rail systems and the lack of integration and interoperability reduces the chances of rail companies to offer fast, reliable and efficient international services and increases the current imbalance in modal split.

an higher market for modes alternative to road transport will be probably induced in the coming years by higher fuel prices. Concrete evidence does not yet exist, but recent forecasts (HOP!, 2008) have estimated for 2020 a decrease in road transport's share of 1% on the basis of a fuel price higher than 2 Euros per litre and existing rail capacity. Impacts like this will probably be more evident in countries such as Switzerland, where the rail sector offers competitive services.

Finally, it is important to take into consideration that rail's share in goods transport in Switzerland is already one of the highest in Europe: according to (ARE, 2004), it is about one-third of transit traffic across the Alps and about two-thirds of total traffic (measured in tkm). In addition, Switzerland is currently developing the Alpine Crossing Exchange: as with the trading system for CO2 emissions in the EU, every HGV crossing the Alps will need a permit, as better explained in paragraph 5.3.

The reduction of vehicle kilometres

The ever increasing transit traffic through Switzerland has been the main driving force to introduce a Heavy Vehicle Fee (Balmer, 2006). Given the launch of the fee at the beginning of 2001 and the fact that the weight limit for trucks was increased from 28 to 34 tonnes, it is quite complex to define the absolute impact on vehicle kilometres caused by the heavy goods fee.

By far the biggest impact of the new traffic regime with the HVF and higher weight limits has certainly been on the development of road performance. After a steady increase in vehicle kilometres for over 30 years (5–6% per year before the introduction of the fee), this trend has clearly been broken since the introduction of the heavy vehicle fee.

Indeed, in the first two years of the toll system, a reduction in vehicle kilometres was observed (by 4% and 3% respectively, according to ARE, 2004). This reduction was caused by the combination of the charge and the increase in the maximum allowed weight of HGVs (from 28 to 34 tonnes in 2001).

However, in 2003 the yearly vehicle kilometres increased somewhat compared to 2002, with a further increase in 2004 by 4%.

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17 Forecasts on future capacities of Swiss Alpine links have estimated that 31% of the new rail traffic expected by 2020 will derive from the Gotthard tunnel, scheduled to be operational in 2018, and 15% from the Simplon and Lötschberg tunnels, already operational since 2007 (COWI, 2006).

18 Here the main bottlenecks are the availability of rail tractors and of Italian driving staff, the insufficient number of terminals and their limited capabilities (this is a serious problem especially in northern Italian regions, such as Lombardy).

19 The reduction in vehicle km 2001 and 2002 was not completely caused by the introduction of the LSVA, but also partly as an effect of the reduced economic growth in 2001.
After the increase of weight limit from 34 to 40 tonnes in 2005, a new trend occurred in the reverse direction: by the end of 2005, the total number of kilometres travelled reached a level that was 6.5% lower than in 2000 (DATEC, 2007).

Alpine transit through Switzerland (see figure 4.4), the increased weight limit led to an increased use of semi-trailers. At the same time a reduction of the number of lorries with lower weight limits could be observed, which kept the total number of transit lorry trips more or less constant in 2001. In 2002 the number of transit journeys was reduced by 9%, partly as an effect of restrictions caused by the accident in the Gotthard tunnel. (East West TC, 2007).

Looking at the number of vehicles crossing the Swiss Alps over a long period (see figure 4.5), the consequences of the HVF are quite evident: after a growth in freight traffic from 1981 to 2000, the Swiss Alpine crossings show a fall of 10% in the number of vehicles from 2000 to 2007. However, looking at the recent trend, in the year 2007 the annual traffic of large goods vehicles increased by +7%: 1,263 million large goods vehicles traversed the Alps, 82,000 more than in 2006 (Federal Office of Transport, 2007).
Traffic diversion

There are no effects on route choice for domestic traffic, since the HVF is paid per tonne/km driven in Switzerland, no matter which road is used. Additionally Switzerland is quite small and more service than production oriented, so effects were very limited (East West TC, 2007).

However, the Swiss detour traffic has occurred in neighbouring countries: before 2001 due to the lower Swiss GTW limit (28 tonnes), many HGVs used to choose an Austrian or French Alpine crossing each year instead of taking the route through Switzerland, which would actually be more direct. But, also after the removal of the weight limit (from 28 to 34 tonnes in 2001 and to 40 tonnes in 2005), this situation remained unchanged, due to the higher Swiss fee level from 2005 (ARE, Detec, 2004). Actually, from 2005 the fee rate per truck is, on average, eight times higher than it used to be until 1999 (Balmer, 2003).

According to FIA (www.fiabrussels.org), the lower price of diesel in Switzerland doesn’t generate significant detour or road haulage traffic from neighbouring countries due to the high cost of HVF fee.

Fleet composition

In the year prior to the introduction of the HVF, sales of heavy goods vehicles increased by 45%. After the introduction of the fee, limited evidences were found on the accelerated fleet replacement. The forwarders and hauliers tried to optimise their fleet, either by changing to smaller or to larger vehicles, depending on their customer base. Often, dirtier vehicles are kept as reserve vehicles or used as vehicles for specific transport needs (e.g. crane vehicles) and therefore still appear in stock figures (DIFFERENT, 2008). The changed structure of the lorry fleet and changes in the
forwarding industry led to a change in the earlier experienced growth trend for HGV (East West TC, 2007).

**Fleet renewal**

The fee deployed their effects even prior to its introduction, causing a considerable renovation of the fleet composition and replacing old vehicles with less polluting ones (East West TC, 2007). In 2006, recent data showed a clear domination of the EURO 5 technology for vehicles bought and registered though the hauliers could still buy EURO 3 vehicles: 51% of the new vehicles belong to the emission category EURO 5 and another 29% to EURO 4. One fifth of the new vehicles only comply with the mandatory minimum standard EURO3.

The price and the operation costs of a EURO5 or a EURO4 vehicle is rather higher than for a standard EURO3 vehicle. Therefore, it is possible to assume that the high shares of EURO5 and EURO4 vehicles show the influence of the HVF. The hauliers anticipated the further development of the HVF, i.e. the differentiation between EURO3 (new HVF class 2) and EURO 4/5 (HVF class 3) which Switzerland is planning to introduce during the current year.

From the environmental improvements point of view, it is difficult to quantify the benefits the introduction of the HVF brought (or will bring). In 2003, the IMPRINT study estimated that the emissions of CO₂ and NOₓ caused by heavy goods vehicles in 2007 will be about 30% lower with the new regime than it might have been if the old regime (flat fee, no higher weight limit) had been maintained. The fee led to reductions in heavy vehicle emissions as the trucking industry turned to less polluting vehicles to take advantage of lower fees for vehicles with lower emissions (IMPRINT, 2003).

**Load factor optimisation**

The main effect of the HGV toll was its incentive for fully exploiting the logistic potential to optimise utilisation of the vehicle fleet and especially avoiding empty runs. Efficiency has gained in road freight transport and logistics: the transport and logistics sector has evolved its operations to achieve productivity gains. To avoid empty trips, some companies are now cooperating. Some medium-sized companies that had difficulty adapting have disappeared. (ARE, 2004). Consequently, it can be observed that the new system led to a more efficient haulage industry characterized by a concentration in the haulier industry, either through mergers or through the closure of smaller companies. Larger companies are able to manage their lorries more efficiently and, particularly, avoid empty runs. (IMPRINT, 2003).

**Use of revenues**

In 2002 the gross annual revenue generated by the HVF was 600 million Euro (Imprint.Net, 2006) and the average implementation costs were roughly 8% of gross annual revenue. In 2005 the income from the HVF amounted to €793 million and, in 2007, it reached about €815 million (Swiss Federal Office of Transport, 2007).

Two thirds of the revenues flow into the financing of the large-scale public transport projects (Finöv-Fonds), which includes the New Alpine Rail Transversal (NEAT) - especially Lotscheberg and Gotthard - the improvement and the extension of the railway passenger transport (Rail 2000), the new scheduled links to the European high-performance rail networks, and the noise reduction programme. The remaining 33% is allocated to the cantons, which must use it primarily to pay uncovered costs in connection with road transport (REVENUE, D3).
4.6. Synthesis of the impacts on the four selected countries

As described in the previous paragraphs, the impacts of the reforms of heavy road vehicle pricing regimes are quantifiable only in a few cases. To explain this lack of evidence, it is of the utmost importance to take into consideration that more time may be necessary so that charging policies can reveal their effects (especially for the Czech Republic, where the charging policy came into force at the beginning of 2007), in addition to the existing difficulties in taking impacts of pricing policies out from other factors and/or long-term trends, such as increased fuel prices\textsuperscript{20}, changed vehicle weights or the open market towards Eastern Europe.

The table below summarises the impacts of the distance-based pricing systems for heavy vehicles in the four countries analysed.

