Contract No. TREN / 06 / FP6SSP / S07.56190 / 022578

REFIT

Refinement and test of sustainability and tools with regard to
European Transport policies

Deliverable 3.3:

Assessing transport policy impacts on the Internalisation of Externalities of Transport

Start date of project: April 1st, 2006 **Duration**: 30 months

Lead contractor for this deliverable: TNO Business Unit Mobility and Logistics (The Netherlands)

Final report
08.34.15/N033/034.65128/MC/LK

Project co-funded by the European Commission within the Sixth Framework programme (2006-2008)		
Dissemination level		
PU	Public	Yes
PP	Restricted to other programme participants (including the Commission Services)	No
RE	Restricted to group specified by the consortium (including the Commission Services)	No
CO	Confidential, only for members of the consortium (including the Commission Services)	No

Deliverable title: Deliverable 3.3: Assessing transport policy impacts on the Internalisation of Externalities of Transport

Authors: Dr. Niklas Sieber, Dr. Peter Bickel

Date February 2008

PROJECT INFORMATION:

Project title: Refinement and test of sustainability indicators and tools with regard to European Transport policies

Project acronym: REFIT

Contract no: **TREN / 06 / FP6SSP / S07.56190 / 022578 -REFIT**

Commissioned by: European Commission – DG TREN; sixth Framework Programme

Lead Partner: **TNO Business Unit Mobility and Logistics, Delft (NL)**

Partners: TNO (Nl), TRT(It), CAU (D), ISIS (It), TML (Be), UNI-Stuttgart (G).

DOCUMENT CONTROL INFORMATION

Status: Accepted after 2nd Submission to DG TREN
Distribution: Refit Partners, European Commission
Availability: Public (only once status above is “Accepted”)
Filename: Refit
Quality assurance: Reviewed
Coordinator’s review: Reviewed

Signed: **Date: February 2008**

Prof. Dr. Ir. L. Tavasszy

Project Manager

Table of Contents

List of Tables

List of Figures

List of Abbreviations

List of Abbreviations

CF	Concessionary Fares
LoI	Level of Internalisation of Externalities
HGV	Heavy Goods Vehicle
LGV	Light Goods Vehicle
PPP	Purchasing Power Parity
PSO	Public Service Obligation
VAT	Value Added Tax
VOC	Vehicle Operating Costs
VSL	Value of a Statistical Life
WTP	Willingness to Pay
YOLL	Years of Life Lost

Executive Summary

The main goal of this REFIT Workpackage WP 3.3 is, to develop a methodology on how to assess transport policies regarding their contribution to the objective of fair pricing. The indicator "Level of Internalisation of Externalities" (LoI) is the degree, to which external costs have been internalised according to the polluter pays principle. To compute the LoI, REFIT uses the combination of the TRANS-TOOLS, TREMOVE and CGEurope models.

Two approaches have been identified to calculate the LoI: (i) The Equity Approach, based on a full cost assessment, and (ii) the Efficiency Approach, based on the marginal social cost pricing principle. The Equity LoI assesses macro economic effects of pricing policies, especially the question of cost coverage. The Efficiency Approach assesses if pricing of specific transport situations on a given time and location is efficient, i.e. if marginal revenues cover marginal costs.

The Equity LoI includes the following components: Vehicle Operating Costs, Value of Time, Infrastructure Costs, External Costs (Air Pollution, Climate Change, Noise, Accidents, and Congestion Costs) Taxes, Charges and Subsidies. The Efficiency LoI includes only a subset of these costs and revenues, i.e. marginal components that are directly related to transport volume.

The LoI is a powerful tool for assessment of transport policies, since it concentrates a vast quantity of information in a single indicator. However, the interpretation should be done with caution, taking into account that powerful assumptions had to be taken to generate the LoI.

1. Introduction

The main goal of this Workpackage WP 3.3 is, to develop a methodology on how to assess transport policies regarding their contribution to the objective of fair pricing. The indicator on this issue is "level of internalisation of externalities". The Level of internalisation (LoI) is the degree, to which external costs have been internalised according to the polluter pays principle.

This paper discusses the theoretical and practical implications of the LoI calculation. Of relevance are different topics such as the questions to be assessed by the LoI, theoretical implication of marginal social cost pricing and data availability in the existent transport models.

Chapter 2 researches which purposes a LoI might have, taking especially into account the questions raised by the Mid Term Review of the White Paper "European transport policy for 2010: time to decide". Chapter 3 discusses the methodological issues related to the LoI, taking into account the scientific dissent on the approach of marginal social cost pricing vs. a full cost approach. The outcome of this discussion is used to define the framework concept of the LoI and develop general calculation procedures. Chapter 4 specifies all cost components of the LoI and assesses their relevance with regard to the discussion of the previous chapter. Chapter 5 continues the above specifications for taxes, charges and subsidies. After the termination of the theoretical part, Chapter 7 assesses the data availability in the models and determines on this basis the calculation procedures of the LoI.

The objective of REFIT is to provide a set of sustainability indicators for assessing the effects of various transport policies through state-of-art models at European scale. REFIT builds upon the combination of the TRANS-TOOLS, TREMOVE and CGEurope model. These three models offer a particular strong quantitative tool that is able to cover many of the aspects needed to evaluate most of the transport policies and measures. The three models can be described as follows:

- TRANS-TOOLS[1] is a European transport network model covering both passenger and freight, as well as intermodal transport. The TRANS-TOOLS model is made of different modules, which exchange information according to a sequential approach, i.e. the origin/destination matrix produced by the passenger model is transferred to the modal split model, etc.. Feed back effects are taken into account, i.e. transport costs and times produced by the assignment model are fed back to the modal split model. The main sub-models are for freight, passenger and assignment. In additions to these main elements of the model system, the TRANS-TOOLS Model also includes a regional economic model based on CGEurope and impact models. The different models are linked applying a number of conversion routines. The model framework allows feedbacks between the sub-models to achieve equilibrium between supply and demand.

[1] The project has been developed within the 6th Framework Program RTD for the Directorate General for Transport of the European Commission. http://www.inro.tno.nl/transtools/index.html

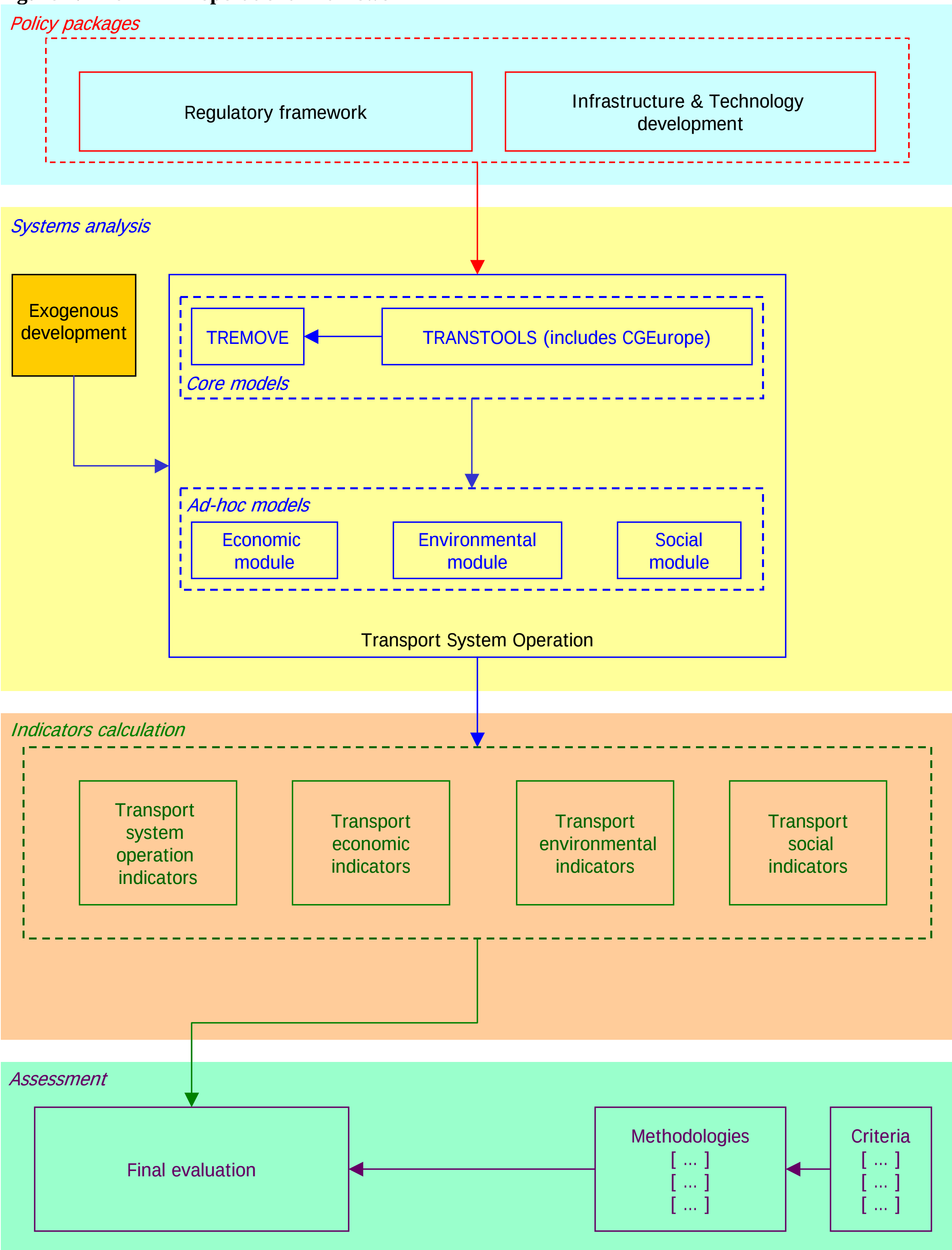
- TREMOVE[2] is a transport and emissions simulation model developed for the European Commission. It is designed to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates the transport demand, the modal split, the vehicle fleets, the emissions of air pollutants and the welfare level under different policy scenarios. TREMOVE predicts the overall emissions from the transport sector in different policy scenarios. The strength of the model is that it is also able to assess the effects of environmental policies on future vehicle fleets and on overall transport demand and its modal split. TREMOVE consist of 21 parallel country models, and one maritime model. TREMOVE comprises three inter-linked 'core' modules: a transport demand module, a vehicle turnover module and an emission and fuel consumption module, to which a welfare cost module and a life cycle emissions module is added.

It is the task of REFIT to combine the above models in order to calculate the above mentioned sustainability indicators. Amongst them, the Level of Internalisation will be calculated using the assessment scheme given in Figure 1. The turquoise box on top represents the policy packages to be analysed using the LoI. The yellow box below depicts the models used for the analysis including the ad-hoc models on economic development, environment and social impacts. TRANS-TOOLS delivers the inputs for TREMOVE, and both feed the ad-hoc models. The brown box below symbolizes the indicators to be derived from the outputs of the transport system. The LoI is one of the indicators to be assessed. The final evaluation of the indicators is depicted in the green box on the bottom of Figure 1. For this purpose specific methods and criteria have to be considered that allow for a comprehensive appraisal of the policy package to be assessed.

However, before this can be done, the rational and purpose of the LoI is discussed in the next chapter.

[2] http://www.tremove.org/

Figure 1: The REFIT operational framework



Source: REFIT, D3.1, p.11

2. Rational and Purpose of the LoI

Before exactly defining the Level of internalisation of externalities (LoI) indicator it is worth deliberating, for which purpose the indicator might serve. Of course, it is clear that the LoI is developed to analyse EU policy options. But how can this indicator contribute to the analysis? And which policies can be analysed? Of special interest is the Mid Term Review of the White Paper since it raises a number of questions that might have impacts on internalisation of external costs.

2.1. Mid Term Review of the White Paper

In 2006 the EU Commission published a Mid Term Review (European Commission 2006) of its Transport White Paper that assesses the effects of European transport policies and lays down the major future activities in this field. An analysis of this paper reveals the requirements, which the LoI has to meet, in order to support the evaluation of the EU's future transport policy. The following issues were identified as of major importance:

- Debate on transport scenarios with a 20 to 40 year time horizon, to develop tools for an overall sustainable transport approach
- Road: excessive differences in Fuel Excise Duty levels
- Rail: promote a rail freight oriented network within a broader transport logistics policy
- Aviation: monitor the state aid and competition; functioning of the internal market; include emissions from air transport
- Water Transport: action to reduce pollutant emissions from waterborne transport
- Safety: an integrated approach to road safety
- Energy: Action Plan on energy efficiency in transport
- Congestion: Investment in airports and ports in order to avoid future congestion; intelligent infrastructure to eliminate bottlenecks.
- Intermodality: Promote co-modal transport solutions
- Smart charging to finance infrastructure, help optimise traffic and reduce environmental impacts; develop before June 2008 model for the assessment of all external costs
- Another important policy discussion -not part of the midterm review- is the reduction of greenhouse gas emission by transport. The EU Commission (7.02.2007) has planned a framework to reduce average car emissions by 2012 from 2160g/km to 120g/km.

Resuming the paper, the following four issues are of major importance for this REFIT task in designing the Level of Internalisation LoI:

1. The EU Commission is putting little emphasis on the road sector, while a strong need for action is perceived in the air and water sectors. Presently, both modes experience the strongest growth rates and thus the largest bottlenecks regarding infrastructure.
2. The objective of shifting the balance of modes is not directly addressed, but implicitly included in the demand for sustainability and in the issue of intermodality.
3. This is enhanced by the demand for smart charging in order to reduce environmental impacts. The issue of energy efficiency is related to this demand.

4. An increased effort to improve transport safety. This issue should be reflected when internalising the accident costs.

One of the major points of criticism on the implementation of the White Paper was revealed in the Assess Paper (De Ceuster G. et al 2005 p. 114), which compiled information for the mid-term review: "The biggest failure in implementation of the White Paper proposals is the failure to implement appropriate Social Marginal Cost Pricing for all transport modes, in order also to deal efficiently with the environmental issues." Possibly, one of the reasons for this failure was missing information on the effects of appropriate measures. REFIT will fill this gap by providing relevant indicators – amongst them the LoI - for the assessment of policy measures.

2.2. Purpose of the LoI

The LoI is designed to assess how much policies contribute to the objective of fair pricing. According to theory, pricing and taxation is justified if markets are imperfect and distorted. FACORA (2006) list the following distortions:

- Externalities,
- natural monopolies,
- additional social aims,
- regulation failures,
- implementation or enforcement failures.

The most important cause for market distortions are external effects. In economics, an externality is an effect from one activity which has consequences for another activity but is not reflected in market prices. An externality occurs when a decision causes costs or benefits to stakeholders other than the person taking the decision. The most appropriate remedy for market failures caused by externalities is the internalisation of external cost which can be achieved through the levy of a tax which compensates for the externalities. For instance, a Pigouvian tax may be levied on producers who pollute the environment to encourage them to reduce pollution. Additionally, the state has the option to use the revenues to counteract the negative effects of the pollution. Analogous measures can be taken if other market distortions occur.

The LoI indicator to be developed has the main goal to specify to which degree market distortions have been compensated by taxes or charges. Since subsidies are causing similar price distortions, they have to be included in the analysis as well. The objective is to assess the balance between external costs imposed on society and the costs borne by the users. The LoI can be used for the following purposes:

i. *Indicator for sustainability*: To which degree are social costs covered in the whole transport sector or in the respective mode? A low internalisation (LoI) indicates a strong need for action, since costs are not borne by the users.
ii. *Indicator for Efficiency*: How efficient are present pricing systems regarding specific transport situations.
iii. *Intermodal comparison of the LoI*: The degree of internalisation differs from mode to mode and this difference reflects the market distortions. A lower LoI for

mode A compared to B indicates that state interventions are necessary in order to rebalance the market.

iv. *Inter-country comparison of LoI*: A comparison of countries shows to which degree national policies have taken account of externalities, especially in the field of environment. The LoI visualises the need for action according to countries and modes.

v. *LoI designed to assess policy options*: The LoI can be used as well to assess the effects of economic policy measures. The indicator is flexible and can be used for many policy measures, given the fact, that they can be implemented in transport models.

The latter purpose is the most important one, since the LoI is meant to be used as a flexible tool for policy analysis. Internalisation of externalities is not an automatic procedure, where taxes are charged according to pre-determined rules. It is rather a political process, which reflects political goals and targets. According to Van Essen et al (2007, p. 36) three motives for internalisation pricing policies can be distinguished:

i. Influencing behaviour, to:
   - reduce environmental impacts and
   - allow a freer flow of traffic.

ii. Generating revenues, to:
   - cover (fixed) costs of infrastructure management, operation and maintenance,
   - finance new, extension or modernisation of infrastructure and
   - finance the general budget.

iii. Increasing fairness, to:
   - make the polluter / user pay,
   - conceive socially acceptable taxes and charges,
   - compensate for income inequalities considered unfair,
   - prevent undesired changes in income distribution and
   - level the playing field between modes.

Thus, the internalisation strategy depends on the underlying aims and motives (Van Essen et al, p.38). If internalisation takes place out of equity considerations, intersectoral externalities are especially relevant, because these make up the 'unpaid bill' that transport imposes upon society. Charging for external congestion costs may be of less interest then. In contrast, if the improvement of economic efficiency is the goal, both intra- and intersectoral externalities should be internalised.