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Austria</th>
<th>Czech Republic</th>
<th>Germany</th>
<th>Switzerland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modal split</td>
<td>No evidence of impact</td>
<td>No evidence of impact</td>
<td>No evidence of impact</td>
<td>No evidence of impact</td>
</tr>
<tr>
<td>Yearly reduction of vehicle kilometers</td>
<td>More than 10% in East-West transit traffic in 2007</td>
<td>No quantified growth in transit traffic</td>
<td>No data available</td>
<td>By the end of 2005, the total number of km travelled was 6.5% lower than in 2000</td>
</tr>
<tr>
<td>Traffic diversion</td>
<td>About 2-3% of freight traffic to free-tolled network in 2005</td>
<td>No evidence of impact</td>
<td>6.6% of traffic growth on secondary roads in 2006</td>
<td>No evidence of impact (HVF on the whole road network)</td>
</tr>
<tr>
<td>Fleet composition</td>
<td>No data available</td>
<td>No data available</td>
<td>75% growth of new 10/12 tonnes lorries (1999-2005)</td>
<td>Not quantified evidences on the accelerated fleet replacement</td>
</tr>
<tr>
<td>Fleet renewal</td>
<td>No impact because of no differentiation according to the emission classes</td>
<td>No evidence of impact</td>
<td>No quantified growth of EURO 5 and EURO 3 HGV</td>
<td>51% of the new vehicles registered in 2006 belong to the emission category EURO 5</td>
</tr>
<tr>
<td>Load factor optimisation</td>
<td>9% reduction of empty running trucks between 1994 and 2004</td>
<td>No data available</td>
<td>6% reduction of empty trips in 2007</td>
<td>No quantified reduction in the number of empty trips</td>
</tr>
<tr>
<td>Use of revenues</td>
<td>Road construction and maintenance, 58% for underground construction in 2007</td>
<td>Revenues from HVF on national motorways to motorway network completion; Revenues from HVF on minor roads to regions to improve the road network quality</td>
<td>20% to toll operator for charging technology, 80% to federal transport networks</td>
<td>2/3 of the revenues to the Finöv-Fund; 1/3 to the regions to construction and maintenance of road infrastructure</td>
</tr>
</tbody>
</table>

\textsuperscript{20} Oil prices have increased by more than 400% (in nominal terms - EIA data) since 2001, reaching a new record above 130$ per barrel in May 2008. This increase is leading to higher operating costs for all modes of transport. Particularly on the freight modes side, trucks’ costs would be increased substantially. As the road haulage market is a very competitive one, profits are very low so there is no room to absorb higher fuel costs. Consequently the main effects of the increased fuel prices, overlapping the infrastructure pricing effects, would be the modal shift toward less expensive modes and pressure to organise transport more efficiently (e.g. through increasing the load factor). However, both may occur in the short run only for a modest share: a significant increase of rail capacity of lines and nodes (stations, intermodal centres) and changes in the logistics organisation of transport companies could not be quickly realised.
Before illustrating the details, it is important to mention that the four existing distance-based road user charging systems in Europe have different objectives:

- the Austrian system is mainly focused on road infrastructure financing, but also on the environmental sustainability of the transport system, as shown by the recent decision to differentiate charges according to emission classes since the year 2010 (see table 5.1);
- the Swiss system has a clear focus on applying the “user pays” principle, protecting the environment and increasing the rail share;
- in the German system the infrastructure financing aspect is the most important but there is also a focus on applying the “user pays” principle, more efficient use of transport capacities and emission-related tolls as well as providing fairer conditions for rail-road;
- the Czech system was planned and now is implemented on the basis of the German model.

The different goals are reflected in the way the road fee structures are differentiated, in the choice of which roads to be included in the different schemes, and in the chosen fee level.

4.6.1. Modal split

The occurrence of modal split effects are difficult to separate from other influencing factors, taking into account the strategic nature of the choice between rail and road, where price is only one of the decision criteria.

In Germany there are some indications of a modal shift among larger shippers towards an increased use of rail transport, although this impact is mixed with the effect of the large increase in fuel prices since 2000, which has lead to an increase in tariffs, and with the increase in rail tonne-km as effect of longer transport distances rather than increased transport volumes.

In Switzerland there are almost no measurable impacts on modal split and the effect of the road toll has been almost totally compensated by efficiency gains in the road sector through higher permitted lorry weights.

Also, for Austria and Czech Republic, indications of changes in modal split due to the road tolls cannot be easily spotted.

However, the modal shift effects would become more evident especially thanks to the following factors:

- The increasing capacity of rail transport due to new rail infrastructure, especially in the Alpine region where the new tunnels will be opened: as the study COWI 2006 has estimated, the 31% of new rail traffic expected by 2020 will derive from the Gotthard tunnel - scheduled operation in 2018 - , the 25% from the Brenner tunnel- scheduled operation in 2020 - , and the 15% from the Simplon and Lötschberg tunnels - already operative since 2007.
- The extension of the pricing system to the whole European network, which reduces traffic diversion towards non-tolled countries.
- The future higher level of road charges due to the internalisation of external costs, as explained in paragraph 6.2.1).
- The use of innovative systems, such as the Alpine Crossing Exchange, as explained in paragraph 5.3.
4.6.2. Reduction of vehicle kilometres

Vehicle kilometres reduction could be considered relevant only in the Swiss case, where the new traffic regime with the HVF, the high level of tariffs and the higher weight limits have had a substantial influence on the development of road performance, cutting off the thirty-year increase in vehicle kilometres. Further increases in road transport costs, due to high oil prices as well as to the implementation of internalisation of external costs criteria, might provoke a more significant impact on the travelled vehicle kilometres.

4.6.3. Traffic diversion

Toll avoidance de-routing is a negative impact of the implementation of road tolls in Austria and Germany. In Germany there have been tendencies to de-route to secondary roads (national roads) which run parallel to motorways, have a motorway-like standard and are as efficient in terms of time. This led to the extension of toll measures also to these roads. The same tendencies can be found in Austria but to a somewhat lesser extent. The de-routing leads to unwanted effects in the form of, e.g. increased maintenance costs, increased number of accidents and noise levels, not to mention the acceptability of the schemes among the population.

This negative effect was avoided in Switzerland thanks to the fact that all roads in this country are included in the scheme. However, Swiss transit traffic has been diverted to neighbouring countries such as Austria and France, as explained in paragraph 4.5.4. Data are not yet available for Czech Republic.

4.6.4. Logistics

The impacts of the implemented road toll systems on logistics are to be found mainly in an increased efficiency in the road freight sector in terms of e.g. changes in fleet composition, fleet renewal, aggregation of road transport, reduced number of empty runs and concentration in the haulier business. These effects are apparent in Germany, Austria and Switzerland and also, in some cases are quantifiable.

In particular, there is an increased use of vehicles with reduced emissions in Germany and Switzerland and in general, there is a tendency in all countries towards adjustments of the fleet composition as a response to the charging criteria. This however, is a slow process following the normal life cycle of the vehicle fleet.

4.7. Implication of different pricing systems on vehicle fleets

In order to capture possible differentiations or similarities existing among impact dimensions deriving from different road pricing systems using distance-based charges, concessionaires tolls and time-based charges, this paragraph focuses on one of the most strategic reaction of haulage businesses to the introduction of road user charges on a network that is making better use of their vehicle fleet through transport logistics improvements.

Einbock and other researchers at the Vienna University of Economics and Business Administration (Einbock, 2006) have carried out two empirical study surveys on companies from different sectors, concerning the importance of expected impacts of the introduction of the Lorry
Pricing systems for road freight transport

*Maut* in Austria\(^{21}\). Both of the surveys indicate that a reorganisation of transport logistics and an intensified cooperation with other logistics providers are the most relevant strategies.

To make better use of the fleet composition is possible by shifting towards more cost-effective vehicles, either by using lighter or heavier vehicles not subject to tolls or by adapting the vehicle fleet composition as a consequence of emission-differentiated charges, as shown respectively in paragraph 4.7.1 and 4.7.2.

### 4.7.1. Fleet composition

The table below shows the growth rate of registration of new HGV vehicles between 2004 and 2005, divided into commercial vehicles (3.5\( < \)tonnes\( > \)16) and heavy commercial vehicles (\( > \)16 tonnes), in some countries belonging to different pricing systems.

In Germany, as a result of the introduction of tolls for HGV over 12 tonnes gross weight at the beginning of 2005, it can be seen that in the first year the number of new registered lorries higher than 16 tonnes has increased more than the commercial vehicles category. This result can be explained by the desire of haulage companies to reduce costs by employing heavier vehicles which are more cost-effective per tonne of goods.

<table>
<thead>
<tr>
<th>Charging systems</th>
<th>Country</th>
<th>Commercial Vehicles 3.5( &lt; )tonnes( &gt; )16</th>
<th>Heavy Commercial Vehicles ( &gt; )16 tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td>Distance-based systems</td>
<td>Germany</td>
<td>38,735</td>
<td>42,018</td>
</tr>
<tr>
<td></td>
<td>Switzerland</td>
<td>921</td>
<td>1,058</td>
</tr>
<tr>
<td>Distance-based concessionaires</td>
<td>Italy</td>
<td>10,843</td>
<td>12,101</td>
</tr>
<tr>
<td></td>
<td>France</td>
<td>9,037</td>
<td>11,314</td>
</tr>
<tr>
<td>Time-based systems</td>
<td>Belgium</td>
<td>2,584</td>
<td>3,344</td>
</tr>
<tr>
<td></td>
<td>Sweden</td>
<td>836</td>
<td>1,255</td>
</tr>
</tbody>
</table>

Source: DGTREN, 2006

This effect is even more evident in Switzerland, where hauliers' choices are strongly more oriented to the purchase of heavy commercial vehicles. With respect to the higher degree of charging differentiation according to the vehicle weight, in contrast to the German charging structure\(^{22}\), the Swiss case shows clearly that there are incentives to use heavier vehicles. This proposition is also confirmed by the market development.

Italy and France, characterized by distance-based pricing for all vehicles, show results similar to Germany. On the contrary, Belgium and Sweden, despite their vignettes applied to vehicles over 12 tonnes, show a more accelerated fleet replacement for commercial vehicles under 16 tonnes, answering to the need to cut costs by using lighter vehicles not subject to tolls. It is important also to consider that the vignette system is time-based and therefore the advantages derived from the vehicle kilometres reduction have to be excluded from haulage business decisions on fleet composition.

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\(^{21}\) The first survey was in the autumn of 2003, 4 months before the Austrian toll was implemented, and concerned over 1,000 companies from different sectors. At the end 140 valid questionnaires were returned. 34 of these were from forwarders and carriers. A follow-up study was carried out in June 2005 in which 47 companies from the transport sector participated.

\(^{22}\) The German tariff structure is simply separated between vehicles over 12 t (which have to pay a charge) and vehicles under 12 t (no charge).
The above analysis of the fleet trends seems to prove that finer differentiated tolling schemes according to vehicle weight can provide the right incentives for vehicle use.

However, it has to be taken into consideration that toll costs represent only one of the cost categories that influence the companies’ choices in modifying their fleets. Nagel (Kummer und Nagel, 2005) stresses that route choices are cost-driven and that the toll is only one of many costs (staff, petrol, oil, tyres, distance-based depreciation, distance-based repair and maintenance).

A survey realized on behalf of the DIFFERENT Project (DIFFERENT, 2008) of a selected sample of multimodal operators and third-party logistic providers, as well as small companies and single hauliers, provides some interesting results on the subject. Tolls’ share of total vehicle operating costs is less than 10% for more than 80% of the operators, while for the remaining 20% the share is less than 15%.

4.7.2. Fleet renewal

Turning to the differentiation according to the emission classes, the existing differences may have significant effects on the vehicles used.

In Germany and Switzerland, both systems are similarly differentiated according to emission standards. All vehicles are separated into three categories according to their EURO classification. This has separation changed over time for both systems. However, this occurred in Germany faster than in Switzerland. The Swiss differentiation seems to follow the market development rather than to frame it.

Fig. 4.7 Registration of new goods vehicles of different EURO standards in Switzerland and in Germany, year 2006

For Switzerland, we see a clear domination of the EURO5 technology for vehicles bought and registered in 2006, though the hauliers could still buy EURO3 vehicles.

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23 The survey was organised according a two-steps procedure as follows: step 1: A main group of operators contacted and interviewed by phone in Italy (TRT) and Poland (ILiM), filling in a standard interview form (completed) and step 2: A larger sample of operators throughout Europe contacted by e-mail with an invitation to fill in a simplified electronic version of the questionnaire (questionnaire designed, invitation to log in to DIFFERENT website to be circulated).

24 Of a total of 30 (20 to Italian operators and 10 to Polish operators) relatively long and complex questionnaires sent, 17 were returned, 9 from Polish operators and 8 from Italian operators.
In Germany, we find a much higher share of EURO3 and a clearly lower share of EURO5 vehicles as regards total sales and registration of new HGV. It can be assumed therefore that a comparison with figures from other European countries would lead to an even larger difference “in favour” of Switzerland. In 2006, German motorways were tolled with a charge that also differentiated between vehicles of different emission standards. EURO4 – only until September 2006 – and EURO5 vehicles paid lower rates than EURO3 vehicles. As the German toll is only levied on motorways and is substantially lower in absolute terms, the incentive to switch to cleaner vehicles is obviously less strong than in the case of the Swiss HVF.

The fact that since September 2006, EURO4 and EURO3 vehicles pay the same toll on the German motorways may be one reason why the share of EURO4 vehicles is so low in Germany. The other reason is that EURO4 vehicles do not have cost advantages compared to EURO5 vehicles. These tendencies are expected to strengthen if we take into account the intention of the German Government to subsidise the investment in vehicles of the EURO5 class. This is evident in the lastest developments in the accelerated use of EURO5 vehicles (with respect to vehicle kilometres).

As the German toll is only levied on motorways and is substantially lower in absolute terms, the incentive to switch to cleaner vehicles is obviously less strong than in the case of the Swiss HVF.

The Swiss HVF demonstrates that the differentiation according to emission classes is particularly important because it represents an incentive to anticipate market developments following the definition of the emission standards. The lack of this kind of pricing differentiation has a strong stopping power in the capacity of national fleet renewal, as for instance the Italian case study shows.²⁵

Fig. 4. 8  HGV fleet composition by EURO standards in Italy, year 2006

Source: ACI, 2006

²⁵ Comparison with other national fleets presents many difficulties mainly due to the lack of data availability. As a matter of fact car manufacturers consider data on vehicle fleet selling according to Euro categories as too confidential because it is strictly linked to their market strategies. That is why to find information on fleet renewal results to be very difficult.
Italy has a concessionaire system based on distance-matrix pricing scheme, applied only on part of the national motorways\textsuperscript{26}, without differentiation by emission class. As the figure above shows, the Italian fleet still presents a higher share of EURO0 and a dramatically lower share of EURO5 and EURO4 vehicles in total sales and registration of new HGV. The EURO4 category began to become a mandatory provision for new HGV registrations since 1\textsuperscript{st} of October 2006, but, in comparison with Switzerland and Germany, the capacity of Italian HGV manufactures and haulage businesses to anticipate the emissions standards legislation through market developments seems to be of no value.

Information on fleet renewal in countries that apply time-based vignette systems is not available or is too differentiated to allow a comparison with the other pricing approaches.

\textsuperscript{26} In Italy, there are currently 23 tolled motorway operators administering a total network length of more than 5,600 km (against 6,500 km of the whole Italian motorway network). Half of these are operated by Autostrade S.p.A. AISCAT (Associazione Italiana Società Concessionarie Autostrade e Trafori), the umbrella organisation of the motorway operators. Some motorways in southern Italy are not tolled.
5. Analysis of expected impacts of potential measures

5.1. Introduction

This chapter provides a synthetic overview of planned measures in EU Member States and Switzerland, with a focus on countries that are debating the introduction of a distance-based system applied on the broad network: namely the UK, Sweden and the Netherlands. In addition, the text includes the description of the innovative schemes for the Alpine region under policy evaluation in Switzerland, the future development of the Eurovignette Directive towards the internalisation of external costs, and eventually the potential contribution that technological innovation could give towards the interoperability of the systems.

5.2. Overview of planned measures

Table 5.1 shows the main changes that are expected in Member States with a road pricing systems, starting from the current status and describing synthetically the planned measures. The table shows future possibilities also for countries currently without charging schemes, in particular Finland, Ireland and the United Kingdom, due to the fact that these countries are currently examining the possibility of introducing road pricing policies.

Concerning the planned measures, it is possible to summarise the main likely developments as follows:

- countries with a distance-based system are planning to move towards nationwide systems and take into consideration the external costs of transport in the calculation of tariffs, following the Swiss example;
- countries with distance-based concessionaire systems are discussing the introduction of the Eurovignette Directive;
- countries with time-based systems and countries without any charging system are debating the introduction of a distance-based scheme by 2015.

In general, as also the Eurovignette Directive suggests, the main goal is the differentiation of charges by EURO categories and the application of specific mark-ups in areas considered more sensitive, such as mountainous regions.

The following graph shows the degree of full application of the Eurovignette Directive in different countries. The rules are considered as fully applied when the following four aims are fully accomplished:

- Vehicles tolled: > 3,5 tonnes;
- Environmental target: charge differentiation according to Euro emissions classes;
- Revenues target: use of revenues to finance other transport modes or new infrastructures;
- Network target: motorways, secondary and local roads.
<table>
<thead>
<tr>
<th>Country</th>
<th>Current status</th>
<th>Planned measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>&gt; 3.5 tonnes&lt;br&gt;All motorways and a few express ways&lt;br&gt;Axles</td>
<td>• The federal government passed a resolution on “greening” the road toll system for heavy vehicles in the Council of Ministers on 17 September 2007&lt;sup&gt;27&lt;/sup&gt;&lt;br&gt;• Discussion on inclusion of parallel roads, but there are no immediate plans</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>&gt; 3.5 tonnes&lt;br&gt;All motorways and express ways&lt;br&gt;Axles and EURO classes</td>
<td>• Plans are planned for the use of revenues from toll on minor roads by the regions to improve the quality of the road network&lt;br&gt;• By 2009-2010 tolls for vehicles &gt; 3.5 tonnes on other roads</td>
</tr>
<tr>
<td>Germany</td>
<td>&gt; 12 tonnes&lt;br&gt;All motorways and 3 national highways&lt;br&gt;Axles and EURO classes</td>
<td>• Possible inclusion of more parallel roads&lt;br&gt;• Possible introduction of pricing differentiated according to day time or place in order to tackle congestion on road links&lt;sup&gt;28&lt;/sup&gt;</td>
</tr>
<tr>
<td>Switzerland</td>
<td>&gt; 3.5 tonnes&lt;br&gt;All roads&lt;br&gt;Maximum laden weight and EURO classes</td>
<td>• No plans&lt;br&gt;• Alpine Crossing Exchange under debate</td>
</tr>
<tr>
<td>France</td>
<td>All vehicles&lt;br&gt;80% of motorway network&lt;br&gt;Axles</td>
<td>• Proposal by several associations to introduce road charging in Alsace due to volume of HGV traffic diverted due to German tolls&lt;br&gt;• Discussion about implementation of the Eurovignette Directive</td>
</tr>
<tr>
<td>Greece</td>
<td>All vehicles&lt;br&gt;All motorways&lt;br&gt;Axles</td>
<td>• No plans</td>
</tr>
<tr>
<td>Italy</td>
<td>All vehicles&lt;br&gt;87% of motorway network&lt;br&gt;Axles</td>
<td>• No plans&lt;br&gt;• Introduction of distance-based charges under debate (see the box 5)</td>
</tr>
<tr>
<td>Portugal</td>
<td>All vehicles&lt;br&gt;78% of motorway network&lt;br&gt;Axles</td>
<td>• No plans</td>
</tr>
<tr>
<td>Slovenia</td>
<td>All vehicles&lt;br&gt;Motorways and express roads&lt;br&gt;Weight, axles</td>
<td>• Plans to introduce distance-based system for all vehicles on all roads are under discussion, but no plans have yet been finalized</td>
</tr>
<tr>
<td>Spain</td>
<td>All vehicles&lt;br&gt;29% of motorway network&lt;br&gt;Axles</td>
<td>• No plans</td>
</tr>
</tbody>
</table>

---

<sup>27</sup> The new rules are to enter into force no later than in 2010. With effect on 1 January 2010, toll rates will be differentiated according to EURO emission categories. The vehicles are grouped into EURO categories based on their emission levels. The EU made the introduction of charging categories in 2010 a binding requirement: in Austria the go-ahead has been given for restructuring the road charging system even before that. Different road tolls based on emission classes can be enacted by decree already in the next two years. Furthermore, it will become possible to establish charges varying according to the time of the day (EurActiv, 2007).

<sup>28</sup> In the Master-plan for freight transport and logistic (2008), the German Federal Ministry of Transport stresses how the constantly increasing freight traffic results in an increasing number of road links, which are almost always more stacked with traffic. The introduction of road pricing with different tolls according to daytime or place should improve traffic control and it would decrease the congestion on road links. Moreover the road pricing system as designed by the Ministry should be determined according to driving time and emissions classes of the vehicle.
<table>
<thead>
<tr>
<th>Country</th>
<th>Current status</th>
<th>Planned measures</th>
</tr>
</thead>
</table>
| Belgium    | > 12 tonnes  
All motorways  
Axles and EURO classes               | • Plans for introduction of a vignette for vehicles under 12 tonnes  
• Debate on the introduction of “Maut” system implementation in the Flanders and recently also in Wallonia²⁹ |
| Bulgaria   | All vehicles  
All roads  
3 categories of vehicles              | • No plans                                                                 |
| Denmark    | > 12 tonnes  
All motorways  
Axles and EURO classes               | • No plans                                                                 |
| Hungary    | All vehicles  
95% of motorway network  
Weight | • Possible introduction of distance-related system |
| Lithuania  | Goods and agricultural vehicles, buses  
Highways and national roads  
Weight/length | • No plans                                                                 |
| Luxembourg | > 12 tonnes  
All motorways  
Axles and EURO classes               | • No plans                                                                 |
| Netherlands| > 12 tonnes  
All motorways  
Axles and EURO classes               | • Plans under discussion for possible introduction in 2012 of distance-based system (for all vehicles on all roads) |
| Poland     | > 3.5 tonnes and motorised vehicles  
Motorways and national roads  
Weight, axles, EURO classes | • Possible introduction of user charges on all national roads in 2009 or 2015 |
| Romania    | All vehicles  
All roads  
Axles, weight, EURO classes            | • No plans                                                                 |
| Slovakia   | All vehicles  
Motorways and first class roads  
Weight | • By 2009 distance-based system for vehicles over 3.5 tonnes (all vehicles from 2011) on highways and first class roads |
| Sweden     | > 12 tonnes  
All motorways  
Axles and EURO classes               | • Plans for a distance-based charge are under discussion, not yet finalised |
| Finland    | None                                                           | • No concrete plans to introduce road user charging, but a preliminary study has been undertaken in 2006 on road charging for heavy and light vehicles |
| Ireland    | None except for 3 motorway links:  
All vehicles  
Vehicle class | • The Irish National Roads Authority is considering construction of new toll roads under public-private partnership |
| United Kingdom | None except for 42 km motorways:  
All vehicles  
Vehicle class | • There are ongoing discussions on a national distance-based system for all vehicles. Provisional implementation date is 2015 |

Source: TRT elaboration on T&E

²⁹ In December 2007 the Flanders region decided to cooperate with the Netherlands in order to implement a km charging system like the German Maut. The application of this system on motorways and probably on other roads, including also passenger transport, is under discussion. The Brussels region joined the Flanders region position. Wallonia, which until the beginning of 2008 had showed a preference for the implementation of the vignette sticker, joined the “Maut” group in March 2008. So Belgium, with the Netherlands, and probably also Luxembourg, seems to have have begun the negotiation for a common system, like the German one, to be implemented in 2012.
5.2.1. United Kingdom

Objectives

At present in the UK there is only one tolled motorway: the M6 Toll. Several studies analyse the possibility to introduce a road pricing system in the UK. “Feasibility study of road pricing in the UK” (Department of Transport, 2004) suggests that a national road pricing scheme would probably become technologically feasible in ten years' time. The focus of this study is to consider whether it would to feasible to apply a more efficient and less congested road system and introduce charges to use roads depending on how congested they are.

Characteristics of the planned measures

The Government has announced its intention to introduce a distance-based charging scheme for all goods vehicles on UK roads. The main features of this system are:

- The charge will apply to all goods vehicles on UK roads, regardless of their nationality of origin.

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30 This is a 42 km three-lane motorway, opened in 2003. Tolls are differentiated by vehicles size and time of day (day/night tariffs).

31 Best forecasts is that the earliest starting date would be about 2014, as a national road pricing system is not currently technologically feasible in terms of practicality, functionality and costs.
The charge may differentiate between motorways and other roads, and could reflect other factors such as time of day,

Regular users will be required to install an on-board unit which will be used to calculate the charge.

**Acceptability actions**

Public acceptability is key to the successful implementation of road pricing. In 2003 over two-thirds of people agreed that charging would be successful in reducing emissions and congestion.

The study (Department of Transport, 2004) stresses key actions for central government to take:

- Acceptability action: to inform and lead a national debate developing better understanding of what the change of pricing scheme would mean and how it might be achieved in practice;
- “Use of revenues” action: to develop proposals on how revenues would be governed, managed and accounted for;
- Technological action: to optimise more practical research and experiments.

**Implementation costs**

The study investigates, among other scenarios for the implementation of road user charges in the UK, a road pricing scheme for all vehicles on all UK roads assuming that all road vehicles would be required to use a on-board unit which employs GPS technology so that charging is carried out according to distance travelled. The estimated implementation costs for road pricing are shown in the following table.

The investment costs depend on a large extent on the costs of OBUs and on the large amount of roadside equipment needed.

<table>
<thead>
<tr>
<th>Tab. 5.2 Implementation costs (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total implementation costs (€)</td>
</tr>
<tr>
<td>Investment</td>
</tr>
<tr>
<td>Investment per user</td>
</tr>
<tr>
<td>Annual operating costs</td>
</tr>
<tr>
<td>Annual operating costs per user</td>
</tr>
</tbody>
</table>


**Current experiment**

Presently, trucks driving around the UK capital (so-called “low-emission zone”) have to pay £200 per day to improve the city's poor air quality. The initiative will be closely watched in Brussels as the Commission is currently considering action to “green” transport in Europe's cities (EurActiv, 2008). The scheme, which started on 4 February 2008 and runs 24 hours a day, seven days a week, initially applies only to large diesel trucks over 12 tonnes; it will be extended to cover buses, coaches and vehicles between 3.5 and 12 tonnes in July and to others in October 2010.

London's scheme, covering a 1,577-square kilometre zone inhabited by 7.5 million people, will be the largest in the world and it is estimated that each day, some 50,000 vehicles are used to deliver goods and services to businesses and consumers within the low-emission zone. Hauliers claim that the charging scheme is very expensive and underline that cars are mainly responsible for traffic pollution in London and the scheme does not apply to them.
5.2.2. Sweden

Objectives

In Sweden a governmental commission has examined the possibilities of implementing an inter-urban kilometre charging system for heavy goods vehicles (Governmental Commission on road tax charges, 2004). The commission’s proposal is based on the principles that charges will be collected on all public Swedish roads as well as some of the privately owned ones and that the payment basis will be the distance travelled in combination with vehicle characteristics.