The design of the LoI has to take into account the above mentioned motives. TREMOVE and TRANS-TOOLS are models that can be used to demonstrate to decision makers to which degree their policy goals can be achieved. The LoI can contribute to this as follows:

i. The LoI indicates which level of charges has to be attributed in order to cover social costs.

ii. The LoI specifies to which degree transport policies contribute to optimal transport pricing. The tool shows the impact of most transport policies on the level of internalisation. For example safety measures decrease external cost and thus change the LoI.

iii. Once an optimal level of taxes and charges has been assessed and implemented, the state revenues can be estimated. This is important information for budgeting of future investment policies.
iv. The impacts of the internalisation on environmental, social and transport conditions can be assessed. TREMOVE and TRANS-TOOLS are able to show the reaction of transport users and assess their impacts.

For a better understanding of the concept of LoI, Table 1 gives an impression how suitable the LoI is to answer important questions in transport research.

Table 1: Suitability of approach for answering relevant questions

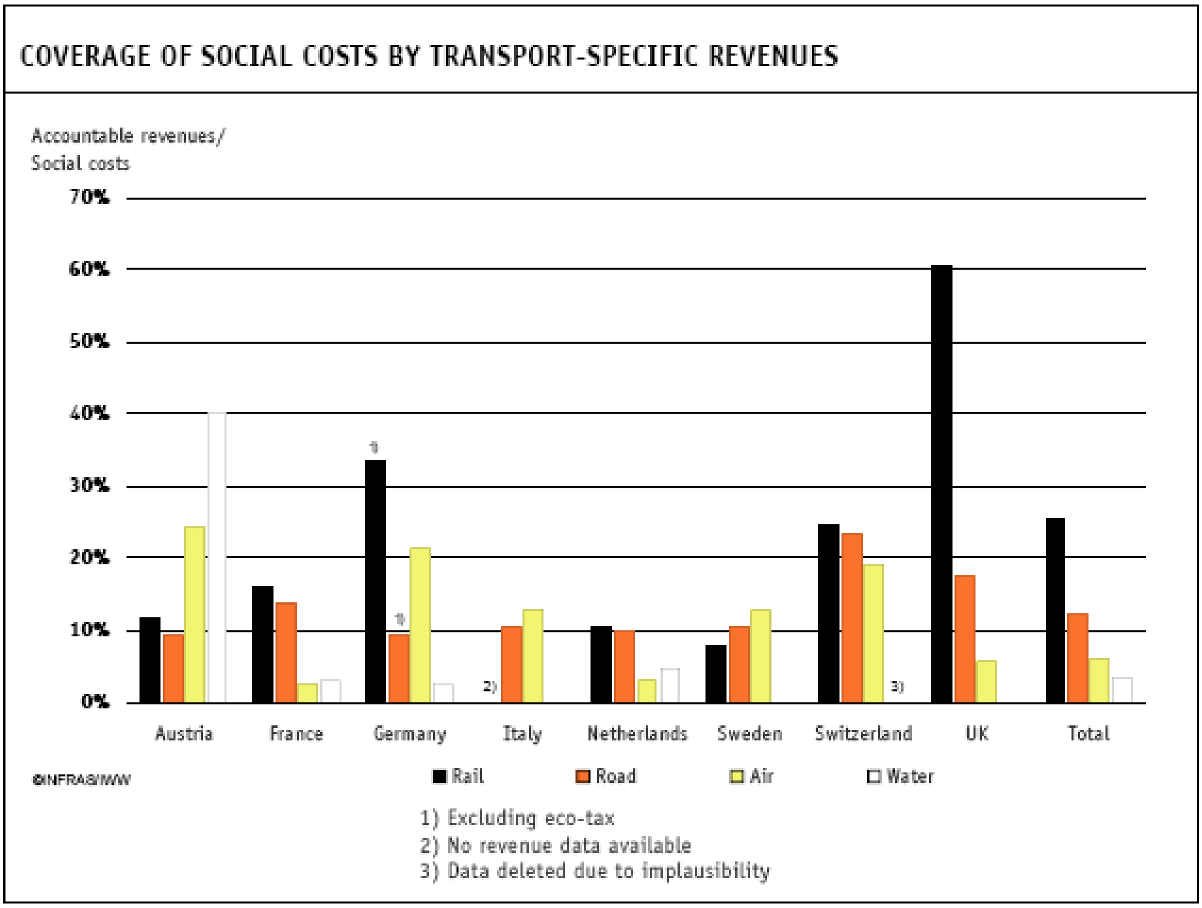
Research Question	Relevance
General Assessments	
Indicator for sustainability: level of charges to compensate for external costs	high
Intermodal comparison of Level of Internalisation	high
Inter-country comparison of Level of Internalisation	high
Contribution of policies to optimal pricing (efficiency and equity criteria)	high
Option to estimate state revenues after optimal transport pricing	high
Assessment of specific transport investment opportunities with respect to LoI	high
Comparison of specific transport demand segments	high
Specific Questions raised in the EU Midterm Review	
Assess transport scenarios with a 20 to 40 year time horizon	low
Reduce excessive differences in road Fuel Excise Duty levels	high
Promote a rail freight oriented network within a broader transport logistics policy	low
Aviation: State aid and functioning of the internal market; contain emissions	middle
Water: Transport: action to reduce pollutant emissions from waterborne transport	middle
Safety: an integrated approach to road safety	low
Energy: Action Plan on energy efficiency in transport	low
Congestion on airports and ports; intelligent infrastructure to eliminate bottlenecks.	low
Intermodality: Promote co-modal transport solutions	low
Smart charging to finance infrastructure	high

2.3. Empirical Example of an Internalisation Ratio

A comprehensive assessment of the Level of internalisation is given in FACORA 2004. The study and its methodology is often used as a reference in the text and thus is explained further down in the text. However, the FACORA methodology differs significantly from the REFIT approach, and thus values are not comparable[3]. Figure 2 shows the coverage of social costs by transport-specific revenues calculated by FACORA as the ratio between accountable revenues and social costs. Accountable revenues comprise infrastructure user charges and a share of the fuel tax revenues. Social costs comprise infrastructure costs (according to Unite 2002) and external costs (according to INFRAS/IWW, 2004).

The figure shows, that cost coverage is on average below 25%, for railways 12%, for roads 6%, for air transport and 4% for waterways. If total fuel levies would be taken into account, the ratios would increase to 26% for railways, 30% for roads and remain similar for the other modes. A further internalisation of external costs, e.g. through environmental taxation, would increase the cost coverage.

[3] In REFIT resource costs are included, as will be shown later in the text. This is not the case for FACORA.



Source: FACORA (2004), p47
Figure 2: Level of Internalisation computed by FACORA 2004

This example from FACORA reveals, that a number of methodological issues crop up, if the ration of internalisation is discussed. These issues are discussed in the next chapter.

3. General Methodology

During the past decade a number of research projects have been conducted, which have scrutinised the external costs of transport and their internalisation[4]. Science has clarified a number of issues, but revealed as well many new and unresolved research topics. The main area of disagreement was the question if marginal social cost should be used for internalisation or whether a full cost approach is more appropriate. This issue will be discussed in this chapter and the results of this discussion are used to identify the outline of the LoI.

3.1. Marginal vs. Full Cost Pricing

Research on transport pricing has revealed two schools of thought that discussed the issue whether marginal or full cost pricing is the appropriate approach for transport pricing. Even though the discussion has been ongoing for a long time, no consensus is reached to date. This is probably due to the heavy theoretical content of the issue and the difficulties related to the practical implementation of the theoretical concept.

The **Equity Approach** takes into account all costs such as infrastructure investment costs, cost for regular and periodic maintenance, vehicle operating costs, taxes, charges, subsidies, congestion, environmental and other externals costs. The basic idea is to undertake a cost assessment which is as comprehensive as possible. This approach is designed to assess overall levels of state revenues and spending, levels of subsidies or cost-covery-ratios. The consequence of this approach is that for internalisation purposes specific average cost figures are calculated. Specific means along the lines of modes, road types, times of day etc. The latter issue will be clarified below.

The aim of the equity approach is to identify, for each vehicle category, the total costs they cause and compare these costs with the total charges paid by the category in question. In order to design a pricing system that covers all costs, the LoI could be used to reveal which additional charges and tax reductions are needed.

The **Efficiency Approach** is more focussed on optimisation of social welfare than on cost recovery. The aim is to increase the efficiency of the transport system by using the principle of marginal social cost pricing. The underlying theory is that the markets will, over time, cause goods to be sold at their marginal cost of production. In the REVENUE research program, 'pure marginal social cost pricing' has been defined as a situation where prices in transport are set equal to the short-run price relevant cost.

The EU White Paper (1998, p.10) defines marginal costs as "those variable costs that reflect the cost of an additional vehicle or transport unit using the infrastructure. Strictly speaking, they can vary every minute, with different transport users, at different times, in different conditions and in different places". With this definition, the Commission has committed itself to the short run marginal costs, which implies that all cost components that do not react to minor changes in use are excluded. This relates to all costs that are fixed in the short run, such as costs of the administration, operational readiness or depreciation and interest on capital. In

[4] UNITE (2003), GRACE (2007), INFRAS/IWW (1996, 2000, 2004), FACORA (2004), ExternE (2004), NewExt, 2004, HEATCO (2006), FISCUS, REVENUE, CE (2004), FUNDING (2006), MC-ICAM (2004)

the definition of the White Paper, social marginal costs comprise (i) operating costs, (ii) costs of the wear and tear of infrastructure, (iii) congestion and scarcity costs, (iv) ecological costs and (v) accident costs caused by an additional transport unit using the infrastructure. The aim of the marginal social cost approach is, to establish - for each vehicle category - how variable user charges compare with usage-dependent external costs (Vermeulen et al 2004, p. 26). It is the most efficient option in economic terms, i.e. from the perspective of optimising overall welfare.

This concept has been largely criticized in the scientific discussion[5]: “the conceptual blackboard models often used for illustrating the motivations for and ‘blessings’ of transport pricing certainly may be of great pedagogical and illustrative value, but nevertheless often leave the policy maker largely empty handed when it comes to the design of pricing schemes for realistic situations, on real transport networks.” (Lindsey and Verhoef 2001). “As soon as one relaxes the strict assumptions of neo-classical welfare theory the ‘first-best’–rules like marginal cost pricing collapse. In the real world it is the major issue of economic advice to consider the dynamic incentive patterns, the acceptability and the institutional consequences of a pricing scheme. Once these aspects are introduced step by step into the analysis the pricing of transport infrastructure on the base of marginal costs is no longer optimal, on the contrary, it can lead to serious disturbances of long term incentives. It can easily be shown that the introduction of a budget constraint leads already to the result that nonlinear, non-uniform pricing such as multi-part tariffs is Pareto-superior.” (Rothengatter 2001) The constraints for marginal cost pricing are:

- technological and practical constraints,
- acceptability constraints,
- institutional constraints,
- legal constraints,
- financial constraints,
- market interaction constraints and
- political constraints[6].

The resulting pricing scheme may be too complex, not feasible, not acceptable, not legal etc. Summarizing, there may be three reasons for deviating from marginal social cost pricing[7] :

1. Limited scope of a pricing scheme: First-best pricing is not applied throughout the whole network considered, the whole transport sector and/or throughout the economy. Pricing measures generally cover a much smaller part, such as a single mode of transport or even only a part of a network. This may give rise to boundary-effects, in particular a shift from the priced modes or parts of the network to the other parts or modes. From a welfare point of view this could lead to much less positive welfare effects.
2. High system requirements and costs: Pure marginal social cost pricing requires a system that can differentiate price levels according to all cost drivers for the various external costs, e.g. the actual congestion level, the actual vehicle emissions factors for pollutants and noise, the actual fuel consumption and maybe even the actual blood al-

[5] Lindsey and Verhoef 2001, Rothengatter 2001, Lakshmanan, T.R. et al (2001), Vermeulen et al (2004), Van Essen et al (2007)
[6] See as well Adler, N et al (2003), Marler, N et al (2003).
[7] Van Essen et al (2007), p. 39

cohol level of the driver. Such a system would be too complicated from a technological point of view and the price incentives would be far too complicated for users to respond to.

3. Insufficient revenues: If the principle of pure marginal social cost pricing is applied to both infrastructure costs and external costs, the revenues of such a scheme may not be sufficient to cover the total infrastructure costs.

Especially the latter point was taken up by a number of authors, which emphasize, that “in marginal social cost pricing, no consideration is given to the financial implications of the pricing scheme in terms of surpluses of deficits for each mode. This implies that there is no guarantee that the total revenues from marginal social cost pricing are sufficient to cover all infrastructure costs”(van Essen et al 2007). Rothengatter (2001) supplements: “If the transport technology were convex then marginal costs would increase with traffic and equilibrium would be achieved with full cost recovery. If transport investments were perfectly divisible then a clear rule for the network extension could be developed: The savings of marginal user costs should exceed or at least be equal to the increase of marginal infrastructure costs. … And if there were perfect information and foresight then the transport system could be optimally controlled by one authority… In reality, not one of these … ‘ifs’ is given. Transport infrastructure technology is not convex such that marginal costs are below average costs and a deficit occurs.”

The latter statement results in the main criticism, that a marginal cost charging system would not reap sufficient revenues to cover all costs, even if an optimal pricing system would be applied. Marginal cost pricing is regarded as especially detrimental for railways, which are characterised by scale economies and a high proportion of fixed costs. (Peter 2004, p. 6).

As a result of the above discussion, the concept of pure marginal cost pricing was widely abandoned and instead second best concepts proposed, which aim at setting the prices that are available optimally, under the constraints applying:

- Ramsey Pricing: Price markups on marginal costs using the inverse price elasticity of demand. The aim is to maximize social welfare under the constraint of deficit coverage.
- Fully-Distributed Costs attribute the marginal cost pricing according to the club principle. They cover the deficit by allocating the remaining costs according to selected parameters.
- Multi-part tariffs consist of fixed, blockwise variable, and variable parts. They can be flexibly adjusted to the cost and the demand characteristics. They are not based on marginal costs

In the following period four research projects - FUNDING, MC-ICAM, ASSESS, AFFORD - were conducted, which had i.a. the aim to ascertain practical ways of implementing pricing schemes in transport taking into account the above discussion.

AFFORD (2001) modelled first-best and second-best pricing schemes in four European cities (Athens, Edinburgh, Helsinki and Oslo) and assessed substantial welfare benefits for the urban population. The direction of effects in the second-best solutions is generally the same as in the first-best solution, but the overall efficiency gains are considerably smaller, especially where the constraints of prevailing legal and institutional arrangements are assumed.

However, the second best solutions have downside effects, such as increased informational needs implied for the regulator since second-best rules are usually far more complex than the standard first-best Pigouvian rule, in which the regulatory tax is equated to the marginal external costs. Thus AFFORD fears "a large risk of additional government failures, adding to unavoidable welfare losses arising from the second-best nature of the instruments themselves. Therefore, the first-best benchmark should not be ignored in the process of policy-making, for the reason that it is 'only a hypothetical policy' " (p. 99).

The FP6 project MC-ICAM (2004) uses a second best approach by applying "marginal cost based pricing" principles when developing a phased approach for future pricing policies for Paris, Brussels, Oslo and Helsinki. The project discusses the use of second best pricing approaches under the constraint of limited public acceptance of the measures. These principles "are to be understood as a sequence of second-best (constrained) optima, jointly defined by the progress of barriers and the implied constraints over time, and the transport regulator's (second-best optimal) response to this progress of barriers and constraints."

Another research topic was the development of Policy Packages, which are a composition of charges. However, MC-ICAM states that for useful policy advice, "models are needed that incorporate the important details of the situation at hand to provide policy guidance in actual situations. This also makes it difficult to provide generally applicable guidelines for the implementation of marginal cost based pricing." For the assessment of the policy packages, MC-ICAM proposes the following methods:

- Quasi first-best pricing: This entails the naïve application of marginal-cost pricing rules that ignore second-best distortions.
- Average-cost based pricing: Average-cost pricing may be legally required by self-financing constraints, or deemed necessary by political or social acceptability pressures to respect the user-pays principle.

The above research projects were not able to solve the problems of the scientific discussion, whether in transport pricing, second best solutions shall be based on marginal cost pricing or on average prices. It is unclear, if a mixture of both approaches, for example multi part tariffs for one mode and Ramsey prices for another is theoretically sound with regard to equity or efficiency issues. Another matter is the question, whether first best approaches can be used for benchmarking of policies, even though the methodologies are not eligible for practical implementation. These questions cannot be solved within the REFIT project, and most probably will not be solved in the near future in scientific discussions, due to the different positions of the researchers involved.

To resume, the regulation of transport externalities can be either viewed from the perspective of economic efficiency or from an equity angle. Thus, it is no surprise that the mixing up of equity and allocative efficiency arguments often leads to rather fuzzy discussions about the policy implications of research findings on external costs of road transport. This shall be avoided within REFIT.

3.2. Consequences for the LoI Concept

As a consequence of the above theoretical discussion, two indicators shall be used within REFIT: One to analyse equity issues in transport and another to assess the efficiency of specific transport situations. The questions listed in Table 1 can be used as examples: An inter-country comparison of the LoI makes only sense, if the indicator is highly aggregated on the country level. The same holds true, if a comparison of the modes is undertaken. For these type of questions, the equity approach is relevant. The marginal approach is more valuable, if specific segments of the transport demand are analysed, such as peak hour traffic in metropolitan areas.

This approach goes as well in line with the methodology that Vermeulen et al (2004) use for their transport cost assessments (Figure 3). "The first approach proceeds from the 'fairness' principle, taking as its point of departure that every mode of transport should be confronted with the sum total of social costs to which it gives rise: the total cost variant. This means that both variable and fixed costs are allocated to users. The second approach employs pricing policy as a means to optimise social welfare, by charging all variable costs to users: the efficiency variant. Because the precise level of these costs depends strongly on a variety of real-world parameters of the transport mode in question, in this variant we distinguish a best and a worst case, defining the former (latter) as that in which there is least (greatest) difference between variable costs and the variable charges actually paid." The latter method can be used for questions such as inter-country comparison.