Characteristics of the planned measures

The Swedish government plans to present a proposal for a distance-based road user charge for HGV to the Parliament to come into force around 2010-2011, but until now, it has not been finalised. A national project called “Arena”, which aims to develop “a road user charging scheme” for heavy vehicles, is currently under discussion. The pricing system proposed, designed to be simple, user-friendly and flexible, has been developed in cooperation with public authorities and road users.

Main features of this pricing scheme are:

- All heavy vehicles over 3.5 tonnes shall be charged;
- The pricing system shall encompass all public roads;
- Kilometre tax shall be based on vehicle characteristics, distance, type of road and time;
- Differentiation shall be based on environmental characteristics (EURO emissions classes);
- Km-charge system will apply to both Swedish and foreign heavy vehicles.

Potential impacts

East West TC has published a report “Structuring and Analysis of the East-West-Corridor via Skåne-Blekinge” which is focussed on the potential modal split effects of road user charges along an East-West corridor via the Skåne-Blekinge region, northern Europe (northern Germany and Poland) as well as in the southern Baltic Sea corridor. The forecasting exercise has been carried out on three separated corridors (southern Sweden, northern Continental Europe as well as in the southern Baltic Sea corridor) within the overall defined East-West corridor.

The changes are compared between the existing situation and a possible scenario with the introduction of a road pricing scheme in Sweden.

The estimated impact of road charging system shows a reduction of approximately 10% for road transports and an increase by 5% for rail transport in Skåne-Blekinge. Some modal shift is also expected from road and sea transport in the northern German/Poland corridor and in the southern Baltic Sea corridor (traffic diversion). In the Skåne-Blekinge corridor, there would be a reduction by approximately 15% of road transport and an increase by 17% of rail transport.

5.2.3. Netherlands

Objectives

Plans to introduce a road charging system in Netherlands have been under discussion since 1990, but the politicised nature of the issue has led to many delays. Then the Dutch government established a stakeholder platform on road pricing, including motoring associations, environmental
groups, employers and regional governments. The platform has advised the two-phase introduction of a road pricing system, firstly to address bottlenecks and a nation-wide kilometre charge in a second step.

**Characteristics of the planned measures**

In November 2007 the Dutch government set conditions for the implementation on all roads of a kilometre charge differentiated by time, place and environmental characteristics of the vehicles and for both passenger and freight transport: the implementation will start with a pricing scheme for road freight transport in 2011 to be further extended to all road transport in 2016. The objective is to reduce road traffic congestion and environmental pollution.

The proposed technology is a satellite based (GPS) system with on-board units in all vehicles, but the technical details are, as yet undecided. BZM\textsuperscript{32} will be fully converted into kilometre charge. The price per kilometre will be determined calculating a basic rate applied throughout the Netherlands and differentiated according to vehicle weight on an environmental basis (EURO emissions) and then a further differentiation by time/place to take account of congestion.

**Implementation costs**

Several studies have been published with the intention of analysing the possibility of the introduction of road pricing system.

The study on External Effects of variants for Different Payment for Mobility, completed by Ministry of Transport, Public Works and Water Management in 2005, suggested four different scenarios for road charging schemes, which differ by some characteristics as shown in the table 4.3.

A second study “Making a start on a price per kilometre” by the Ministry of Transport, completed in 2007, updated and reviewed scenario A and came to the conclusion that the investments could be lower than the 2005 estimate: approximately €1.3-2.7 billion with a cost per user of €163-338, and operating costs between €250-925 million per year and €31-119 per user.

<table>
<thead>
<tr>
<th>Tab. 5.3 Different road pricing scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario</strong></td>
</tr>
<tr>
<td><strong>a) Kilometre charging</strong></td>
</tr>
<tr>
<td><strong>b) Kilometre charging heavy vehicles</strong></td>
</tr>
<tr>
<td><strong>c) Kilometre charging and congestion charging</strong></td>
</tr>
<tr>
<td><strong>d) Toll charging</strong></td>
</tr>
</tbody>
</table>


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\textsuperscript{32} Eurovignette in force since 1994 for the use of motorway for HGV.
In Italy, there are currently 23 tolled motorway operators administering a total network length of more than 5,600 km (against 6,500 km of the whole Italian motorway network). Half of these are operated by Autostrade S.p.A. AISCAT (Associazione Italiana Società Concessionarie Autostrade e Trafori) is the umbrella organisation of these motorway operators. Some motorways in Southern Italy are not tolled. This distance-based charging scheme covers all types of vehicles (motorcycles, cars and light and heavy goods vehicles); additional fees are also levied on some cross-border tunnels: Mont Blanc (to France), Fréjus (to France), Grand St-Bernard (to Switzerland) and Munt la Schera (to Switzerland). Tariffs are differentiated per five vehicle classes (number of axles). Cars are included in only one class (number of axles=1). None of the schemes differentiates tolls according to emission classes. Although the tolls are distance-based, their level is not usually indicated per kilometre but in the form of a matrix from motorway entry to exit.

Recently, an Italian economic newspaper (Il Sole 24 ore, 2008) reports from a ministerial document estimations about increased costs for the high-speed Turin-Lyon link due to the review of the project. According to this article, financial resources to finance the project should derive from a new distance-based pricing system, designed according to Eurovignette Directive, which should be extended to new primary and the secondary roads and to congested or sensitive areas through the use of additional mark-ups. The following figure shows the map of possible new tolled motorways and inter-urban roads:
5.3. Alpine countries

Transalpine road freight traffic has been expanding rapidly for many years. This leads to traffic congestion at vulnerable points of the road network and has harmful effects on people and on the environment. For these reasons, additional charges are levied for tunnels between Italy and France (Fréjus and Mont-Blanc), between France and Spain (Puymorens and Envalira in Andorra) and between Switzerland and Italy (Grand St-Bernard). However, only at Fréjus and Mont-Blanc are tunnel tolls differentiated according to vehicles emission classes.

In order to encourage a shift of freight transport from road to rail, studies have considered what further actions could be implemented in combination with the existing scheme, such as the Swiss heavy vehicle charge.

The proposed Alpine Crossing Exchange (ACE) uses market mechanisms to ration the number of trips across the Alps or the scarce road capacity at the Alpine crossing points and it is considered one of the most interesting schemes (ECOPLAN, 2007).

Two basic approaches for an ACE can be distinguished:

- “Cap-and-Trade”
- “Slot-scheme with dynamic price”

In “Cap-and-Trade” system, all heavy goods vehicles with a maximum operating weight of more than 3.5 tonnes have to produce an Alpine Crossing Permit (ACP) for their journey through the Alps, which is subject to the Alpine Crossing Exchange. The ACP is assigned to a specific vehicle and entitles that vehicle to a one-way journey through an Alpine crossing within a specific period of time.

A defined amount of Alpine Crossing Units (ACU) qualifies for an ACP. The required amount of ACU may be dependent on the vehicle type (e.g. emission category). Local and short distance transport may be treated differently concerning the required amount of ACU.

ACU are auctioned at regular intervals. The auction is considered the best means of assignment: it is easy to implement, ensures an efficient result and sets the right incentives. The auction is open for the hauliers as well as to financial institutions and intermediaries. The auction takes place once per year, and during the auction, the ACU of the present year and those of the future years are auctioned. This principle allows all participants to develop long-term strategies and to evaluate the market price of the future ACU.

ACU are traded off-market, i.e. there is no central platform on which the ACU transaction can be carried out. Hauliers, financial institutions and intermediaries may trade ACU directly with each other. Short and local transalpine journeys will profit from a possible privileged handling, i.e. an adjustment of the conversion rate, equal to a reduction of the tariff.

The “Slot-scheme with dynamic pricing” is an enhancement of the planned reservation system, with charge that is made for reservation. A maximum transit capacity is set due to safety reasons. The hauliers who want to have a guaranteed passage at certain day and time, must book and purchase a slot in advance, otherwise they will have to wait for a free slot.

The reservation of the slot can be done on an internet platform; the price of the slot will vary according to traffic forecast and length of the slot period. Both types of alpine transit exchange require an On-Board Unit for heavy goods vehicles, charging and enforcement stations and on ACE back-office system.
The expected costs amount to CHF 50-60 million (€30-36 million), and the minimum level of operational costs is estimated at CHF 15 million (€9 million). Both forms of the Alpine Crossing Exchange are technically and operationally feasible, but the “Cap-and-trade” model can achieve the goal of relocating traffic from road to rail in an efficient and non-discriminatory way. The aim would be to introduce this system together with neighbouring Alpine countries.

5.4. Towards the internalisation of external costs

The new proposal for a revision of the Eurovignette Directive, expected for July 2008, could open up a long-term perspective and improve the prerequisites for sustainable goods transport. To achieve this, it would have to provide the possibility to extend the toll scheme to recover not only infrastructure costs but also, gradually, external costs.\footnote{At present, in accordance with the Eurovignette Directive user charges should be equal to the allocated average costs of the construction, the maintenance and the operation of the road network and require additional charging for external accident costs (EC, 2006)}

At present, the existing pricing schemes still show little coherence with the external costs internalisation pricing principle. Despite differences between countries and some growing interest in environmental concerns, one of the main findings of the survey is that the majority of the schemes do not take expressly into consideration external costs, except for the air pollution, noise and accidents costs in Switzerland and the congestion costs on some motorways in the Paris region, where experiments with tariff modulation according to time are in progress.

<table>
<thead>
<tr>
<th>Tab. 5.4 State of the art of cost coverage in charge calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
</tr>
<tr>
<td>Switzerland</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Austria</td>
</tr>
<tr>
<td>Czech Republic</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Norway</td>
</tr>
</tbody>
</table>

Source: TRT

However, some elements of the external costs internalisation can be found, namely:

- The distance-based charging systems in Switzerland, Austria, Germany and, recently, the Czech Republic, which, in comparison with the matrix-based pricing systems managed by concessionaires (as in Italy and France), have the advantage of allowing a more rigorous application of the user pays principle for “getting the prices right”, i.e. making the users pay for the costs they cause;

- The introduction in the distance-based system of Switzerland, Germany and the Czech Republic of the HGV tariff differentiation by emission category (Euro class), taking indirectly into consideration the environmental costs, in addition to the infrastructural ones.
The distance-dependent Swiss HVF, with its differentiation between more or less polluting trucks, meets the principle of internalisation (polluter-pays principle) embodying it in the Swiss constitution. This principle inspired a charge that includes in its calculation the external costs, such as health costs and damage to buildings caused by air pollution and costs of noise and accidents, nevertheless excluding congestion costs.

The French experience of motorway charges modulation according to time takes into consideration the congestion level. On several tolled motorways in France toll levels are differentiated to spread returning holiday traffic more evenly over the day. Tariffs are modulated according to peak and off-peak hours in order to better manage the infrastructure capacity and to reduce the increasing level of greenhouse gases emissions.

To ensure that Member States can use the toll instrument in the near future for reducing the external costs originating from road freight transport, the expected changes to the Eurovignette Directive should either improve the ‘degree of convergence’, which concerns the level of current harmonization between existing charging practices across European countries, or the ‘degree of differentiation’, which concerns the capability of existing charging differentiation schemes to address the variability of transport conditions, e.g. time, location, traffic conditions, etc, in order to charge the users at the point of use of the infrastructure by taking account of the full range of externalities (DIFFERENT, 2007).

The analysis of how the internalisation of external costs can influence the potential impacts of HGV pricing will be developed in paragraph 6.2.1.

5.5. Potential contribution of pricing technologies towards interoperability

Charging for the marginal external costs of environmental damage, noise and accidents adds further requirements to the design of road pricing schemes. The charging technology has to be designed in a way that makes it possible to distinguish between vehicle types and their emission levels, between road sections with high and low accident rates, or between vehicles with few or many safety features.

In many countries electronic road tolling systems are in use, but, although many of them use similar technologies, few of them are compatible at present. This leads to inefficiencies in the operation of such systems and frustration among drivers. Currently in Austria, Germany and Switzerland (distance-based charging systems) there are three technologies: respectively, DSRC, GPS, and DSRC/tachograph, and each one has different characteristics, as shown in the table below. Moreover, Sweden’s Governmental Commission has proposed the introduction of a distance-based road charging system.

Implementation costs of technologies show a downward sloping trend: this may be observed by comparing the results for the 2005 and 2006 studies from the Dutch Ministry of Transport, as confirmed by the 2007 study for the UK. The following table synthesizes the information available for existing pricing schemes and different studies:
Tab. 5.5 Overview of implemented and planned technologies for HGV road user charges in Europe (2005)

<table>
<thead>
<tr>
<th>Country</th>
<th>Technology Technique</th>
<th>Price list</th>
<th>Pre/post</th>
<th>Method</th>
<th>Means</th>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>DSRC Server</td>
<td>Both</td>
<td>Cash</td>
<td>Debit cards, Credit cards</td>
<td>Euro, Quick (electronic purse), Major fuel and credit cards</td>
<td>Daily transmission of data from credit institute, Bill sent out every fortnight</td>
</tr>
<tr>
<td>Germany</td>
<td>GPS/GSM OBU</td>
<td>Both</td>
<td>Cash</td>
<td>Debit cards, Credit cards</td>
<td>Euro and at terminal location official foreign currency, Major fuel and credit cards</td>
<td>Daily transmission of data from credit institute, Monthly check of credibility</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Tachograph DSRC (GPS for check) OBU</td>
<td>Both</td>
<td>Cash</td>
<td>Debit cards, Credit cards</td>
<td>CHF, Euro, Major fuel and credit cards</td>
<td>60 days to send billing information, 1 calendar month for paying bill</td>
</tr>
<tr>
<td>Sweden</td>
<td>Possible solution: DSRC Server, OBU</td>
<td>Both</td>
<td>Cash</td>
<td>Debit cards, Credit cards</td>
<td>Not decided</td>
<td>Post pay up to several days</td>
</tr>
</tbody>
</table>

Source: Blomberg and Poersch, 2004 and updated by Blythe, Schelin and Gustafsson, 2005

Tab. 5.6 Overview of technology implementation costs

<table>
<thead>
<tr>
<th>Source</th>
<th>Technology</th>
<th>Investment per user in €</th>
<th>Annual operation costs per user in €</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Real data DSRC</td>
<td>417 – 617</td>
<td>58</td>
</tr>
<tr>
<td>Germany</td>
<td>Real data GPS</td>
<td>500 - 1000</td>
<td>393 - 508</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Real data DSRC/tachograph</td>
<td>450 - 565</td>
<td>100</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Study Ministry of Transport, 2005</td>
<td>DSRC</td>
<td>1250 - 1500</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Study Ministry of Transport, 2007</td>
<td>GPS</td>
<td>818 -1660</td>
</tr>
<tr>
<td>UK</td>
<td>Study CE Delft, 2007</td>
<td>GPS</td>
<td>662 – 4925</td>
</tr>
</tbody>
</table>


Road pricing technology is continuously developing and it may be expected that costs will decrease even further in the future: i.e. OBUs’s costs for GPS based systems are likely to shrink, because this kind of technology will be used for other applications in the car (TNO/CE Delft, 2003). This will help facilitate the spread of a distance-based road pricing system, progressively less expensive in comparison with the time-based systems (characterized by low enforcement costs) and will favour the way towards interoperable systems.

The European Commission Directive (2004/52/EC) on Electronic Fee Collection stresses the need for interoperability of road pricing systems to ensure easy and free movement of goods as well as fair competition among hauliers. The aim is to have a single contract between the users and all operators and a set of technical standards that allow the industry to provide the required equipment.
in an open market with a significant number of potential systems and OBU suppliers. The Directive describes the essential principles of the system and a committee will work with the definition of the so-called “European Service”.

According to the Directive all new electronic toll systems shall use one or more of the following technologies:

- Satellite positioning: this is an advanced technology capable of distinguishing which roads are being used as well as the distance driven. Technically, this is solved through the use of a digital map to which satellite positions are matched, as well as a price list. The data is communicated to the road operator through the use of mobile communication. Germany is the only country that has introduced a system of this kind.

- Mobile communication using GSM-GPRS standard, utilising the positioning function of the mobile technology for both distance measurement and communication of the fees. GSM-GPRS is included in the German system, but only for communication purposes.

- 5.8 GHz microwave technology, using dedicated short-range communication (DSRC) between a small device placed in the windscreen of the vehicle and an antenna placed by the road-side. This technology demands roadside infrastructure with transceivers, enforcement systems and other necessary equipment processing all charging points along the road or on each link of a road network for communication with the on-board unit. Austria has adopted a DSRC-based HGV charging system and this technology has been chosen for road tolling.

Harmonisation would certainly facilitate comparability and simplify the users’ understanding of charges, if there is harmonised classification of vehicles. To enable EFC systems to fulfil the likely requirements of future charging and pricing legislation, the set of classification parameters should include in addition to the usual vehicle characteristics, environmental attributes such as emission or noise characteristics. With the definition of the EURO emission categories, a step in the direction of harmonization has already been taken.

Full interoperability in Europe may be reached within the next 10 years, depending on market force. A study of the use of each of the technologies, as well as a cost-benefit analysis, is planned for December 2009. The study should stimulate the definitions of standard technologies and get the adequate level of interoperability.

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34 Different EFC (Electronic Fee Collection) systems are fully interoperable if the user of one EFC system can access a tolled road of another EFC system without being treated as a non-equipped user and without aggravation of the price of the trip. Any new technologies should at least be interoperable and capable of communicating with each other, and existing tolling technologies should ensure full compatibility and interfacing with the technologies defined in the Directive, as well as with each other.
Part III: Conclusions

6. Conclusions and Recommendations

6.1. The Preference for the Distance-Based Pricing Approach

Two pricing approaches have been currently chosen by EU member states (TIS.pt, 2001):

- **Time-Based pricing**: is defined as being a charge (vignette) which is levied for permission to drive within a certain area and within a certain time period and which is differentiated according to vehicle classes;

- **Distance-Based pricing**: is defined as a pricing scheme based on the kilometres driven on a limited network of interrelated roads. The two categories of this scheme can be distinguished as follows:
  - Limited network: the system applies to part of the road network in the country (countries with motorway concessionaires, Austria, Germany and the Czech Republic, which are progressively extending the toll scheme to a number of selected secondary roads);
  - Nation-wide network: the system applies to the whole network in the country, including secondary and local roads (Switzerland).