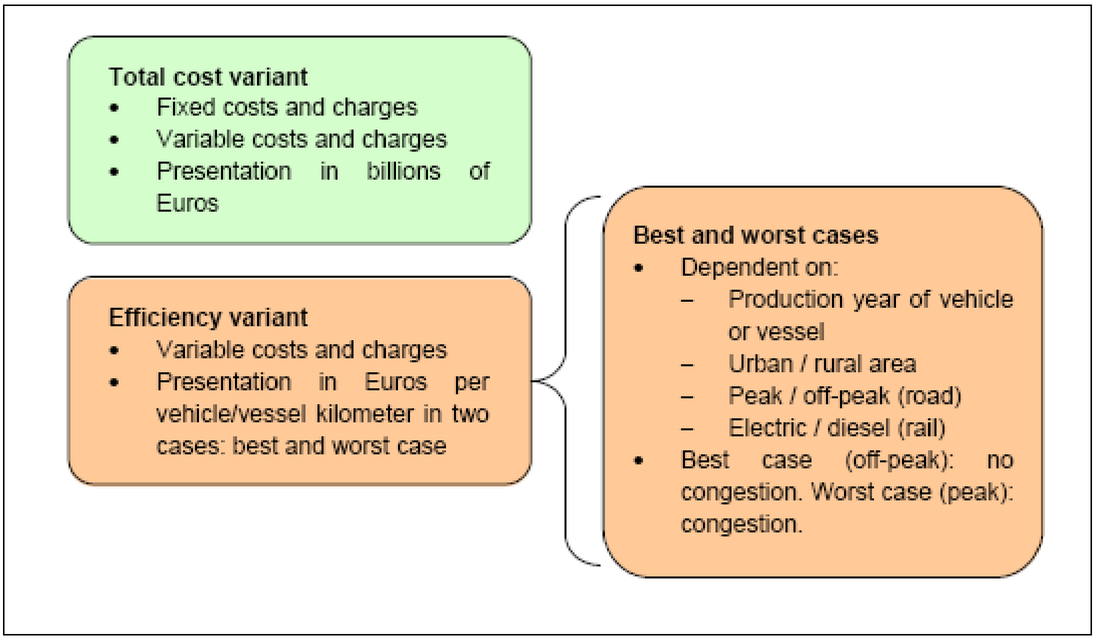


Figure 3: Assessment approach used in Vermeulen 2004

3.3. Calculation of the LOI

The basic reasoning which drives the internalisation, in a nutshell, is the following: in an optimal transport system the social cost of transport should be equal to the private costs that are paid by the transport users. Social Costs are all costs borne by the society, including the cost for implementing the infrastructure, costs for the operation of the vehicles, time costs and the external costs caused by transport. The Private Costs are the costs paid by the consumer for the transport operation of the vehicle and the time spent travelling. Thus, the LoI depicts the ratio between the amount the consumer has to pay for his transport and the costs which the society carries.

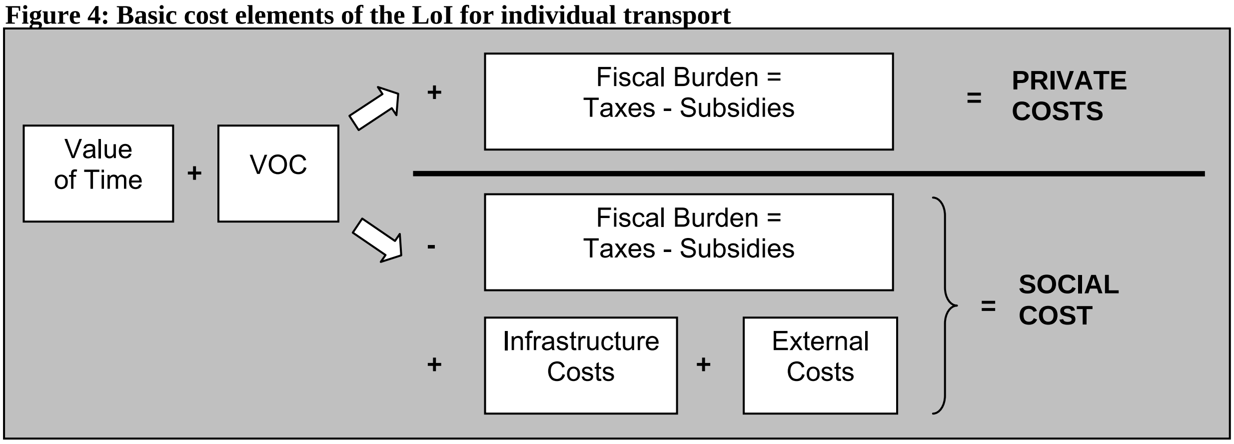
$$LoI = \frac{Private\_Costs}{Social\_Costs}$$

This general method has to be applied differently to the individual and public transport modes, since the cost structures are unlike.

3.3.1. LoI for Individual Transport

Figure 4 shows the main principle how consumer price and social costs are computed for private transport. Private costs are generated through vehicle operating costs plus the value of time. Additionally, the transport user has to pay taxes, but receives as well subsidies, which have to be deducted. The difference may be called Fiscal Burden, which is carried by the consumer. Social costs include vehicle Operating Costs and Value of Time as well. Since the state receives revenues from taxes and pays the subsidies, the algebraic sign of the Fiscal Burden is inverse. Additionally, the society has to carry infrastructure costs and external costs.

Figure 4: Basic cost elements of the LoI for individual transport



The basic cost elements of the LoI are

(i) Vehicle Operating Costs comprise i.a. vehicle operating costs, driver wages, fuel cost, insurance, etc. They are part of the private costs, as well as the social costs.

(ii) The Value of Time are costs borne as well by the consumer and by the society as such.

(iii) The Fiscal Burden comprises the difference between taxes minus subsidies: The consumer has to pay direct taxes, fees and charges. They comprise i.a. vehicle registration fees, fuel levy, road user fees, etc. The private user profits from direct subsidies, e.g, through subsidised catalytic converters. The Fiscal Burden is added to the private costs and deducted from social costs.

(iv) Infrastructure Costs are costs related to implementation and maintenance of transport infrastructures. These costs are borne by the state.

(v) External Costs are generated through the transport activities and comprise the costs for airborne emissions, global warming, noise and accidents. Only the cost components that are not internalised according to the polluter pays principle are external.

The main idea is that cost coverage is achieved by adjusting the Fiscal Burden in a manner, that the consumer price is equal to the social cost. The above elements are combined differently in (i) the Equity and (ii) the Efficiency Approach.

The Equity Approach for individual transport

The aim of the Equity Approach (or Full Cost Approach) is to identify the total costs they cause and compare these costs with the total charges paid by the category in question. Thus, the approach takes into account all the above mentioned cost elements. The Equity Approach defines the LoI as follows:

$$LoI_i = \frac{VOC_i + VT_i + (\sum T_i - \sum S_i)}{VOC_i + VT_i + IC_i + \sum_e EC_{i,e} - (\sum T_i - \sum S_i)}$$

$EC_{i,e}$	External Costs for mode i and external effect e
IC_i	Infrastructure Costs attributed to individual transport mode i
LoI_i	Level of internalisation for individual transport mode i
S_i	Subsidies for individual transport mode i
T_i	Taxes and Charges for individual transport mode i
VOC_i	Vehicle Operating Cost for individual transport mode i
VT_i	Value of Time for mode i

Using the above method, all relevant cost components are included in the calculation: Infrastructure cost will be included as well as subsidies paid and external costs. However, the congestion cost will not be included in the Equity Approach, as explained further below. The most important difficulties related to the approach are a high demand for data, especially regarding infrastructure costs and the attribution of infrastructure cost to the modes.

The Efficiency Approach for individual transport

The aim of the Efficiency Approach is to establish how variable user charges compare with usage-dependent external costs. This variant aims at the assessment of the efficiency of specific transport situations. Pricing based on variable user costs is the most efficient option in economic terms, i.e. from the perspective of optimising overall welfare. According to theory, marginal cost pricing is the principle that the market will, over time, cause goods to be sold at their marginal cost of production. If this law is broadened by taking into account market distortions, such as externalities, a welfare optimum can be reached if the consumer price is equal to the marginal social cost.

$$LoI_{m,s} = \frac{MVOC_i + MVT_i + (\sum MT_i - MS_i)}{MVOC_i + MIC_i + \sum_e MEC_{i,s,e} - (\sum MT_i - MS_i)}$$

$LoI_{i,s}$	Level of internalisation for mode i and transport situation s
$MEC_{i,s,\,i}$	Marginal External Costs for individual mode i, transport situation s and external effect e
$MIC_{i,s}$	Marginal Infrastructure Costs for mode i
$MS_{i,s}$	Marginal Subsidies levied on individual mode i
$MT_{i,s}$	Marginal Taxes and Charges levied on individual mode i
$MVOC_{i,s}$	Marginal Vehicle Operating Costs for individual mode i
$MVT_{i,s}$	Marginal Value of Time for individual mode i

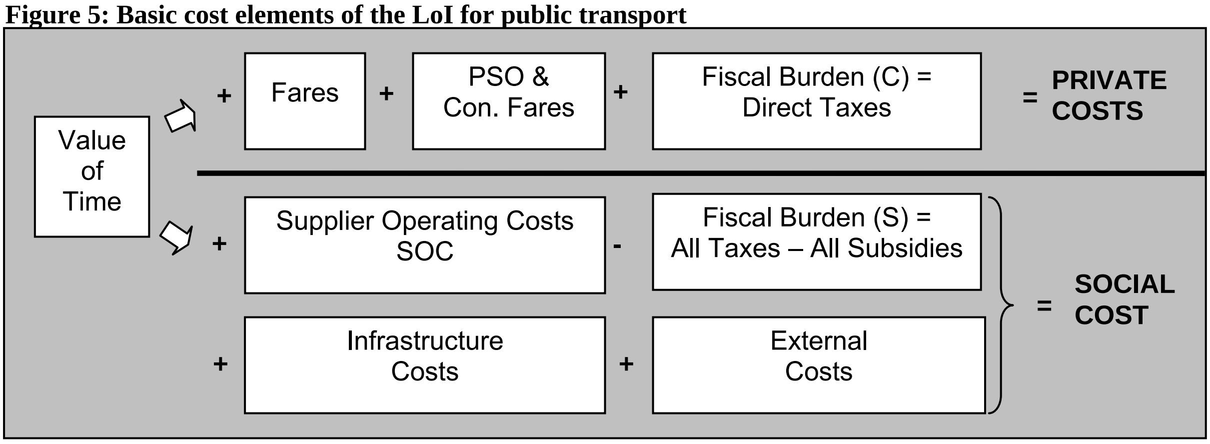
For transport this approach translates into the following: The additional costs paid by the consumer for one kilometre of travel is equal to the marginal social costs carried by society. Therefore, the efficiency approach is only taking into account variable cost components. For this reason only a small share of the infrastructure costs and only the variable components of Vehicle Operating Costs and Taxes are included. Subsidies are excluded from the Efficiency Approach, since their variable character cannot be verified in practice. This is explained in more detail further in the text on page 45.

In this context it should be noted that to achieve the economic optimum, it is not only important that the total of variable user costs corresponds to the total of variable charges. In addition, the structure of the charges levied on vehicle usage should reflect the structure of the costs arising through that specific behaviour, so that precisely the right incentives are given for a socially and economically optimum pattern of transport mobility. In this approach, then, costs and charges are expressed per pkm or tkm.

3.3.2. LoI for Public Transport

For public modes of transport the situation is different compared to individual transport, because three parties are involved: The consumer, the service provider and the society as such, which bears the social costs. The following graph depicts the calculation method:

Figure 5: Basic cost elements of the LoI for public transport



The main differences compared to the individual transport modes are:

(i) Time costs are borne as well by the consumers and are thus part of the denominator. However, these costs are - similar to individual transport- included as well in social costs.
(ii) The fares for the transport services comprise the price paid for the ticket by the user.
(iii) Public Service Obligations PSO and Concessionary Fares are transport services ordered by the state for social purposes and cannot be regarded as subsidies to the transport sector. Detailed explanations are given on page 44. However, since the payments are part of the revenues of public service providers, they have to be treated in the same manner as transport fares.
(iv) The service provider bears the Supplier Operating Costs, such as fuel, wages for personnel, insurance, etc.
(v) The Fiscal Burden for the consumer comprises direct fees, such as airport charges and direct taxes such as VAT. Here double counting has to be avoided, if the latter are included in the ticket price. Since subsidies are usually paid to the service providers, they are not included in the Fiscal Burden of the consumer.
(vi) The Fiscal Burden for the society, listed in the denominator includes all taxes and subsidies received and paid to consumers and service providers. The Fiscal Burden of the consumer as given above has to be included. Additionally, the society receives payments from the service providers, such as rail track charges, landing & take-off fees, VAT on fuel etc. Subsidies are transferred to the service providers either as a lump sum or on a fee for service basis.
(vii) Infrastructure and External Costs are treated similarly to individual modes of transport.

The Equity Approach for public transport modes

Following the logic of the above, the LoI for the Equity approach for public transport modes calculates as follows:

$$LoI_i = \frac{VT_p + F_p + PSO_p + DT_p}{VT_p + SOC_p + IC_i + \sum_e EC_{p,e} - (\sum T_p - \sum S_p)}$$

DT_p	Direct taxes for public transport mode p
$EC_{p,e}$	External Costs for mode p and external effect e
F_p	Fares for public transport mode p
IC_p	Infrastructure Costs attributed to public transport mode p
LoI_p	Level of internalisation for public transport mode p
PSO_p	Public Service Obligations and Concessionary Fares
SOC_p	Supplier Operating Costs for public transport mode p
S_p	Subsidies for public transport mode p
T_p	Taxes and Charges for public transport mode p
VT_p	Value of Time for public transport mode p

The Efficiency Approach for public transport modes

Following the same arguments as given in the discussion of the individual transport modes, the LoI for public transport services can be calculated using the following method:

$$LoI_{i,s} = \frac{MVT_{p,s} + MF_{p,s} + MPSO_{p,s} + MDT_{p,s}}{MVT_{p,s} + MSOC_{p,s} + MIC_{p,s} + \sum_e MEC_{p,e,s} - (\sum MT_{p,s} - MS_{p,s})}$$

$LoI_{p,s}$	Level of Internalisation for public transport mode p and transport situation s
$MDT_{p,s}$	Marginal Direct Taxes for public transport mode p
$MEC_{p,e,s}$	Marginal External Costs for mode p, external effect e and transport situation s
$MF_{p,s}$	Marginal Fares for public transport mode p
$MIC_{p,s}$	Marginal Infrastructure Costs attributed to public transport mode p
$MPSO_{p,s}$	Marginal Public Service Obligations and Concessionary Fares
$MS_{p,s}$	Marginal Subsidies for public transport mode p
$MSOC_{p,s}$	Marginal Supplier Operating Costs of public transport mode p
$MT_{p,s}$	Marginal Taxes and Charges for public transport mode p
$MVT_{p,s}$	MarginalValue of Time for public transport mode p

3.3.3. Differentiation of LoI

The main difference between Efficiency and Equity Approach is, that marginal costs are exclusively designed to analyse specific traffic situations. For this purpose, the LoI has to be differentiated according to

- Infrastructure types (e.g. Motorways, interurban roads, urban roads, ...)
- Day time (e.g. Peak/off-peak, nigh/day, ...)
- Spatial differentiation (e.g. metropolitan city, other city, non urban, national data)

It is the advantage of the efficiency approach to be able to analyse these situations appropriately. Precondition for this analysis is the knowledge of the specific cost function depending on the transport volume v.

$MEC_{m,s} = f(v)$

Given this function, figures vary for each of the above situations: E.g. a free flow situation would generate lower costs per vehicle km for airborne emissions than a slowly moving congested road. A differentiated analysis is essential, especially if differentiated fees, such as zonal and time related charges shall be designed. In the specific situation where the existing tax or charge was introduced to cover fixed costs, differentiation may be an improvement from the perspective of economic efficiency. The total costs will still be financed, and users of infrastructure receive incentives to adapt their behaviour to account for e.g. congestion or emissions of pollutants.

The project MCICAM (2004, p. 63) revealed the impacts of differentiation: “The urban case studies showed considerable social benefits from differentiation of prices over time (peak and off-peak). The interurban case studies showed that geographic differentiation can have remarkable social benefits and significant impacts on modal shares. But the studies also showed that differentiation can benefit those (here road freight) who are the object of pricing."

- In Paris time-differentiated tolling yielded greater efficiency gains than did flat tolling.
- In Brussels, greater efficiency gains derived from measures such as peak and off-peak pricing of public transport fares or if road tolls were differentiated by space and time.
- In Helsinki and Oslo a differentiation of prices increased total welfare
- In the Netherlands, the welfare effects from charging road freight increased almost linearly

However, it has to be emphasised that a efficiency approach assessing the whole sector or a whole mode would make no sense. For an overall comparison, comprising all transport situations, only the Equity Approach is relevant. However, the Equity Approach can be used as well to analyse specific traffic situations. In this case specific average costs based on the particular transport situation would have to be used. Again the attribution of infrastructure cost is the most difficult task.