In order to assess the validity of the two main pricing approaches, the table below answers synthetically to the following question: what are the advantages and disadvantages of the different existing charging systems for road freight transport?

<table>
<thead>
<tr>
<th>Tab. 6.1 Advantages and disadvantages of HGV road pricing approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time-Based pricing</strong></td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
</tr>
<tr>
<td>~Low implementation costs</td>
</tr>
<tr>
<td>~Simple and easy to understand</td>
</tr>
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<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
</tr>
<tr>
<td>~Low effectiveness for environmental improvements</td>
</tr>
<tr>
<td>~Unsuitable for fighting congestion</td>
</tr>
<tr>
<td>~No influence on traffic management</td>
</tr>
<tr>
<td>~Low tech</td>
</tr>
<tr>
<td>~Low revenue potential</td>
</tr>
</tbody>
</table>

Taking into account the analysis illustrated in part II of this study and in the previous table, the two regimes (time-based and distance-based) could be considered as steps towards a common
European pricing policy characterized by a distance-based system applied to the whole network. The main reason for moving from a time-based to a widely applied distance-based approach can be summarised as follows:

- To increase the coverage of external costs, reducing negative environmental impacts of HGV transport;
- To reduce the negative impacts of pricing applied only to a limited network, such as detours of traffic to secondary roads;
- To guarantee the harmonization with other national pricing systems through an interoperable technology system, progressively less expensive thanks to the developments in technology;
- To increase revenues and assure funds to finance other modes of transport towards a more balanced modal shift.

This direction is clearly pursued by the current legal framework which illustrates its success factor in the ability to reach the above mentioned objectives. Moreover, from the point of view of achieving the EU's transport policy goals, the distance-based pricing system, based on the user pays principle, fulfils the objectives of:

- Developing infrastructure charging systems based on the polluter pays principle, as requested by the “Ten year strategy on environmental sustainability of transport sector” (White Paper, 2001);
- Encouraging differentiated charging according to air pollution damage and impacts in environmentally sensitive areas, as requested by the Commission Communication on “Thematic Strategy on Air Pollution” (COM(2005) 446 final).

6.2. Checklist of potential impacts to set an Optimal Pricing Policy

Case studies have shown that impacts of the HGV pricing regimes, where they are applied, are quantifiable only in a few cases. The lack of evidence is due to the fact that a longer period of time may be necessary in order for charging reforms to reveal their effects, in addition to the existing difficulties in taking impacts of pricing policies out from other factors and/or long term trends such as increased fuel prices, changed vehicle weights and an open market towards Eastern Europe, etc.

However, commencing from the observed impacts analysed in case studies and taking into account the existing difficulties in the road freight transport market, the table below summarises the potential impacts that are important to consider when outlining an optimal pricing policy:

- **Fleet renewal**: the pricing schemes might help in accelerating the truck fleets renewal rates: it is important to coordinate the pricing schemes with the emission standards time schedule so that truck operators can plan their investments in advance: e.g. an early announcement of the development of the charge differentiation by emission standard over time would increase the effectiveness and efficiency of the differentiation because it improves the planning ability of the haulage companies (and thus rewards first movers). In other words, the interplay between a charging regime and the regulation framework in the same policy field is highly relevant.

- **Vehicles size/weight**: the experience has shown that the market adjusts on the basis of the limits imposed by the pricing policies and therefore provisions should made to include all types of freight vehicles in the schemes. In the case of the Swiss HVF, the exemption of light goods vehicles (<3.5t) from the charging regime created an incentive to switch to such vehicles
even if this strategy is not efficient from a purely internal cost point of view (such a switch to light goods vehicles would have been more marked if the borderline had been set at 12t as in the case of the German Maut).

- **Detours:** there is evidence that a distance-based pricing system applied to the motorway network implies the possibility of detours, i.e. trucks using parallel roads of minor importance to avoid tolls and thus travelling for more km, producing more emissions and noise, in some cases, even in residential areas. This phenomenon happens where there is an existing dense secondary network of good quality roads adjacent to the motorways and where such a secondary network is not already congested. There are two ways to tackle this aspect: either to enforce speed limits and restricted access on the secondary roads, or to extend the pricing system to the whole network. In this second case, it is important to consider that a traffic detour could however also occur in the neighbouring countries.

- **Road haulage optimisation:** the pricing systems might help in reducing empty trips as well as in increasing load factors, even though it has to be stated that the market is already quite efficient and highly competitive. In order to preserve their own competitiveness, truck companies will react quickly by putting in place cost-reducing measures (in purchase and investment decisions as well as in decisions concerning the use of vehicles), but the improvements are rather marginal.

- **Modal shift:** up to today, experiences have shown limited effects on modal shift. However, HGV pricing might have more visible impacts on modal shift if alternative modes offer a good quality of service, if revenues are re-invested in more sustainable transport modes and if higher level of tariffs are applied, taking into account the internalisation of external costs. There are already special cases such as Switzerland, where: rail transport offers a real alternative to road, especially for transit traffic (even though the existing lack of integration and interoperability between Alpine countries, especially between Italy and Germany, reduces the chances of rail companies to offer fast, reliable and efficient international services); HVF revenues flow into the financing of the large-scale public transport projects; and tariffs are higher and include part of external costs (external health costs, air pollution and external costs of noise and accidents). Consequently, the Swiss experience could be considered as a laboratory to test the possibilities to shift goods from road to rail.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet renewal</td>
<td>+++</td>
</tr>
<tr>
<td>Vehicle size/weight</td>
<td>++</td>
</tr>
<tr>
<td>Detours</td>
<td>Small geographic area ++</td>
</tr>
<tr>
<td></td>
<td>Larger geographic area +</td>
</tr>
<tr>
<td>Road haulage optimisation</td>
<td>+</td>
</tr>
<tr>
<td>Modal shift</td>
<td>+/-</td>
</tr>
</tbody>
</table>

### 6.2.1. How can the internalisation of external costs influence the potential impacts of HGV pricing?

The existing Eurovignette Directive 2006/38/EC gives the possibility to add mark-ups in mountainous areas and to levy specific congestion charges or regulatory charges to combat environmental impacts on any road. However, at present, full internalisation of external costs is not possible.
The amendment of the current directive, expected in June 2008, will be an important first step towards a more efficient pricing system and which allows for Member States to explicitly charge HGV for all external costs on top of infrastructure costs. Efficient pricing for road transport means that charge levels should better reflect the marginal external and infrastructure costs.

Firstly, this requires differentiation to various parameters such as axle load (infrastructure cost), Euro standard, day/night and to location. In particular, differentiation between urban and interurban areas is important because of the large difference in the marginal cost levels. Potentially a differentiation with regard to vehicle noise emission class could be allowed for.

Secondly, efficient pricing would probably mean that the overall charge level of road transport increases. The handbook, presented in Deliverable 1 of IMPACT, could serve as a common framework on which the charge levels for internalising external costs could be based and consequently it could provide an estimation of future charge levels. However, at present, there is still no certainty of cost data being internalised.

It is then expected that the higher level of charges would change the impacts assessed in the previous paragraph. A higher magnitude of charges can, firstly, increase the shift of vehicle travel to unpriced or lower priced infrastructures (traffic diversion), or to alternative modes (modal shift) and can reduce vehicle kilometres. In particular, the expected impacts would vary on the basis of the following elements:

- **Demand elasticities**: either defined as the percentage change in the use of the road transport caused by a one-percent change in its tariff, or as cross-elasticities with respect to the changes in demand for a mode of transport that results from a change in the charge for a competing mode. Implicitly, cross-elasticities are informative on the modal shift that can potentially take place.

- **The availability of transport alternatives**: the size of the impacts caused by an infrastructure pricing measure depends also on how much a competing alternative can substitute the priced one. The better the travel alternatives, the more infrastructure pricing will cause mode shifts.

Data on future increase of impacts resulting from the internalisation of external costs is not available, but it may be predicted from an overall impact assessment similar to the countries that have already relatively high tolls (such as Switzerland).

### 6.3. Recommendations

As pointed out in the introduction, in view of the expected growth of road freight transport and in order to obtain a sustainable transport policy that ensures that road freight transport pays the price for the costs it is producing, the European Commission and Parliament are debating on how best to improve the efficiency of infrastructure use and reduce negative externalities.

As the theoretical, legislative and regulatory aspects of the study have shown, an efficient pricing system for road freight transport means that the charges should clearly reflect the marginal external and infrastructure costs. This requires differentiation of tariffs in accordance with various parameters such as axle load (infrastructure cost), Euro standard emissions, day/night (congestion), location and, potentially, a differentiation with regard to vehicle noise emission class.

In addition, the more efficient pricing, the internalisation of external costs and the consequent higher level of charges would probably increase the shift of vehicle travel to unpriced or to lower priced infrastructures (traffic diversion) or to alternative modes (modal shift), and this can reduce vehicle trip frequency.
The overview of current charging systems has demonstrated that a univocal way to act does not already exist: current charges in different countries are based on different charging principles and include different costs categories.

The analysis of the effects of the ongoing practices in charging for infrastructure use have shown that strong impacts on reducing emissions and energy consumption are very difficult to obtain even when distance-based systems are applied.