4. Computation of Social Cost Components

As already stated above, the Social Costs of transport contain the following components[8]:

- Vehicle Operating Costs
- Value of Time
- Infrastructure costs
- External costs

The cost figures vary (partly) with the given approach: E.g. the Efficiency Approach includes only a share of Vehicle Operating Costs and excludes capital costs for infrastructure investments entirely. For the definition of the calculation methodology a EU funded project HEATCO (Bickel et al. 2006) is used as the main reference. The research project had the aim "to propose harmonised guidelines for project assessment for trans-national projects in Europe. This includes the provision of a consistent framework for monetary valuation based on the principles of welfare economics, contributing in the long run to consistency with transport costing."(p S1) The guidelines are based on latest research results on the different aspects of transport project appraisal and on an analysis of existing practice in the EU countries and Switzerland. Thus, the HEATCO methodology represents the present state of the art in transport appraisal and shall be used by REFIT to define the social cost components of the LoI.

4.1. Vehicle Operating Costs

The EU funded project EUNET (Nellthorp et al. 1998) developed a definition for vehicle operating cost in Europe. Out of 18 countries that have a definition for vehicle operating costs, only two have a definition that is not fully consistent with that recommended by EUNET. Neither of these two countries have a definition that deviates materially from that definition. Thus, there is a high degree of consensus within the EU regarding the definition of vehicle operating costs (Odgaard et al., 2005). HEATCO (Bickel et al. 2006, p.135) recommends that vehicle operating costs are defined as comprising the standing costs which are invariant with distance, and operating costs which vary with distance of the transport vehicle. The salient cost components are given in Table 2. The Full Costs Approach comprises all components listed in Table 2, while the Efficiency Approach lists only the variable cost components given in the right column of the table.

[8] Taxes and subsidies are discussed in the next chapter

Table 2: Cost components of Vehicle Operating Costs

Standing cost components	Operating cost components
• Depreciation (time dependent share) • Interest on capital • Repair and maintenance costs • Materials costs • Insurance • Overheads • Administration	• Personnel costs • Depreciation (distance related share) • Fuel and lubricants
Source: Bickel et al. 2006, p. 136	

Operating costs for **road vehicles** comprise of those incurred by road users and road service providers, e.g. road haulage companies. The nature of these costs is that they are distance dependent, however, some vary linearly with distance travelled (e.g. fuel costs) whilst others vary in a step like or lumpy manner, e.g. vehicle purchases and maintenance schedules. Road vehicle costs vary by vehicle type, the condition of the road surface, the road gradient and vehicle speed.

The operating costs for **railways** are those incurred by the service provider. These costs vary as follows:

- Between freight and passenger services
- By the type of freight carried. If the freight is high volume low density than the cost per tonne will be higher than if it is low volume high density.
- By the length of the journey (costs per mile decline with distance)
- By track alignment and morphology (terrain)
- By train vehicle utilisation which in turn depends on operational features, physical characteristics of the network, geographical locations, the regulatory and labour market, congestion effects and rates of utilisation.

As with road vehicles, the nature of train operating costs are that some cost items are 'lumpy', such as replacement costs for locomotives, whilst others are proportional to distance (e.g. train fuel costs). For further explanation please refer to HEATCO (Bickel et al. 2006, p.137).

Ship and aircraft operating costs vary in a similar manner to train operating costs. They are heavily dependent on vessel or aircraft type, manner of operation, utilisation and maintenance strategies, as well as the regulatory framework in which the vessel or craft operates.

4.2. The Value of Time

Case studies conducted within the framework of HEATCO researched the benefits and costs generated by exemplary transport projects in Europe. The analysis revealed that the Value of Time plays a dominant role in the transport appraisals. For the road projects roughly 80%-90% of the benefits are generated through travel time savings and reduced Vehicle Operating Cost[9]. The overwhelming share of the benefits was generated by the Value of Time generated through travel time savings.

[9] Compare Figure 9 on page 31.

There are countless examples in everyday life of people's willingness-to-pay to save travel time - think of a tolled bridge over an estuary, or the premium fare that a high speed train service attracts. Clearly therefore time savings have value. However, the apparently simple question as to what the value set is, has to be answered using many areas of economic thought including that of labour supply, home production and transport. In essence changes in welfare occur when individuals transfer time from intermediate activities (such as travel) to leisure or work activities and vice versa.

Similar to Vehicle Operating Costs, there is a high degree of consensus between the EU-25 countries plus Switzerland as to what constitutes a saving in travel time (Odgaard et al., 2005). Whilst not all national appraisal guidelines include a definition of time savings the approach adopted across the EU typically takes any change in the door-to door journey time to constitute a change in travel time. The change in door-to door journey time is therefore the definition adopted in the HEATCO guidelines. This definition means that travel time is a composite of in vehicle and out of vehicle time.

HEATCO (Bickel et al. 2006, p.53) recommends that different valuation methodologies are used for the following three broad categories of trips:

(i) passenger-work,
(ii) passenger-non-work and
(iii) commercial goods traffic.

Commercial goods traffic is traffic whose primary function is the delivery of goods and products; business passenger traffic is traffic where the driver or occupants are travelling on behalf of their employer; and non-work related passenger traffic is the remainder. For the assessment of the values HEATCO uses three approaches: the Cost savings approach, the Willingness-to-Pay and an approach developed by Hensher (1977) that allows for the fact that not all travel time is unproductive and not all savings are transferred to extra work.

HEATCO defines a number of issues, such as differentiation, value of walking and waiting time, treatment of small time savings, variation of passenger time values with income, journey length and journey purpose, the value of time in commercial goods traffic, the treatment of uncertainty and values over time. These issues shall not be quoted here in detail but can be retrieved from HEATCO (Bickel et al. 2006, p.53ff).

Given a free traffic flow and assuming a constant speed, the marginal and the average costs of time are equal. This situation changes if congestion occurs which is treated further in this paper. As an example, the average travel time costs for passengers are depicted in Figure 6. The graph shows a strong variation of the costs according to distance and travel purpose.

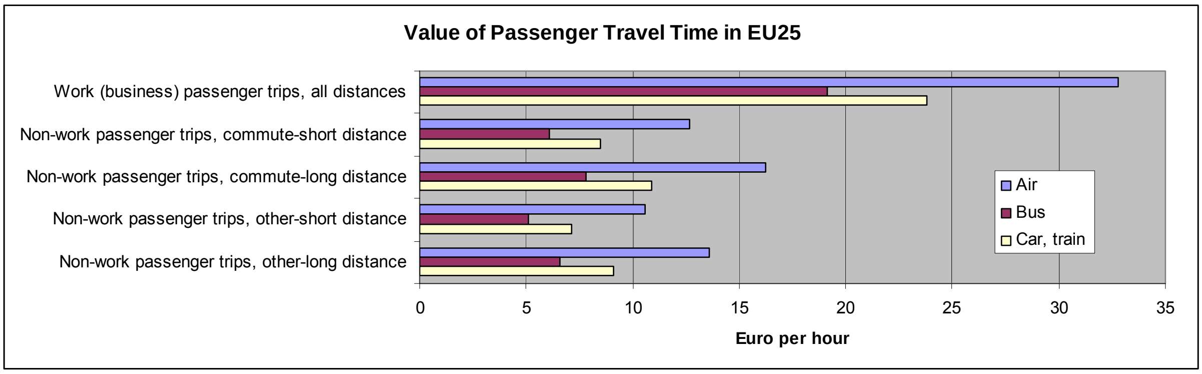


Figure 6: Value of time for passenger trips (Average EU 25)

4.3. Infrastructure Costs

In order to assess infrastructure costs, HEATCO recommends using a whole life costing framework. Figure 7 provides the structure for this whole life costing approach. The inputs to the framework are the costs associated with the investment in the new infrastructure (capital and future maintenance costs) plus the changes to the maintenance costs on the existing network over the lifetime of the project.

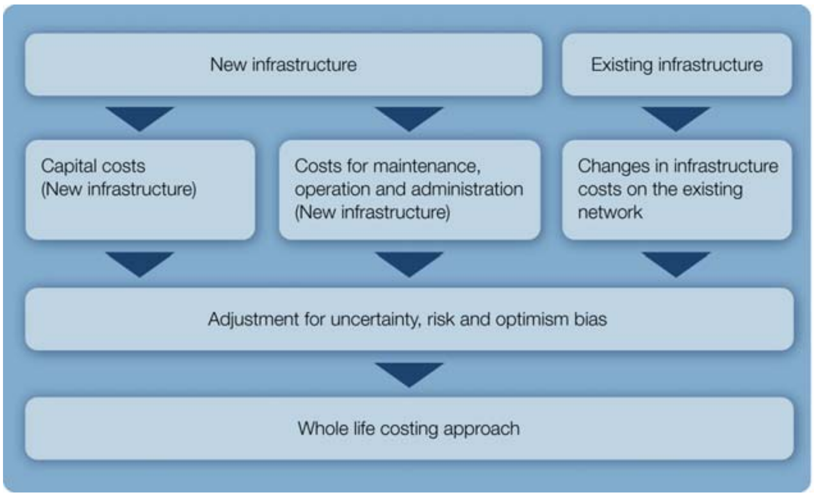


Figure 7: The whole life costing approach

Capital costs of transport infrastructure

HEATCO (Bickel et al. 2006, p. 123) recommends using the following cost components:

- Construction costs, including materials, labour, energy, preparation, professional fees and contingencies.
- Planning costs, including design costs, planning authority resources and other planning costs.
- Land and property costs, including the value of the land needed for the scheme (and any associated properties), compensation payment necessary under national laws and the related transactions and legal costs.
- Disruption costs, e.g. the disruption to existing users to be estimated using the same values of time as are used for travel time savings arising from the scheme.

Additionally, other components have to be taken into account:

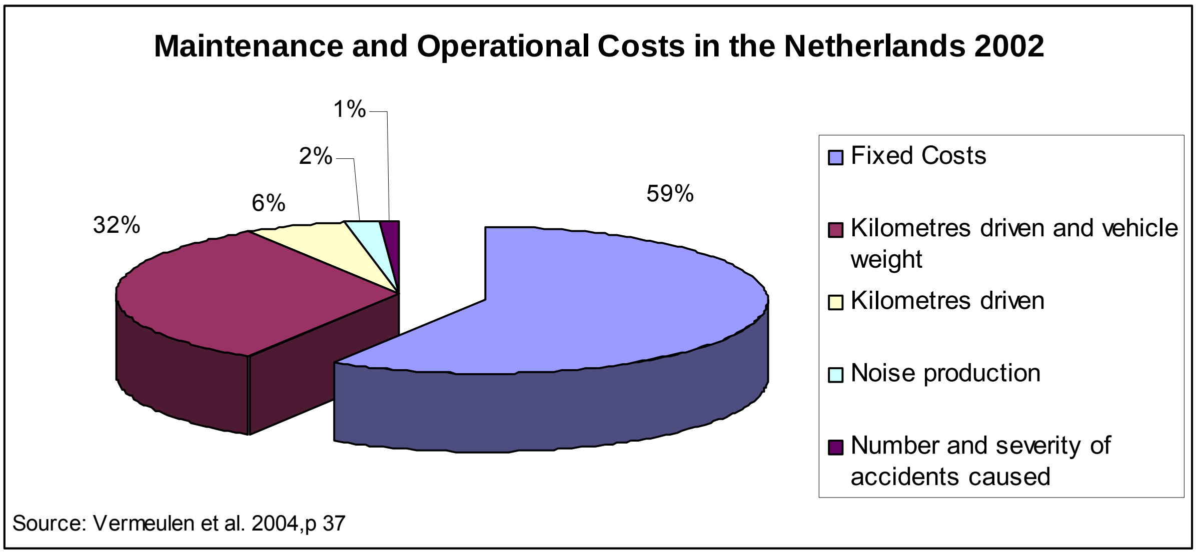
Costs of maintenance, operation and administration
Costs of maintenance, operation and administration are costs accrued during the operating life of the transport infrastructure by the infrastructure owner for the parts of the network which are changed by the project.

Fixed and variable costs
Usually infrastructure costs are regarded as sunk cost, which are invested once and are not dependent on the actual transport usage. However, some cost components, such as maintenance and operational costs can be directly attributed to transport volume. Vermeulen et al (2004, p37) show, that road maintenance and operational costs are dependent on

- damage to the road pavement (wear and tear); these user costs are a function of kilometres driven and vehicle weight,
- kilometerage only, such as the costs of traffic control measures, or signs and beacons,
- noise provisions, which are a function of vehicle noise emissions and
- the number of traffic accidents caused (part-dependent on kilometerage) and their severity.

According to the study 59% of the maintenance and operational costs in the Netherlands are fixed costs (see Figure 8), while the remaining cost components are dependent on kilometres driven, on vehicle weight, on noise and on accidents

Figure 8: Road Infrastructure Maintenance and Operational Costs in the Netherlands 2002



If the whole infrastructure costs are taken into account, the share of variable costs comprises 13% of total costs for all roads. For rural roads this ratio amounts to 15%, while for urban roads 10 % of the costs are fixed expenses. Thus, infrastructure costs are by no means purely sunk costs and could be neglected when calculating marginal costs. This would imply a neglect of 10% of total costs.

Table 3: Share of fixed and variable road infrastructure costs in the Netherlands 2002

Cost category	Urban	Rural	Total
Construction	29%	62%	46%
Maintenance and operation, fixed	16%	22%	19%
Maintenance and operation, variable, depending on:			
vehicle kilometres & vehicle weight	9%	12%	10%
vehicle kilometres	2%	2%	2%
noise production	0%	1%	0%
number/severity of accidents	0%	1%	0%
Cycle lanes*	2%	1%	2%
Parking space*	43%	0%	21%

* Excluding costs of land purchase.
Source: Vermeulen et al. 2004,p 39

Allocation of costs

Another important issue is the allocation of fixed costs to the modes, which is only relevant if a mode specific LoI is calculated. This has to be undertaken, in order to assess which share of the infrastructure costs is attributed to the respective mode. Since the methodology is rather technical, only an overview of the approaches is given in Table 4 presenting the methodology used by Vermeulen et al (2004). In the urban environment, road transport infrastructure not only serves the traffic it carries but other functions, too as in the case of pavements, town squares and pedestrian zones. As a result, only 45.5% of urban costs to road users are attributed to transport.

Table 4: Attribution of Road Infrastructure Costs to the Transport Modes

Construction Costs	Fixed Maintenance and Operational Costs	Variable Maintenance and Operational Costs
• axle load • peak-time road capacity utilisation	• vehicle kilometerage • ‘kilometre-equivalence factors’, as defined in the European Commission’s proposal for amendment of the ‘Eurovignette’ Directive	• vehicle weight • kilometerage • axle damage factors’

By Vermeulen et al (2004, p. 40)

A similar approach is proposed by Link and Maibach (1999, p. 32) which includes as well cost categories such as major repairs and renewal works. The report makes it clear that for marginal cost calculations require a large amount of quality data (p. 34ff).

Infrastructure costs for rail and waterways

For rail and waterways other costing methods have to be used than in the road sector. The separation of variable and fixed cost drivers is relevant for both modes as well as the distinction between infrastructure and maintenance costs. The attribution of infrastructure costs to the modes is only relevant for rail passenger and freight. Again the methodology is very technical and reference is made to Vermeulen et al (2004, p 48ff). An overview on marginal, variable and fixed costs for rail and road infrastructures is given in Link and Maibach (1999 p.24, 29).

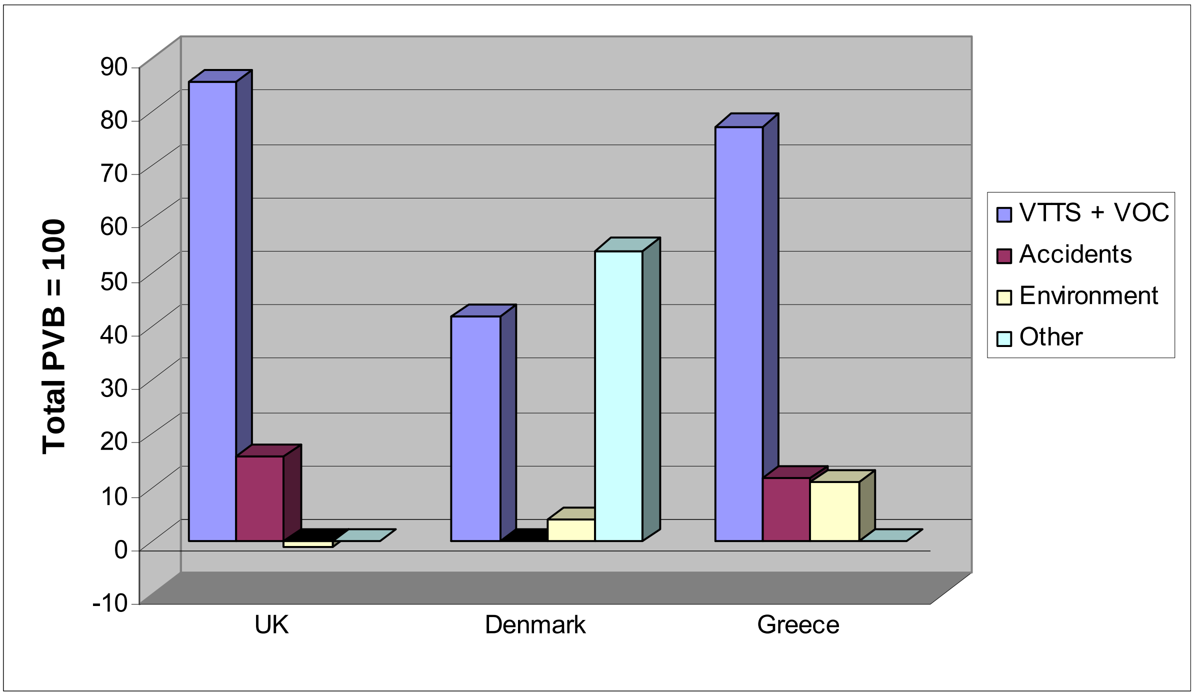
Since data on infrastructure costs in the models used in REFIT are scarce, as will be shown later in the text, Table 5 gives an overview on the infrastructure costs as presented by the research project UNITE.

Table 5: Infrastructure Cost in Europe

[Mill Euro]	AT	FR	DE	IT	NL	SE	CH	UK	Total
Road	4,374	25,520	29,100	13,645	4,411	2,172	4,030	12,728	95,980
Rail	1,933	4,790	10,277	5,605	1,095	856	2,762	3,288	30,606
Air	509	1,080	3,488	571	98	447	804	2,236	9,233
Water	22	2,377	2,225	58	3,694	-	10	175	8,561
Source: Unite 2002, 2003									

4.4. External costs

Externalities have been already defined above as effects from one activity which has consequences for another activity that are not reflected in market prices. For the calculation of the LoI, external effects are confined to air pollution, climate change, noise emissions, accidents and congestion. Each of these effects is assess through the Impact Pathway Approach developed in ExternE (European Commission, 1999, p7-30) and applied by using appropriate calculation methodologies for cost assessment, which are explained below. Since the current state of the art of external cost computations is reflected in the above quoted HEATCO project, the methodology shall be briefly explained in the text. It is recommended not only to use the HEATCO methodology and the fall-back values, but include as well the approaches for sensitivity tests.



Source: Bickel et al. (2006b, p. 9)
Figure 9: Distribution of benefits (PVB) in the GRACE Case Studies

However, the overall value of external effects should not be overestimated. The above mentioned case studies conducted within the framework of HEATCO revealed, that the impacts of environmental effects and accidents are low, compared to value of time and vehicle operating costs. Environmental effects range between -1% and 11% and accident costs between 0% and 16% of total benefits of the observed projects (compare Figure 9).

4.4.1. Air Pollution

According to HEATCO (Bickel et al. 2006 p94ff) the valuation of air pollution effects should be based on the damages caused by air pollutant emissions. The types of impacts for which dose-response relationships are established are human health impacts, agricultural production losses, as well as soiling and corrosion of building materials. Existing work identified damage to human health as the most important effect in terms of quantifiable costs. In particular losses in life expectancy in terms of Years of Life Lost (YOLL) contribute to health costs.

HEATCO recommends using country-specific cost factors (Euro/ton) taking into account local population densities. The list of pollutants should cover primary $PM_{2.5}$ for transport emissions (PM_{10} for emissions from power plants), NO_x (as precursor of nitrate aerosols and ozone), SO_2 (direct effects and as precursor of sulphate aerosols), NMVOC (as precursor of ozone). The emissions should be calculated using national emission factors; if such are not available emission factors from international sources can be applied, taking into account national vehicle fleet compositions as far as possible.

HEATCO provides country specific impact and cost factors that were calculated using the EcoSense software tool developed and applied amongst others in the EU-projects ExternE and UNITE. Impacts and resulting costs occurring in each country were calculated for an increase of 10 percent for existing NO_x, SO_2, $PM_{2.5}$ and NMVOC emissions. Both were compared to those calculated for the unchanged reference scenario; the difference between both scenarios is caused by the additional emissions. For the estimation of impacts and damages on human health in the environment close to the sources, sector and population density specific estimates were used which were derived from a number of calculations and results within former EC projects (Droste-Franke and Friedrich 2003, Link et al. 2002, Preiss et al. 2004, Schmid et al. 2001).

Given the physical impacts, appropriate monetary values are needed to derive damage costs. For material damage and crop losses, market prices can be used. This is not the case for major aspects of health impacts, for which three components of welfare change can be distinguished (see e.g. European Commission 2005):

i. Resource costs, i.e. medical costs paid by the health service
ii. Opportunity costs, i.e. mainly the costs in terms of productivity losses
iii. Disutility, i.e. other social and economic costs of the individual or others

Components (i) and (ii) can be estimated using market prices and are known as "cost of illness". The latter must be added to a measure of the individual's loss of welfare (iii). This is important because the values for disutility are usually much larger than the cost of illness. Stated preference methods are regarded as the state of the art for valuing component iii. Cost estimates can be based on the work done in ExternE and UNITE.

Marginal costs of air pollution are the costs generated by pollutants emitted when a vehicle drives an additional kilometre. These are dependant on the transport situation e.g. urban, non-urban, type of road used and speed. Considering that the most important exposure-response functions are linear and neglecting non-linearities in air chemistry the simplifying assumption can be taken that marginal costs equal average costs .

4.4.2. Climate Change

The methodological framework for the estimation of external cost of climate change is presented in HEATCO (Bickel et al. 2006, p. 115ff). The method basically consists of multiplying the amount of CO_2 equivalents emitted with a cost factor. The CO_2 equivalent of a greenhouse gas is derived by multiplying the amount of the gas by the associated Global Warming Potential (GWP). The GWP for methane is 23, for nitrous oxide 296, and for CO_2 it is 1.

In high altitudes other emissions than CO_2 from aircrafts have a considerable climatic effect. HEATCO recommends multiplying high altitude CO_2 emissions by a factor of two in order to consider the warming effect of other species than CO_2.

Due to the global scale of the damages caused, there is no difference how and where the emissions of greenhouse gases take place. For this reason, HEATCO recommends to apply the same values in all countries. Guidance values are given in Table 6 as central estimate, with the lower and upper estimate for sensitivity analysis. Since future emissions will have stronger impacts than present emissions, values for future years are higher.

Table 6: HEATCO guidance values for the costs of CO_2 emissions

	Central guidance	For sensitivity analysis	
Year of emission		Lower central estimate	Upper central estimate
2000 – 2009	22	14	51
2010 – 2019	26	16	63
2020 – 2029	32	20	81
2030 – 2039	40	26	103
2040 – 2049	55	36	131
2050	83	51	166

As an input for the valuation of climate change effects, the quantity of CO_2 equivalents emitted is needed. Due to the global effects of greenhouse gas emissions specific average costs per vkm, dependent on fuel consumption can be used.

4.4.3. Noise

The treatment of external noise cost is given in HEATCO (Bickel et al. 2006, p.103ff). It is suggested to use country-specific values per person exposed to a certain noise level. The impact indicator is the number of persons exposed to transport noise. Figure 10 gives an example on the annual costs per person generated by transport noise in Finland. Values for other countries have to be adjusted with the ppp as described in HEATCO (Bickel et al. 2006, p.23ff).

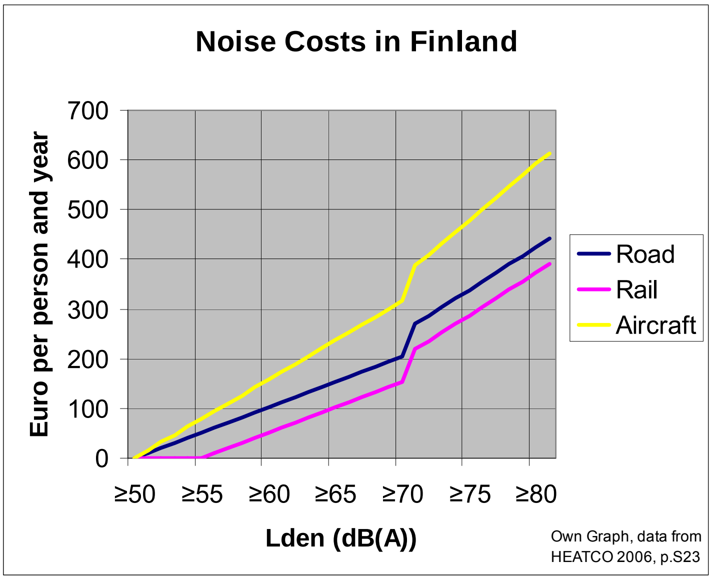


Figure 10: Noise costs in Finland

Inputs for external cost calculations are the number of persons exposed to certain noise levels. These numbers will be multiplied with the costs figures, such as exemplary given above.

Marginal noise costs are determined by the transport volume. It is the characteristic of the noise function that marginal costs are decreasing with increasing number of vehicles using the infrastructure. In a dense traffic situation, an additional vehicle would add only a small portion of acoustic pressure, which causes an infinitesimal increase of the noise level measure in dB(A), L_{den} and entails costs smaller than average. On the other hand, given low initial transport volumes, marginal costs are high. Therefore, in order to asses the marginal cost of traffic noise, a function is needed that describes the change in population exposure depending on traffic volume. It poses a major problem for research to develop this function, since it depends on a number of variables, such as traffic volume, distance to the road, population and site densities. Therefore, as a second best approach, average cost figures are used in REFIT.

4.4.4. External Accident Costs

The recommendations given in HEATCO (Bickel et al. 2006, p. 81) focus on a consistent set of monetary values for assessing accident risks and of factors for correcting underreporting for accident risks based on accident statistics. The following cost drivers are taken into account

- Fatality: death arising from the accident.
- Serious injury: casualty that requires hospital treatment and has lasting injuries, but the victim does not die within the recording period.
- Slight injury: casualties whose injuries do not require hospital treatment or, if they do, the effect of the injury quickly subsides.
- Damage-only accident: accident without casualties.

A 30 day period restriction for fatalities is a pragmatic simplification for accident reporting, because it would be quite demanding to observe all severely injured persons for a longer time period. As there is evidence for considerable under-reporting due to the 30 day limit, available statistical data should be adjusted. Underreporting of road accidents is a well recognized problem in official (road) accident statistics and an adjustment is recommended.

The valuation of an accident can be divided into direct economic costs, indirect economic costs and a value of safety per se. We recommend using values as follows:

i. Value of safety per se: WTP for safeguarding human life based on stated preference studies carried out in the country concerned.
ii. Direct and indirect economic costs: mainly medical and rehabilitation cost, administrative cost of legal system, and production losses
iii. Material damage from accidents: cost values for average damage caused by accidents in the country under assessment.

The costs due to accidents can be expressed as

$\Sigma_i (r_i * c_i * m)$

with
i = accident impact (fatality, serious injury, slight injury, material damage)
r_i = risk of accident impact type i per vehicle-km
c_i = cost per accident impact type i
m = mileage in vehicle-kilometres

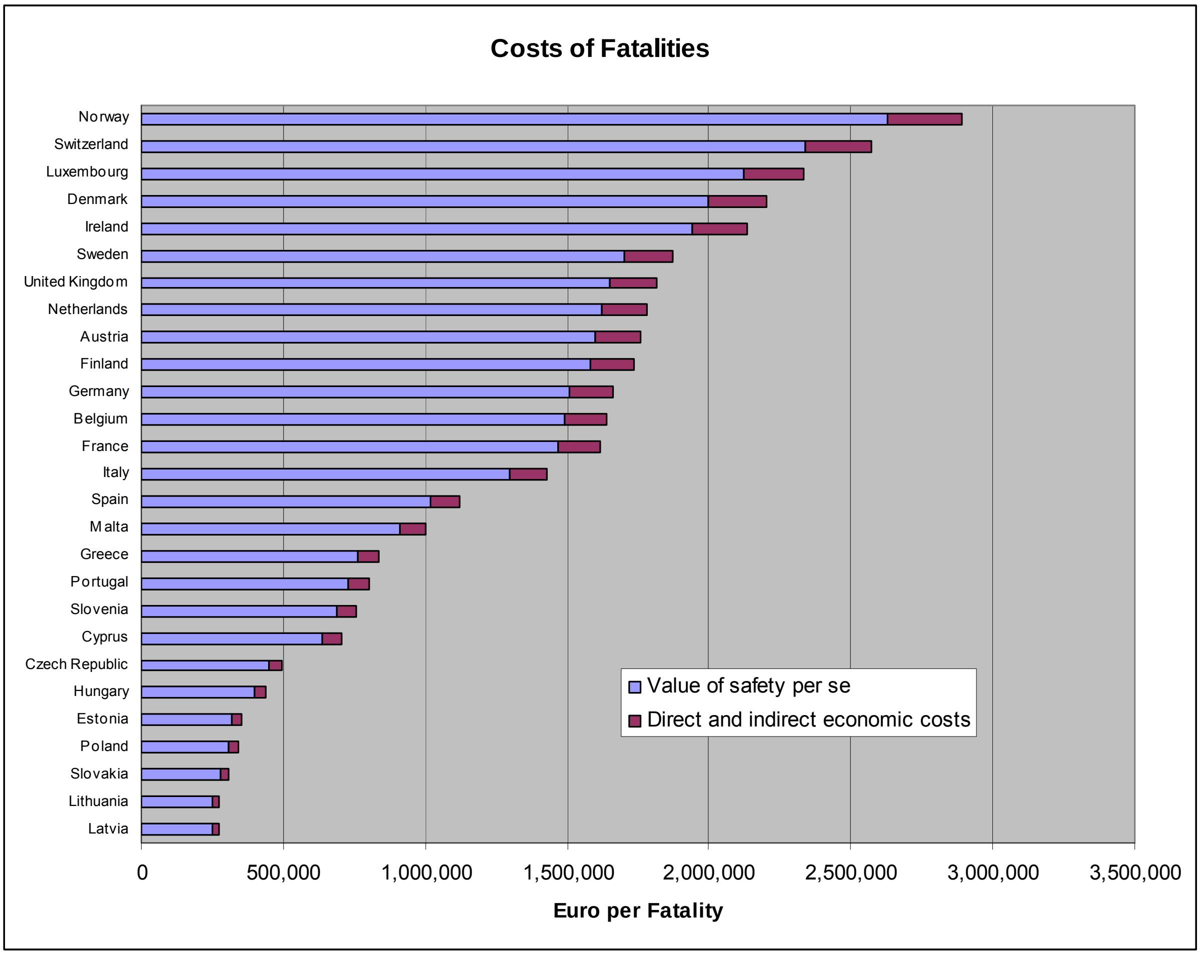


Figure 11: Cost values for fatalities in Europe (€ 2002, factor costs)

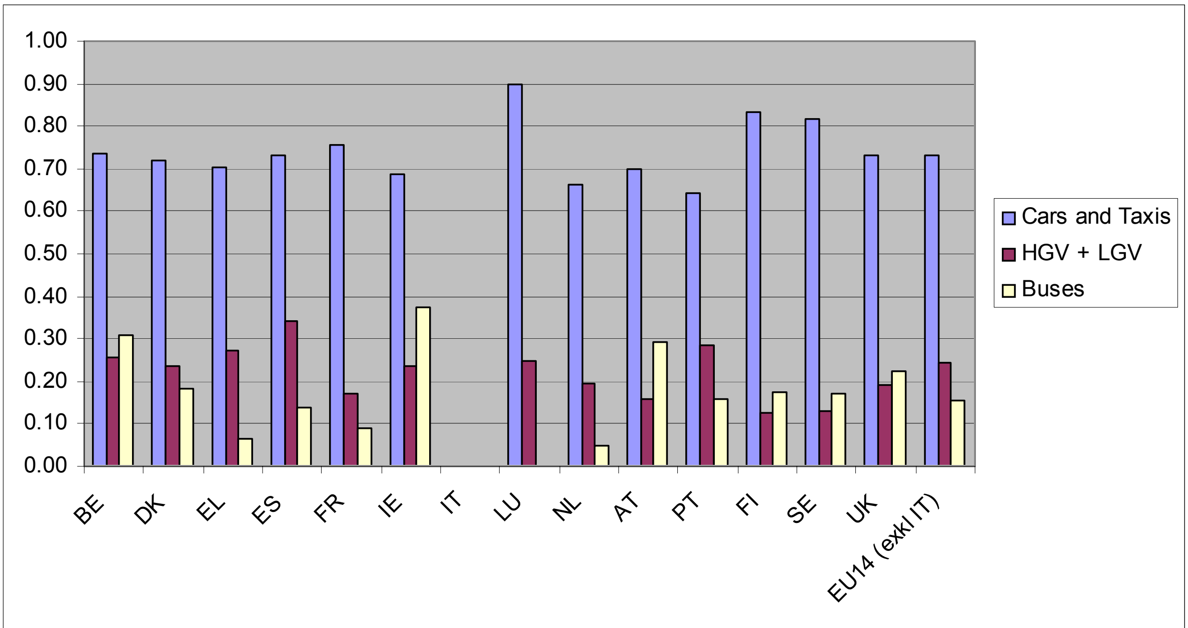
Figure 11 gives an overview on the cost values for fatalities in Europe, as proposed by HEATCO (Bickel et al. 2006). The range spreads from 275,000 Euro in Latvia to 2,9 million in Norway. Direct and indirect cost comprise 9% of the total value.

Since the uncertainties in estimating the value of safety per se are comparably large, it is recommend, to carry out a sensitivity analysis for this value. The lower boundary of the test should amount to v/3 and the high boundary to v*3(with v = value of safety per se).

Marginal Accident Costs

The computation of marginal accident costs poses some serious scientific problems. Firstly, the dependency of accident rates on transport volume is difficult to asses and secondly only a share of the average costs are regarded as internal. The latter is due to the fact, that the Efficiency Approach regards the individual decision to undertake a trip. Therefore, the value per se of the causer of an accident can be regarded as internalised. Thus, the WTP of the legally responsible has to be deducted from total external costs. Figure 12 gives an overview on the share of internalised marginal road accident costs in Europe. The values range from 65% to 90% for private cars and from 10% to 35% for goods vehicles.