In view of these reflections, recommendations have been produced in order to suggest, for the revision of the Eurovignette Directive, the application of the following progressively compulsory pricing criteria:

▪ **Highly differentiated tariffs.** Apply charges differentiation through technological improvements that allow an increasing tariff modulation on the basis of the weight of vehicle, vehicle axles, emission class, time and specific sections of infrastructure in order to reflect environmental, accident and congestion costs.

▪ **Regulatory charges.** – The use of time-variable tolls in sensitive areas, with higher rates during peak periods and lower rates during off-peak periods so as to reduce congestion and environmental impacts. However, the application of high regulatory charges to fight congestion in densely populated areas or in sensitive areas should not have any discriminatory effects on transit traffic.

▪ **Vehicle target.** Extend tolls to heavy vehicles > of 3.5 tonnes, moving towards a pricing scheme compulsory also for cars.

▪ **Network.** Extend tolls to encompass the entire network: it is necessary to levy charges for heavy goods vehicles also on secondary and local road networks in order to avoid the traffic diversion phenomenon, support modal shift and increase the revenue for transport. The setting of regulatory charges on the secondary network should be primarily imposed where HGV traffic causes considerable problems for environment, and for the inhabitants’ quality of life (sensitive areas).

▪ **Interoperability and harmonisation** – Work towards ensuring standardisation of normative framework and interoperability of technology instruments, as important elements of convenience and efficiency both at national and international level.

Success factors of a pricing policy characterized by the abovementioned criteria are:

▪ **Acceptability.** Ensure that road pricing decisions are transparent, built on public participation and as predictable as possible to increase pricing measure acceptability: clear political objectives related to the introduction or change of the tolls have to be defined, and the comparison of tolls with other possible instruments to reach those objectives has to be carried out with great care. Ensure that careful estimation of the impacts of the tolling scheme is carried out and the engagement of stakeholders is pursued in a systematic manner so that acceptance issues may be managed in a sensible way. It is recognised that these processes always take several years to mature in public opinion and that the choices must be made in “political windows of opportunity” of relatively short duration.

▪ **Policy mix.** Integrate pricing with other strategies that increase haulers’ choice and provide additional incentives to use alternative modes in the same area: prices are just one of the types of instruments in support of transport policy (the main others being vehicle management,
infrastructure management and technological improvements). In search for an optimal intervention on the transport system, policy makers should remember to take into account all of these other types of instruments.

Even if the considerable diversity of objectives and national conditions surrounding the introduction of road tolls will be for a long period of time a legitimate reason for diversity of tolling strategies of national governments, the application of the previous recommendations will allow the EU to face in the long term, the pricing challenge of obtaining an interoperable system all around Europe, capable of guaranteeing welfare efficiency, external costs coverage and revenue generation.

6.4. Complementary measures

The analysis indicates that the introduction of a pricing policy should result in a positive effect but it is important to consider also, the risk of any undesirable outcomes due to a higher level of infrastructure charges.

The level of pricing has to be fixed, taking into account the fact that the road freight transport market is already under pressure due to the ongoing increase in oil prices which is reflected in higher transport costs. In a context of increasing fuel costs – due to exogenous constraints - heavy goods vehicle pricing policy is a bigger challenge for small haulage companies than for large ones: while the latter have more reaction options (logistic competence and possibilities for logistic adjustments), the former face financing problems.

An increase in road tolls would also create a location disadvantage with an accompanying weakening of the European position in the global economy, especially in the presence of a small increase in rail transport. A modal shift from road to rail would not be achieved by weakening road transport through high toll pricing.

Furthermore, in an environment of strong competition, the haulage companies will not be able to fully pass on the cost increase caused by new charging regimes to the shippers, and small haulage companies will have more difficulties to compensate this development with productivity gains. This situation implies a further risk for the safety conditions of haulers: facing the increasing costs of transport, companies could extend the working/driving travel times, reducing the skilled, well-trained, responsible driving conditions and potentially increasing the accident rate of trucks on the road.

Finally, one has to consider that the above-mentioned pricing drawbacks could further increase due to the future pricing level rises in response to the need of internalising environmental costs generated by road freight emissions and energy consumptions.

To face these challenges and complete the EU policy framework, complementary measures should boost the effects of pricing systems in order to improve the environmental performance of the transport system, in particular with regard to the following EU Transport Policy goals: a more balanced modal shift; greater efficiency of the logistic performance of road transport; and reduction of energy consumption and emissions by the road transport sector.
### Tab. 6.3 Complementary measures

<table>
<thead>
<tr>
<th>Policy Objective</th>
<th>Measures and reference documents</th>
</tr>
</thead>
</table>
| **Modal shift**                        | Complementary measures to obtain a more balanced modal shift, particularly toward rail system (TRANSCARE 2006) are:  
  - capacity enhancements,  
  - better management of the existing system,  
  - increasing the quality and structures of rail transport.                                                                                                                                                                      |
| **Efficiency of the logistic performance** | Complementary measures to obtain an efficient, integrated and sustainable freight transport in Europe (COM(2007) 606 final) are:  
  - co-modality, which requires improving the efficiency, interoperability and inter-connectivity of rail, maritime, inland waterway transport, air, road transport and related hubs to achieve their full integration in a seamless door-to-door service  
  - Intelligent Transport Systems, which offer a way to improve transport and cargo management and increase the utilisation of available infrastructure  
  - the concept of green corridors\(^\text{35}\), which gives further substance to the objective of integrating environmental as well as safety and security concerns in the design and operation of infrastructure on the trans-European transport network  
  - driver training programmes to ensure that vehicles are driven in a safer and more responsible manner, with increasing involvement of European truck manufacturers as well as other road users who have an equal responsibility for road safety. |
| **Energy consumption and emission reduction** | Complementary measures to reduce emissions (according to different EU policy actions) are:  
  - promoting energy efficiency through the application of “compulsory agreements” between the European Commission and vehicle manufacturing associations to bring down CO\(_2\) emissions from trucks over 3,5 tonnes,  
  - re-structuring of road registration tax and annual circulation tax by linking taxation to CO\(_2\) emissions and energy consumption (New Directive by 2012). |

\(^{35}\) The notion of "green corridors" has been introduced by the Freight Logistics Action Plan (COM (2007) 607 final) and defines freight transport corridors characterised by low impacts on the human and natural environment. Rail and waterborne transport modes will be essential components of these green corridors.
Pricing systems for road freight transport
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http://www.fiabruussels.org

http://www.ilsole24ore.com/

http://www.iri.org/

http://www.transportenvironment.org/

http://www.vtpi.org/
Annex I - Transport Pricing Research Projects

The European Commission has sponsored a considerable amount of research into transport pricing, feeding directly into the development of policy and enriching the academic debate throughout Europe.

The Commission’s Fourth Framework research programme, which ran from 1996 until 2000, included:

- Projects examining the impacts of more efficient pricing such as PETS (ITS, 2000), TRENIN (Prost et al, 1998) and AFFORD (Niskanen et al, 2000);
- Projects examining acceptability issues, such as PATS (Viegas et al, 2000), PRIMA (Harsman and Wijkmark, 2000) and TRANSPRICE (Vougioukas et al, 1999); and
- Projects examining issues of cost measurement, such as EXTERNE (Friedrich et al, 1998) and QUI TS (Ricci et al, 1999).
- As part of the fourth Framework programme, the Concerted Action on Pricing Research Integration (CAPRI) project was commissioned to facilitate the exchange of information and results from research projects dealing with the pricing of transport (Nash et al, 2000).

The Commission’s Fifth Framework research programme, which commenced in 2000, also includes a range of transport pricing projects. These comprise:

- PROGRESS - a demonstration project on urban transport pricing;
- CUPID - a thematic network on urban transport pricing, designed to assist and link with the demonstration sites which make up PROGRESS;
- DESIRE - a project examining the design of inter-urban transport pricing schemes for heavy goods vehicles;
- MC-ICAM - a wide-ranging project examining barriers to the implementation of more fair and efficient transport pricing and how implementation should be phased; and
- UNITE - a project to develop methodologies for measuring marginal costs of transport, and to link estimates of marginal cost with the assessment of total costs as set out in transport accounts.
- IMPRINT-EUROPE may be viewed as fulfilling a similar role in relation to the fifth Framework to that which CAPRI had for the fourth Framework. That is to facilitate exchange of information, dissemination of research findings and to promote inter-action between policy-making, stake-holder and research communities. In addition, the IMPRINT-EUROPE thematic network has a distinct focus on implementation and is seeking to develop recommendations relating to the implementation process.

The Commission’s Sixth Framework research programme includes others transport pricing projects:

- IMPRINT-NET provide a discussion platform for policy makers, transport operators, researchers and other stakeholders to exchange views on the implementation of new pricing regimes, cost calculation methods derivation of tariffs to be levied and on successful approaches to overcome barriers and to affect attitudes and perceptions;
- GRACE aims to support the development of sustainable transport systems by facilitating implementation of transport pricing systems that reflect the costs of infrastructure use.
- FUNDING aims to develop a scientifically sound approach to determine optimal charging and investment in the EU Member States and the accession countries;
- DIFFERENT aims to determine efficient differentiation of infrastructure cost based charging schemes and methods to assess their impact on user behaviours.