Figure 12: Internal marginal costs of fatalities per total costs of fatalities 2002



Source: Lindberg, Presentation at Imprint Conference, November 2006, http://www.imprint-net.org/conferences/1/

The second problem, related to risk elasticities, entailed large scale research in the past decade. The difficulty is to assess the risks caused by an additional vehicle, since the outcome is dependent on the traffic flow: If an additional vehicle causes congestion that decreases traffic speeds, most probably the severe accident risks would decrease, while minor accidents increase. In order to quantify this effect, a function describing the nexus between traffic flow and accident risk is necessary. To quantify these effects, point elasticities are not sufficient, but functions have to be estimated, that include all relevant variables, such as type of road, traffic volume, speed, vehicles involved and accident severity.

A detailed analysis of existing marginal accident cost functions was undertaken in Infras/IWW (2000, p22ff and p. 182 ff). However, the research concludes: “the knowledge on marginal accident costs is quite poor. Existing studies are piecemeal, are often not comparable or are containing methodological problems." Therefore no similarities between the researched functions could be observed and no general function was deducted. The update of the research by Infras/IWW (2004, p.92) states as well that "the influence of traffic volumes on accident risks and cost is not clear".

Lindberg (2000, p.XV) confirms these statements and concludes that "better knowledge of the risk elasticity is of major importance if improved estimates on the external marginal accident cost are to be made." The author reconfirms this statement in another study (2002, p 12) "The knowledge on the risk elasticity is very limited and a survey of the available information in Stockholm and Lisbon suggests that it is very difficult to make reliable estimates". An extensive literature survey undertaken again by Lindberg (2006, p.57) concludes that "unfortunately, the survey of the literature does not give one single recommendation on the magnitude and the sign on the risk elasticity. The most surprising result is that so many studies find negative elasticities. This is true also for studies that seem to be well executed and control for infrastructure quality etc."

Thus empirical evidence is missing on the nexus of accident risk and transport volume. An approach focussing more on common sense than on theoretical efficiency deliberations reveals some simple insights: Accident risk is much more dependant on weather conditions (e.g. fog), risk averseness of the driver (e.g. drunk driving) and vehicle technologies (e.g. anti blocking system) than on traffic volume.

Therefore, it is recommended to estimate marginal costs on the basis of specific average costs that are adjusted by the internalised value per se.

4.4.5. Congestion Costs

Congestion is a very controversial issue in the scientific discussion. Congestion can affect the performance and quality of the transport system in a number of ways: increased travel times; overcrowding in public transport; deterioration in the 'driving experience' with stop-start conditions; and reliability problems. Theory informs us that a deterioration in travelling conditions, whether that be through increased overcrowding on public transport or stop-start driving conditions, by making travel more onerous will influence the willingness-to-pay for a travel time saving. It is important to distinguish between the following terms:

- Congestion in the narrow sense denotes the social loss due to the fact that users do not care for the additional costs and inconvenience they cause to other users. This is relevant for non scheduled road transport.
- Delays, additional journey times or increased travel costs are the effects of traffic congestion experienced by users.
- Reliability is based on delay information, but the inconvenience for users is not only expressed by the demand-capacity driven prolongation of travel or shipment time, but by their fluctuation.
- Scarcity denotes the economic costs to users and operators occurring when infrastructures cannot be used at the desired time due to overcrowding.

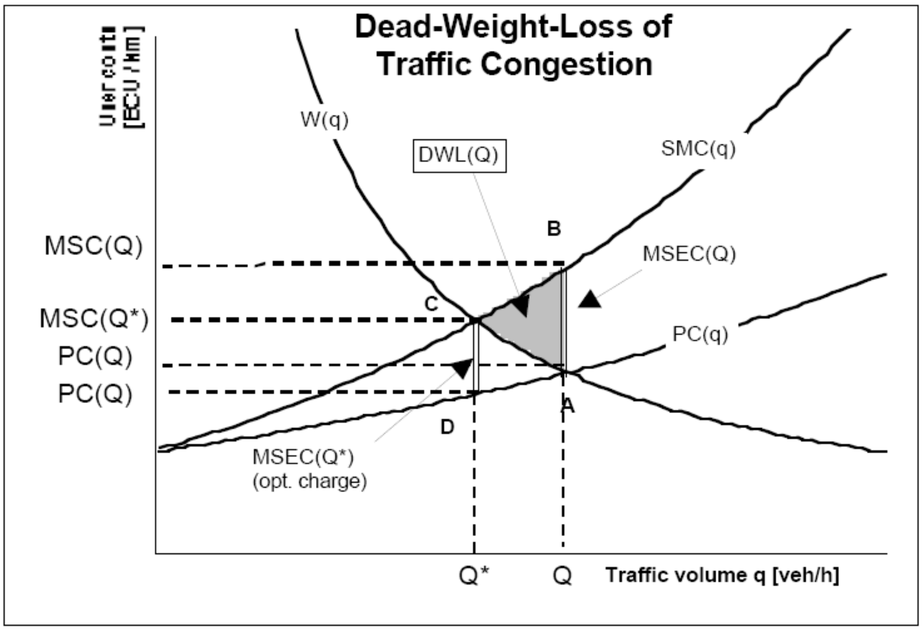
An important scientific dissent on congestion is, whether the costs can be regarded as external or not. INFRAS/IWW (2000 and 2004), Vermeulen (2004), FACORA (2004) and Van Essen et al (2007) only include marginal congestion costs in their analysis. The main argument for not including congestion in the Equity Approach is, that transport should be regarded as a club good, where all the members bear the external costs:

- For private transport congestion costs are mutually caused amongst the transport users and disbenefits are carried by all users. Additionally no causer can be identified and costs remain within the transport sector. Therefore, congestion is not an externality for private transport.
- In goods transport the carriers anticipate congestion in route planning. The additional costs are transferred to the clients and are thus reflected in overall transport costs. Again, congestion has been internalised.
- In business travel externalities might occur, if employees are delayed by congestion causing costs that are not internalised. The theory of club goods cannot be applied, since private transport hampers commuters. However, this can be neglected due to the small cost figures expected.

Therefore, using the Equity Approach and internalising congestion cost in a lump sum manner would cause major inefficiencies, since it would be 'unfair' to charge road users as they are already suffering from the consequences. Additionally, this would not induce any reaction which mitigates congestion. Thus, from the perspective of the Equity Approach congestion costs should not be considered.

However, the Efficiency Approach, which reflects time- and location-specific traffic situations, reveals the existence of externalities caused by congestion. By internalising these marginal costs, a behavioural change of the traffic participants is induced which has a positive effect on the overall social welfare.

The assessment of congestion cost is as simple and straightforward one might wish. It would be too short sighted to compare travel times simply to a free flow situation, since the latter does not represent the economic investment criteria for building the infrastructure. Cost/benefit approaches to justify the investments are based on an average usage of the infrastructures, which do not represent a free flow situation. Instead, Infras/IWW (2000, p.117ff) and UNITE (Doll et al, 2002, p.5) concept of dead weight loss, derived from welfare economic theory. "The costs of traffic congestion are defined by the accumulated difference between the marginal social user costs and the willingness to pay for a particular level of service under the given demand." As depicted in Figure 13, without congestion the equilibrium between willingness to pay W(q) and private costs PC(q) is given under a transport volume Q. If congestion occurs, the social marginal cost curve SMC(q) is relevant and the transport volume Q* represents the new equilibrium. According to welfare theory, the dead weight loss, depicted by the grey triangle ABC, reflects the costs of congestion.



Source: INFRAS/IWW 2000, p. 118
Figure 13: Assignment of congestion costs

This theoretical approach has to be transferred into practical calculations using transport models. Vermeulen (2004, p. 90) states that "in theory, the best method for computing external congestion costs proceeds from a dynamic model. First, an appropriate hypothetical charge level is set, based on the external congestion costs calculated from time-valued vehicle hours lost, using a speed-flow model for the purpose. Next, the effect of introducing this charge on traffic flow and vehicle hours lost is analysed. The result is then fed back into the model to compute a new optimum charge level, with this iterative procedure being continued until equilibrium is achieved."

There is a scientific consensus on the basic approach valuing mainly the value of time based on speed flow characteristics (road transport) and opportunity cost approaches for scarce tracks (rail) (Van Essen et al 2007, p11). However, in practice the difference between proposed values is quite huge, depending on differentiation and traffic characteristics (e.g. corridors, lanes, cordons, etc.). HEATCO (Bickel et al. 2006) recommends using the above mentioned values of time that are modified accordingly:

- Road congestion: 1.5 times the value of time
- Public transport overcrowding: 1.5 times travel time value
- Public transport congestion: Value for waiting time (= 2.5 times travel time value)
- Reliability ratio[10]: 0.8 - 1.4

Presently, in maritime transport major capacity constraints are given, especially in container traffic. These are infrastructure bottlenecks occurring in a rapidly growing market and not externalities. Presently, the state of research does not allow for a quantification of these costs. This is particularly difficult, since harbour charges are in most instance not covering costs.

[10] Standard Deviation of one minute travel time

4.5. Concluding Overview on Cost Components

Table 7 gives an overview on the above discussion. The table the cost components and their relevance for the Full Cost and the Efficiency Approach. While all cost components with the exception of congestion costs are relevant for the Equity Approach, time costs, the air pollution and climate change costs and congestion costs are mostly relevant for the Efficiency approach..

Table 7: Overview cost components and approaches

	Equity Approach	Efficiency Approach
Vehicle Operating Costs	relevant	partly relevant
Time Costs	relevant	marginal costs above average costs
Infrastructure Costs		
Capital costs	relevant	not relevant
Costs for maintenance and operation	relevant	partly relevant
External Costs		
Air Pollution	marginal costs = average costs	
Climate Change	marginal costs = average costs	
Noise Costs	relevant	marginal = average costs (second best solution)
Accident Costs	relevant	marginal = average costs adjusted by the internalised value per se
Congestion Costs	not external => not relevant	relevant, using the dead weight loss approach

Another question arises, which of the above cost components are relevant if the modes are taken into account. Resource and infrastructure costs are unproblematic, but the external costs are only partly relevant. This issue is visualised in Table 8. Airborne emissions on international transports are only partly taken into account, that is to say only the share which is emitted inside the research boundaries. For inland water and maritime transports accidents are mainly occupational accidents and thus can be considered as internal. Risk externalities of air transport are neglected due to the small number of incidents. Congestion costs for air and water transport are existent, since infrastructures are scarce and bottlenecks occur. A valuation would be possible using the values derived from auctioning of slots.

Table 8: Relevance of external cost components for the modes

	Road	Rail	Air	IWW/Maritime
Accidents	relevant	relevant	negligible	occupational accidents are entirely internal.
Air pollution	relevant	relevant	only emissions inside boundaries are relevant	relevant
Climate change	relevant	relevant		relevant
Noise	relevant	relevant	relevant	negligible
Congestion	relevant	overcrowding	relevant, but currently not quantifiable	relevant, but currently not quantifiable

5. Taxes, Charges and Subsidies

5.1. Taxes and Charges

The Green Paper on "Fair and Efficient Pricing" (EC 1995) and the White Paper "Fair Payment for Infrastructure Use" mentions the following main principles regarding internalisation of costs:

- Charges should be directly related to the social costs that users impose on the infrastructure and on others, including the environmental and other external impacts caused by the users
- Charges should be linked as closely as possible to the underlying costs
- Charges should be highly differentiated, and behavioural adjustment to reduce externalities should be rewarded in the form.

These principles cause major inconsistencies, since some taxes, such as VAT have the only purpose to collect state revenues and include no allocative function. VAT is a general tax levied on all consumer goods and services.

The above argument suggests that REFIT should concentrate only on the relevant taxes and charges that are designed to internalise external costs. The following example underlines this proposal: Let us assume that environmental costs caused by airborne transport emissions in the Country C are considerably high. However, a high level of undifferentiated vehicle registration fees compensates for these costs. Since the tax is designed entirely to increase state revenues, it gives no economic incentives to reduce emissions and thus has no guidance effect. Even though the LoI of C might be close to one, the economic incentives are missing and a real internalisation of the costs is not achieved. A major problem arises if C's decision makers and politicians are exclusively observing the LoI and regard a value close to one as a situation, where no policy changes are necessary. This simplistic view might prevent an important change in the environmental charging system.

The OECD[11] has published European data on transport taxes, charges and subsidies that focus on environmental improvements. The data collection is given in the Annex of this report. The overall value from environmental taxation amounts to 1.5% to 2% in Europe, reaching maximum rates of up to 15% of GDP. The taxation comprises between 3% and 16% of total tax revenue.

However, some serious arguments can be quoted against the above proposal to include only these taxes relevant for internalisation: Taxes cannot be easily selected according to their purpose, since no matter what the political will or rhetoric might be, the effect of the charges and subsidies is relevant from the economic point of view. For example, a tax on fuel oil introduced for purely fiscal reasons will have the same environmental impact as a tax on fuel oil introduced to combat CO_2 emissions to the extent that the tax leads to similar changes in the prices of relevant tax-bases. Additionally, it is often difficult to determine what the purpose of a particular levy is. Many levies are introduced with several purposes in mind, and some-

[11] http://www2.oecd.org/ecoinst/queries/index.htm

times new purposes are added to existing levies. In some cases, the 'real' purpose of a levy might be different from what is publicly stated.

To overcome these scientific contradictions, a differentiated approach for the Equity and Efficiency Approach is recommended, which follows the methodology developed by FACORA (2004):

- If the Equity Approach is regarded, the full charges have to be included. The consequence is that all taxes and subsidies have to be included, in order to calculate the total cost coverage of the researched transport segment or mode. This approach is very comprehensive and reflects the overall macroeconomic approach towards transport pricing.
- For the Efficiency Approach only the variable costs have to be included, that influence the traffic behaviour of actors in transport. Thus, this approach only takes into account the taxes and subsidies that influence the short run marginal costs.
- VAT and Fuel Levies are regarded as general revenues of the state that cannot be entirely attributed to the transport sector. As a compromise, only 50% of these revenues are taken into account for internalisation when the Equity LoI is calculated. For the Efficiency LoI both levies are entirely included.

Table 9 gives an overview on the relevant taxes and charges in the transport sector as conceived by REFIT.

The question arises how exemptions should be dealt with, since they could be regarded as a subsidy. However, since the calculation procedures encompass all cost components, the LoI will reflect tax exemptions as well and thus there is no need for additional calculations.

Table 9: Overview on main taxes and charges in the transport sector

Tax/Charge	Relevance for Equity Approach	Relevance for Efficiency Approach
Road Transport		
Annual circulation tax	yes	no
Vehicle Purchase Tax	yes	no
Vehicle Registration Fees	yes	no
Fuel Excise Duties*	50%	yes
VAT on Fuel*	50%	yes
Vehicle sales tax	yes	no
Vat on vehicle sale*	50%	no
Vat on maintenance/repair*	50%	no
Tax on insurance	yes	no
Vignettes	yes	no
Road/Bridge/Tunnel Tolls	yes	yes
Motorway Charges	yes	yes
Parking Fees	yes	yes
Urban Congestion Charges (Cordon Pricing)	yes	yes
Rail Transport		
Infrastructure Charges	yes	yes
Diesel Excise Duty	yes	yes
Electricity Tax	yes	yes
VAT on Fuel and Electricity*	50%	yes
Service Charges (shunting, gauge change etc.)	yes	yes
Aviation		
LTO Charge	yes	yes
En-Route Charge**	yes	yes
Air Traffic Control Charges	yes	yes
Noise Surcharges	yes	yes
Emission Charges	yes	yes
Fuel Excise Duties*	50%	yes
IWW/Shipping		
Harbour Dues	yes	yes
Dues For Locks And Bridges	yes	yes
Fuel Excise Duties*	50%	yes
Other Transport Service Providers		
Charges for Car Rentals	yes	yes
Charges for Hauliers and Carriers	yes	yes
Charges for Taxies and Buses	yes	yes
VAT on Public Transport Fares*	50%	yes

* Only accountable charges are included as determined by FACORA 2004. For explanation, please refer to the paragraph below this table
** Charge for Air Navigation Services, telecommunications services, rescue services, weather information services and briefing, Sweden.

Since data on taxes and charges in the models used by REFIT are not covering all modes, as will be shown later in the text, an indication on the magnitude of the taxes and charges in the transport sector is given. Table 10 gives an overview of the state revenues as presented by the research project FACORA. The project distinguishes between total and accountable revenues, where the latter includes only 50% of fuel excise duty. The reasoning is that the fuel duty can be regarded as general state revenue and not a specific transport charge.

Table 10: State Revenues from Transport

Mill €	AT	FR	DE	IT	NL	SE	CH	UK	Total
Total Revenues									
Road	4,319	27,870	37,151	29,340	9,429	4,320	4,290	38,529	**155,248**
Rail	260	987	4,817	0	155	98	774	3,439	**10,530**
Air	454	2,804	3,936	1,007	225	320	810	1,347	**10,903**
Water	20	76	85		221				**402**
Accountable Revenues *									
Road	1,799	13,527	14,903	10,318	2,611	1,459	3,265	15,943	**63,823**
Rail	258	967	4,692	0	155	89	774	3,439	**10,374**
Air	429	2,804	3,888	995	224	303	810	1,347	**10,800**
Water	20	76	85	0	221	0	0	0	**402**
* Infrastructure user charges + 50% of fuel excise duty									
Source: FACORA 2004, p.47									

5.2. Subsidies

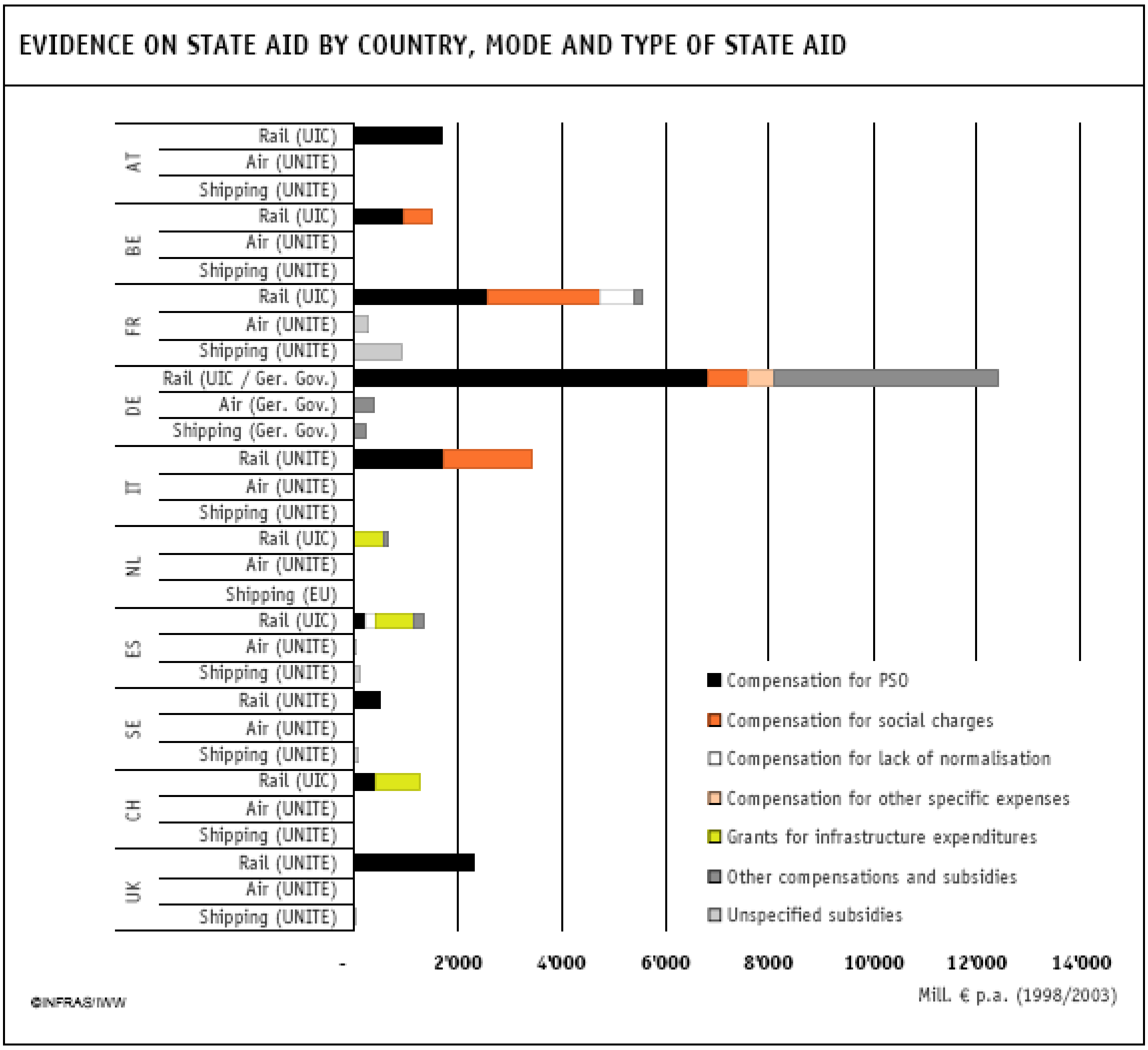
In literature, subsidies are defined as payments by public institutions to individuals or companies, for which the state or other institutions receive no goods or service in return. FACORA (2004 p.68) classifies subsidies as follows:

1. Real subsidies in form of state aids, loans and debt relief.
2. Compensation payments for Public Service Obligations (PSO).
3. Cross-financing from extended business areas to the core business within public transport. For example, services are cross subsidised in order to keep passenger fees attractive.
4. Other subsidies.

In the scientific discussion it is controversial which transfers to public transport enterprises have to be taken into account. The dissent is on the question whether Public Service Obligations (PSO) are subsidies or not. PSO is a government requirement for an operator to undertake services, often with tariff controls, which would not be operated under the same conditions if the operator were acting in his own commercial interests. The framework of Public Service Obligations for transport services was established in Council Regulation EEC/1191/69. The framework requires operators to be adequately compensated for the obligation, thereby defining a category of public budget contribution permitted under EU law. The regulation was revised by 1893/91 so that the PSO must be arranged by contract, and that there must be accounting separation between PSO services and commercial services. These payments may be viewed as subsidies to transport users, but are usually viewed instead as payments for PSO, which provide a real value of service for the money.

A similar argument is valid for Concessionary Fares CF, such as reduced fares for school pupils and handicapped. The first payments are done since education is regarded as a merit good which should be subsidised. The latter payments are for social purposes to enable disadvantaged social groups to participate in transport. Since both payments do not have the purpose to subsidise the public transport sector as such, concessionary fares are not considered as subsidies within REFIT.

Consequently, REFIT considers Public Service Obligations and Concessionary Fares not as general subsidies and thus does not include both in the LoI calculation. However, since the PSO and CF payments are part of the revenues of public service providers, they have to be treated in the same manner as transport fares[12]. Both assumptions for PSO and concessionary fares have considerable impacts on the LoI.



Source: FACORA 2004

Figure 14: State Aid to the transport sectors in European Countries 2003

Table 11 shows a classification of the subsidies according to mode and incidence. The annex lists subsidies in Europe spent for environmental improvements.

The question arises which subsidies have to be included. Van Essen et al (2007) take no account of subsidies and tax exemptions in the Efficiency Approach, "as the aim of this variant is to establish whether, and to what degree, incentives arising through variable charges and tax schemes balance the variable … costs. In this connection, it is not always clear whether subsidies and tax exemptions are keyed to variable costs or are also partly compensation for fixed costs." Since the variable character of subsidies cannot be assessed, it is more often

[12] Following the above example it can be argued, that the school child pays only part of the ticket price and the remaining amount is compensated by the state. For administrative reasons the compensation payments are done to the service provider and not to the pupil. Thus they are part of Private Costs.

than not unclear whether subsidies are eligible to be used in the Efficiency Approach. Only further research can reveal the character of each and every subsidy in the EU. Before this is achieved, REFIT can only include subsidies in the Equity Approach and has to disregard them in the Efficiency Approach.

Another issue is uncovered infrastructure costs, which are generally regarded as subsidies (Nash 2002, p6ff). If the Equity Approach is chosen the LoI will reveal the uncovered infrastructure costs. Thus, they have not to be included as separate item in the formula.

Table 11. Classification of transport subsidies by mode and incidence

Incidence	Mode								
	Road			Rail		Water		Air	
	Car and Motorcycle	Bus and Taxi	LDV and HDV	Passenger train	Freight train	Maritime shipping	Inland shipping	Passenger planes	Air freight
Infrastructure	• Net public spending (i.e. payments exceeding revenues of user charges for road infrastructure) • Subsidies for road construction and management companies			• Net public spending on rail infrastructure • Subsidies for rail track companies		• Net public spending for waterways, harbours (incl. access) and other shipping infrastructure		• Net public spending for airports (including access) and air traffic control	
Means/Vehicles	• Subsidies for road vehicles (i.e. to vehicle production, distribution use and disposal) and related services (e.g. repair)			• Subsidies for production, distribution, use and disposal of railway cars and locomotives		• Subsidies for production, distribution, use and disposal of ships and vessels		• Subsidies for production, distribution, use and disposal of airplanes	
Users	• Subsidies for road transport services (taxi, bus, freight transport) and for user of vehicles (i.e. purchase privileges, depreciation, tax-deductible amount for vehicles, etc.)			• Subsidies to railway companies • Public transfers (in cash or in kind) to rail users (e.g. cheaper train tickets)		• Subsidies to shippers and hauliers		• Subsidies to airlines and their services (reduced VAT on tickets, duty free shopping, etc.)	
Fuel	• Subsidies for production, distribution and use of fuels (e.g. biofuels, agro-diesel, CNG, etc.) • Mineral-oil tax reduction			• Subsidies for electricity and diesel for railway cars and locomotives (e.g. reduced taxes)		• Subsidies for shipping fuels (e.g. no mineral oil tax for maritime and inland shipping)		• Subsidies for aviation fuels (no mineral-oil tax on kerosene and avgas (for commercial use)	
Other	• Distance-oriented income tax reduction, etc.		• Subsidies for settlement, trade, distribution, etc.	• Reduced income tax for commuters	• Subsidies for bulk industries	• Export grants, etc.	• Subsidies for bulk industries		• Export grants

Source: Becker et al. (2005)

6. Data Needs and Availability

6.1. Specification of Inputs

The inputs needed for the calculation of the LoI are listed in Table 12. Data are given per annum and mode and are confined to the assessment area, which varies according to the question researched: e.g. country, region, town, etc. Thus cost figures for taxes and subsidies, which are generated on a national level, have to be confined to the assessment area.

Table 12: Inputs for LoI calculation for the road mode

	Unit	Inputs for the Assessment Area by Mode and Year
Modes		Pass Cars, Buses, MC, HGV, LGV
Transport Volume	pkm, tkm, vehicle km	Transport volume generated by the models
Resource Costs : Value of Time	hours/ tonne hours	Passenger-business, Commercial goods traffic (Driver), Non business: Commute-Short Distance, Commute-Long Distance, other-Short Distance, other-Long Distance, Freight Time
Resource Costs : Vehicle Operating Costs	Euro	Fixed Costs: Depreciation (time dependant share), interest on capital. repair and maintenance costs, materials costs, insurance, overheads, administration, others Variable Costs: Personnel costs, depreciation (distance related share),Fuel and lubricants, other
Taxes and Charges	Euro	Fuel excise duty, VAT on Fuel, VAT on maintenance/repair, VAT on vehicle sale, Congestion Charges (Urban), Motorway Charges, Parking Fees, Road/Bridge/Tunnel Tolls, Tax on insurance, Vehicle Purchase Tax, Vehicle Registration Fees, Vehicle sales tax, Vignettes, other Taxes and Charges
Infrastructure Costs	Euro	Construction, land purchase, fixed and variable maintenance and operation costs, Cycle Lanes/Parking Space, other costs
Subsidies	Euro	Subsidies attributed to the transport in the assessment area
External Costs		
Accidents	Number	Accidents, fatalities, severe, slight injuries
Air pollution	tonnes	Emissions of NOx, NMVOC, SO_2, PM2.5 urban, PM2.5 rural
Climate change	tonnes	Emissions of CO_2
Noise	Number	Inhabitants exposed to transport noise by noise classes (L_{den} db(A))
Congestion	hours	Hours delay due to congestion using the dead weight loss approach.

6.2. Data availability

This chapter analyses which data are presently available in the transport models TREMOVE, TRANS-TOOLS and CG Europe. Table 14 gives an overview of the data availability.

Taxes and Charges
TREMOVE has the largest availability of data regarding taxes and charges. Costs comprise annual circulation tax, vehicle purchase tax, vehicle registration fees, fuel excise duty, VAT on vehicle purchase, VAT on maintenance/repair, tax on insurance, vignettes, road tolls and VAT on public transport fares. Information of the road modes is fairly differentiated according to vehicle types using classes for the cubic capacities. Presently, information on taxes and charges of HGV is missing, but the next model generation will include as well information on taxes and charges for trucks. Table 13 list specific charges that are designed to internalise external effects.

However, data confine to road modes only, rail, air and inland waterways are missing. The other models make no contribution to taxes and charges.

Table 13: Specific charges designed to reduce external effects included in TREMOVE

Name of Charge	Differentiation	Mode	Country
Road user charges	Euro Emission Class	Road	AU, DK
Fuel Excise Duty reduction	Low sulphur diesel	Road Freight	BE, DK, Fin, NL, UK
Eurovignette	Euro class (emissions)	Road Freight	NL, BE, Lu, DK, S
Fuel Excise Duty reduction	Low-sulphur petrol and diesel	Road Freight	D
Fuel Excise Duty reduction	Low sulphur diesel	Road Pass	BE, AU, NL, S
Reduction on purchase tax	Euro IV petrol and diesel cars	Road Pass	NL
Annual circulation taxes	less pollutant passenger cars	Road Pass	E
Five years annual vehicle tax deduction	Cleanest vehicles	Road Pass	S
Purchase tax	dependent on fuel consumption/CO2 and price	Road Pass	AU
Annual vehicle tax	dependent on fuel consumption/CO2	Road Pass	DK
Annual vehicle charges	Euro class (emissions and noise)	Road Pass	D

Subsidies
TREMOVE contains subsidies for the railway and partly for the road sector in Europe. The models have been developed in a manner, that other subsidies can be easily included.

Vehicle Operating Costs and Value of Time
The Vehicle Operating Costs and Value of Time are included in the TREMOVE and TRANS-TOOLS models. Currently, data for 21 European countries are available through TREMOVE, but the new model version will include 31 countries. Data comprise journey time and waiting time. Cost components include costs for vehicle purchase, variable costs (e.g. fuel, tyres), regular vehicle maintenance, vehicle insurance, time costs and other costs. Wages are presently not included, but will be implemented in the next model version for

freight vehicle drivers. Wages for bus drivers are not scheduled at this moment. Resource costs for rail, air and inland waterways are presently not part of the models.

Infrastructure Costs
Infrastructure costs are included for railways only in TREMOVE.

Air Pollution and Climate Change
Both TREMOVE and TRANS-TOOLS generate differentiated data sets on airborne emissions from all transport modes, including passenger and freight transport on roads and rails, air transport, inland waterways and short sea shipping. Data are available in terms of energy consumption, quantity of emissions and environmental cost figures. The emissions include CO_2, NO_x, NMVOC, SO_2 and PM10. TREMOVE makes not only well-to-tank data available but includes as well tank-to-wheel emissions. In the models mainly the outputs of the network assignments are used for calculating the external impacts. To conclude, the data situation for air pollution is quite satisfying for all modes and types of emissions.

Accident Costs
TRANS-TOOLS generates accident costs of road and rail fatalities. Presently, injuries are not included in the models. However, it is planned during the REFIT project to develop a module that estimates accident costs more in depth. It is recommended to confine this module to road and rail, since external cost for the remaining modes are negligible. This is due to the small number of accidents and the fact that most of the costs can be regarded as internalised.

Noise Costs
It is planned to develop a noise evaluation module during the REFIT project. Presently noise costs can be partly assessed for all modes.

Congestion Costs
Congestion costs can be derived from the TREMOVE model for road transport. This is done through speed-flow-relationships which are endogenous in the model and vary by road type. Resulting travel times and time costs are generated by trip purpose, type of good, peak/off-peak period and region. Congestion costs for other modes than road, e.g. low comfort in trains during peak hours or delays of planes are not disclosed separately.

Data on Countries
Currently, data for 21 European countries are available, but the new TREMOVE model version will include 31 countries.

Differentiation
The existent datasets are differentiated according to metropolitan, other urban and non-urban areas. Another differentiation is given by road types according to motorways, interurban roads and urban roads. The data are differentiated by day time which include peak and off peak traffic situations.

Marginal vs. Average Costs
The given data are given as average values, using the above differentiation according to road types, temporal and spatial disaggregation. Thus, the values given are not marginal in the strict sense, but rather specific average values.

Table 14: Data availability in the TREMOVE and TRANSTOOLS

Mode	Taxes & Charges	Subsidies	VOC and Value of Time	Infrastructure Costs	Accidents	Noise	Air Pollution and Climate Change	Congestion
Road	HGV		HGV		Inj.			
Rail					Inj.			
Air								
IWW								
	Available	Planned	No data	not relevant				

To conclude, the data situation is fairly comprehensive for the road and rail sector. Some gaps, such as costs for HGVs, for injuries and for noise disturbance will be filled soon. However, data are – with the exception of railways - incomplete for subsidies and for infrastructure costs. Data availability for air and inland waterways is piecemeal with the exception of air pollution and climate change costs, which can be generated for all modes. This gap cannot be filled during the REFIT project and will thus limit the scope of the LoI to road and rail.

Some of the above data gaps in the models might be filled, using the data given in the past research projects. A number of tables have been compiled and are listed in the Annex of this paper. However, some reservations about the quality of the data may still prevail. Many of the data used are collected from individual country sources, which might not be as compatible as desired. This entails certain insecurities regarding the inter-county comparison of the REFIT results, which consequently have to be interpreted with caution.

Further data needs

If the LoI indicator is to be used in the future for comprehensive policy assessments, additional data need to be provided. Table 15 lists the data gaps that have been assessed in the preceding chapters and are needed to calculate the LoI to answer the questions put by decision makers.

Table 15: Data needs for LoI calculation

Type of data	Modes
Taxes & Charges	Air, IWW
Subsidies	Partly Road, Air, IWW
Resource costs	Air, IWW
Infrastructure Costs	Road, Air, IWW
Accidents	-
Noise Costs	-
Air Pollution	-
Climate Change	-
Congestion/overcrowding	Rail, Air

6.3 Calculation method used

With the above given restrictions regarding data availability in the models, the LoI could not be exactly calculated using the theoretical methodology developed in Chapter 3. A number of changes had to be done.

Most importantly, the Level of Internalisation is presented on the country level without any further differentiation. The argument given in Chapter 3 show, that in this case only the Equity Approach using average values is relevant. The Efficiency Approach would be used for selected case studies or a highly differentiated analysis. Presently, due to data constraints, the LoI is calculated for 19 European Countries.

The calculation of the LoI requires the input of infrastructure costs. However, data availability on infrastructure costs in the roads sector is very limited, and repeatedly data are missing. Not including infrastructure costs in the calculation reduces the level of internalisation, as the infrastructure costs are an important component in the denominator. For this purpose, data on infrastructure costs were retrieved from the Deliverable 2 of the IMPACT study. They were compared to an extensive study in Germany conducted by ProgTrans and IWW 2007.

Subsidies for railways are included, but only partly for the road modes. This entails a slight distortion of the picture, if the LoI of both modes are compared: values for road modes are higher than they would be including subsidies.

The selection of relevant taxes and charges is crucial for the outcome of the Level of Internalisation. Especially the question on the inclusion of VAT and Fuel Excise Duties is discussed in Chapter 5.1. The reasoning is that both can be regarded as general state revenue and not a specific transport charge. However, since this view is not undisputed, three variants of the LoI are calculated:

LoI(H):	High Variant	Excluding VAT and fuel taxes
LoI(L):	Low Variant	Including VAT and fuel taxes
LoI(M):	Medium Variant	VAT and Fuel Tax will be accounted at 50%

Ideally, the LoI(M) should include only a share of VAT and Fuel Excise Duties that is redistributed to the transport sector. However, this is not possible due to the following reasons:

i. Usually state revenues from VAT and Fuel Tax are not earmarked, and thus a pre-defined allocation of the revenues for household budget lines is not given. This means that the share of revenues to be spent on transport is often not defined by the governments.
ii. Fuel Taxes and VAT are general contributions to the state budget. If a revenue/expenditure ratio shall be estimated, the households for each EU country would have to be analysed. For this purpose a model for public households would be needed.
iii. It is still questionable, which cost items would have to be included in the above estimation
iv. Central transport budget, state transport budgets, local transport budgets, maintenance expenditures, new construction, costs according to modes, open and hidden subsidies, traffic police, etc.

Consequently, the Medium Variant LoI (M) was calculated using 50% of VAT and Fuels Excise Duties. By the termination of this deliverable, the IMPACT scenario calculations were not at a stage that would allow for an exemplary calculation of the Level of Internalisation. Results will be presented in Deliverable 6.3.

7. Summary

Theoretical Deliberations

The main goal of this REFIT Workpackage WP 3.3 is to develop a methodology on how to assess transport policies regarding their contribution to the objective of fair pricing. The indicator "Level of Internalisation of Externalities" (LoI) is the degree, to which external costs have been internalised according to the polluter pays principle. For this purpose REFIT uses the combination of the TRANS-TOOLS, TREMOVE and CGEurope models to compute the LoI.

For the development of the LoI a number of theoretical and methodological problems have to be solved or clarified and major assumptions to be taken. Some of the assumptions have considerable impact on the outcome of the LoI. Table 16 summarises the major approaches and critical assumptions made in this deliverable.

The most important methodological issue relates to the scientific discussion on marginal social cost pricing, which took place in the last years. As a consequence, two relevant approaches can be identified for REFIT:

i. The Equity Cost Approach, based on a full cost assessment, assesses if overall costs are covered by revenues. It takes into account all cost components.
ii. The Efficiency Approach, based on the marginal social cost pricing principle, assesses if pricing of specific transport situations on a given time and location is efficient, i.e. if marginal revenues cover marginal costs. For this approach only variable cost components are relevant.

Both approaches have their proper rational and scientific justification and thus have to be included in the research. Ad i) The Equity LoI assesses macro economic effects of pricing policies, especially the question of cost coverage. While this approach poses little theoretical problems, the availability of data is the main constraint. The Equity LoI includes the following cost components: Vehicle Operating Costs, Value of Time, Infrastructure Costs, External Costs (Air Pollution, Climate Change, Noise, Accidents, and Congestion Costs) Taxes, Charges and Subsidies.

Ad ii) The Efficiency Approach is more focussed on optimisation of social welfare than on cost recovery. The marginal pricing approach entails, that merely these costs are included that vary with vehicle usage. This requires more in depth theoretical deliberations, especially regarding the question which cost components are relevant. The Efficiency LoI includes only a subset of these costs and revenues, i.e. marginal components that are directly related to transport volume: While only a small share of the infrastructure costs are relevant, variable components such as fuel costs and external air pollutant costs can be entirely included.

Table 16: Major approaches and critical assumptions (further explanation see text)

Item	Equity Approach	Efficiency Approach
General Approach	Relevant for budgeting and macro assessments: based on a full cost assessment; assesses if overall costs are covered by revenues.	Relevant for pricing of specific transport situations: based on the marginal social cost pricing principle; assesses if pricing of specific transport situations on a given time and location is efficient
Resource and Infrastructure Costs		
Vehicle Operating Costs	No major assumptions	Only variable components are relevant
Value of Time		Marginal costs equal specific average costs
Capital costs		Not relevant, since costs are fixed
Infrastructure maintenance & operation		Only variable components are relevant
External Costs		
Air Pollution	No major assumptions	Marginal costs equal specific average costs (second best solution)
Climate Change		
Noise Costs		
Accident Costs		Marginal = average costs adjusted by the internalised value per se
Congestion Costs	Congestion is not external (p.37) => not relevant	Relevant, using the dead weight loss approach
Taxes and Subsidies		
Taxes and Charges	All taxes and charges are included	Only variable taxes and charges are taken into account
Value Added Taxes	VAT is a general tax and is taken 50% into account	VAT is taken 100% into account
Fuel Excise Duties	Fuel levies are general taxes and taken 50% into account	Fuel taxes are taken 100% into account
Subsidies	All subsidies are included	Not included, since the variable character of subsidies cannot be assessed in practice.
Public Service Obligations	Public Service Obligations are compensation payments for services ordered by the state and are thus not subsidies.	
Concessionary Fares	Concessionary fares are social services provided by the state for selected social groups and not subsidies.	

The quantification of marginal costs poses some problems, which can only be solved by using second best approaches. For instance marginal noise costs exist, but are difficult to quantify due to restrictions in the underlying modelling framework. Consequently, the marginal costs for time, air pollution, climate change and noise are approximated by using specific average cost figures. This is done as well for marginal accident costs, but additionally the internalised value per se is deducted. Congestion is a special case, since it cannot be regarded as an externality if the Equity Approach is taken. Out of equity reasons it would be unjust to levy an undifferentiated congestion charge. This holds not true for the Efficiency Approach, since the individual behaviour of the user determines the efficiency of the transport system and a differentiated charge would change the situation. Consequently, only the Efficiency Approach includes congestion costs.

For taxes, charges and subsidies similar questions arise, namely which components are relevant for internalisation. There are major scientific disagreements on this issue, since some taxes, such as Value Added Tax (VAT) have the only purpose to collect state revenues and include no (intended) allocative function. VAT is a general tax levied on all consumer goods and services. This implies that taxes would have to be selected according to their purpose. However, the purpose cannot always easily be identified and, additionally, no matter what the political will or rhetoric might be, the effect of the charges and subsidies is relevant. For example, a tax on fuel oil introduced for purely fiscal reasons will have the same environmental impact as a tax on fuel oil introduced to combat CO_2 emissions to the extent that the tax leads to similar changes in the prices of relevant tax-bases.

To overcome this dilemma, REFIT developed a differentiated approach (see Table 9 on page 43): While the Equity Approach includes all components, the Efficiency Approach only encompasses the marginal taxes and charges. VAT and fuel levy are exceptions, since they can be regarded as general state revenues and not specific transport charges. Therefore, both are taken into account in the Equity Approach with only 50%, but with 100% in the Efficiency Approach. This is a strong assumption that influences the results of the LoI considerably.

The question of subsidies poses another scientific problem. It is obvious, that they should be entirely included in both approaches. However, the distinction of fixed and variable components is in practice often not possible. For example, how should annual lump sum payments to railways be treated? Their character would only be variable, if the amount changed annually with the transport volume. In practice, the amounts of lump sum subsidies are political decisions that do not relate directly to transport volumes. Only further research can reveal the character of each and every subsidy in the EU. To overcome this dilemma, REFIT follows the approach of Van Essen et al (2007) and does not include subsidies in the Efficiency Approach. However, subsidies are entirely included in the Equity Approach.

In the scientific discussion a dissent exists on the question whether Public Service Obligations (PSO) are subsidies or not. PSO are government requirements for operators to undertake services, often with tariff controls, which would not be operated under the same conditions if the operator was acting in his own commercial interests. In literature, subsidies are defined as payments by public institutions to individuals or companies, for which the state or other institutions receive no goods or service in return. Since this is not the case for PSO, REFIT does not consider them as subsidies.

A similar argument is valid for concessionary fares, such as reduced fares for school pupils and handicapped. The first payments are done since education is regarded as a merit good which should be subsidised. The latter payments are for social purposes to enable disadvantaged social groups to participate in transport. Since both payments do not have the purpose to subsidise the public transport sector as such, concessionary fares are not considered as subsidies within REFIT. Both assumptions for PSO and concessionary fares have considerable impacts on the LoI.

Practical Calculation

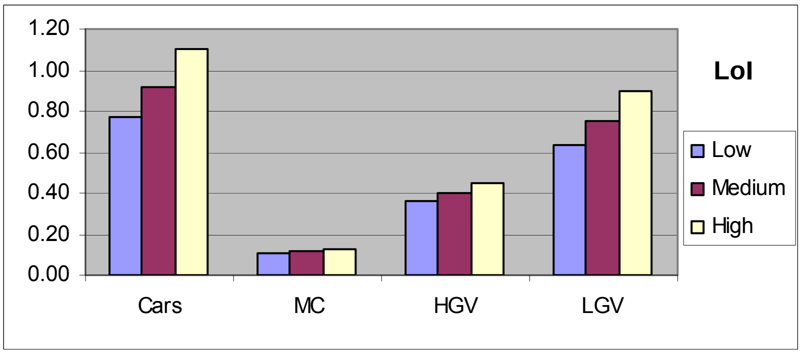
REFIT uses the scenarios compiled by the IMPACT project to calculate exemplary Levels of Internalisation. By the termination of this Deliverable 3.3, the scenario calculations were not at a stage that would allow for an exemplary interpretation of the Level of Internalisation. It was decided, to calculate the LoI on the country level without any further differentiation. Therefore, the Equity Approach using total and average values is relevant.

The selection of relevant taxes and charges is crucial for the outcome of the Level of Internalisation. Especially the question on the inclusion of VAT and Fuel Excise Duties is crucial for the outcome of the LoI. The reasoning is that both can be regarded as general state revenue and not specific transport charges. However, since this view is not undisputed, three variants of the LoI are calculated:

LoI(H):	High Variant	Excluding VAT and fuel taxes
LoI(L):	Low Variant	Including VAT and fuel taxes
LoI(M):	Medium Variant	VAT and Fuel Tax will be accounted at 50%

Figure 15 demonstrates the effects, which the LoI Variants have on the outcome of the LoI. The graph shows the results of provisional calculations using the results of the IMPACT scenarios. Since the data are still to be refined during the course of the project, the absolute levels of the LoI should be disregarded. However, the relative changes, generated through the Variants deliver important information. The left column represents the LoI if no VAT and Fuels Tax are included; the right one is including 100%. For cars, the Low Variant is clearly below one, while the high variant is above one. In the latter case, all external effects would have been internalised[13]. Therefore, it is one of the most crucial assumptions for the LoI, to which degree VAT and Fuel Excises Duty are taken into account. REFIT favours a Medium Variant, that -similar to FACORA –includes half of both taxes.

Figure 15: Impacts of the inclusion of VAT and Fuel Taxes on the LoI



The above theoretical deliberations are confined by practical calculation problems. These relate mainly to data availability. A survey revealed that the data inputs in the models TREMVOE and TRANS-TOOLS are fairly comprehensive for the road and rail sectors. Data for external costs of air pollution, noise, climate change and accidents can be generated for all modes. However, data availability for other modes than road and rail is piecemeal. With the exception of railways, data on subsidies and infrastructure costs are incomplete or missing entirely. Some of the data gaps in the models can be filled, using data generated in past research projects, such as UNITE and FACORA.

[13] Assuming that the IMPACT calculations are correct at this stage of the project.

Another uncertainty relates to the fact, that data are collected from individual country sources, which might not be as compatible as desired. Even though the best available data are provided, certain reservations prevail regarding the inter-county comparison of the REFIT results. Therefore, taking as well into account the assumptions and methodological problems related to the LoI, it is strongly recommended to use the LoI for comparative purposes, as specified below, rather than as an absolute benchmark on the country level. The latter would imply that all necessary data are available and that all assumptions taken are political and scientific consensus, which might not be the case.

Instead of using the LoI as an absolute indicator, it is recommended as a relative measure, which quantifies the changes when applying different policy options. Consequently, the LoI should be used to compare scenarios of investment or policy options or conduct before/after assessments. This is less problematic, since the same assumptions are taken for all scenarios, and only the change of the LoI is the lesson to be learned by policy makers. The LoI might serve as well for inter-country or inter-modal comparison. However in this case, sensitivity calculations should be done, which reveal the effects of the major assumptions described above.

To resume, the LoI is a powerful tool for assessing transport policies, since it concentrates a vast quantity of information in a single indicator. However, the interpretation should be done with caution, taking into account that powerful assumptions had to be taken to generate the LoI.

8. References

Abegg, Peter et al (2004): Study of The Financing of and Public Budget Contributions to Railways, A Final Report for European Commission, DG TREN, Prepared by NERA, January 2004, London

Adler, N et al (2003). Marginal Cost Pricing Implementation Paths to Setting Rail, Air and Water Transport Charges. MC-ICAM Deliverable 5.

Afford (2001):Acceptability of Fiscal and Financial Measures and Organisational Requirements for Demand Management, Final Report For Publication, Project N° : PL97-2258,

Becker, Udo et al (2005): The Use of Subsidies, Taxes and Charges in the EU Transport Sectors, Dresden

Bickel, P., Friedrich, R., Burgess, A., Fagiani, P., Hunt, A., De Jong, G., Laird, J., Lieb, Chr., Lindberg, G., Mackie, P., Navrud, S., Odgaard, T., Ricci, A., Shires, J., Tavasszy, L.(2006): Proposal for Harmonised Guidelines. HEATCO (Developing Harmonised European Approaches for Transport Costing and Project Assessment) Deliverable 5. Institut für Energiewirtschaft und Rationelle Energieanwendung, Universität Stuttgart. http://heatco.ier.uni-stuttgart.de/HEATCO_D5.pdf

Bickel, P., Sieber, N. Kummer, U. (2006): GRACE (Generalisation of Research on Accounts and Cost Estimation), Input to Deliverable D 4, Marginal environmental cost case studies for air and water transport. Funded by Sixth Framework Programme, IER, Universität Stuttgart, Stuttgart, September

Bickel, P., Sieber, N., Arampatzis, G., Esposito, R., Fagiani, P., Hunt, A., Kelly, Ch., Laird, J., Odgaard, T., Ricci, A. (2006b): Case Study Results. HEATCO (Developing Harmonised European Approaches for Transport Costing and Project Assessment) Deliverable 6. Institut für Energiewirtschaft und Rationelle Energieanwendung, Universität Stuttgart. http://heatco.ier.uni-stuttgart.de/HEATCO_D6.pdf

Chen, T.M., et al. (2005). Deliverable 3: Report on model specification and calibration results TRANS-TOOLS (TOOLS for TRansport forecasting ANd Scenario testing) Deliverable3. Funded by 6th Framework RTD Programme. TNO Inro, Delft, Netherlands.

COWI (2002): Fiscal measures to reduce CO2 emissions from new passenger cars, a report for the Environment DG, European Commission, Brussels.

De Ceuster G. et al (2005): ASSESS Assessment of the contribution of the TEN and other transport policy measures to the midterm implementation of the White Paper on the European Transport Policy for 2010, Final Report, DG TREN, European Commission, Leuven.

Doll, Claus et al (2002): Transport User Cost and Benefit Case Studies, UNITE Deliverable 7, Unification of accounts and marginal costs for transport efficiency, IWW, Karlsruhe.

Droste-Franke, B. and Friedrich, R. (2003): Air Pollution, in: European Commis-sion, An applied integrated environmental impact assessment framework for the European Union (GREENSENSE), Final Report, European Commission DG Research, Brussels.

ECMT, (1998): European Conference of Ministers of Transport, Efficient transport in Europe, Policies for internalisation of external costs, Paris

EEA (2005): Market-based instruments for environmental policy in Europe, Technical report No 8/2005.

European Commission (1999): Externalities of Fuel Cycles - ExternE Project. Vol. 7 - Methodology (2nd edition). European Commission DG XII, Science Research and Development, JOULE, Brussels - Luxembourg

European Commission (2006): Keep Europe moving - Sustainable mobility for our continent, Mid-term review of the European Commission's 2001 Transport White Paper, COM(2006) 314 final, Brussels, 22.06.2006.

ExternE (2004): New Elements for the Assessment of External Costs from Energy Technologies (NewExt)." Final Report to the European Commission, DG Research, Technological Development and Demonstration (RTD), Stuttgart.

FACORA (2004): Facts on Competition in the European Transport Market. Infras/IWW, Karlsruhe, Zürich.

Flyvbjerg et al (2003): Megaprojects and Risk: An anatomy of Ambition, Aarhus.

Friedrich, Reiner (2004): NewExt, New Elements for the Assessment of External Costs from Energy Technologies, NewExt, Final Report to the European Commission DG Research, Stuttgart

Funding (2006): Funding Infrastructure: Guidelines for Europe – FUNDING, Deliverable 1 Economics of European Infrastructure Funds: Methodology, Contract No TREN/05/FP6TR/S07.41077/513499, Leuven.

Hensher, D.A. (1977): Value of Business Travel Time. Pergamon Press, Oxford.

INFRAS/IWW (2000): External Costs of Transport, Zürich, Karlsruhe.

INFRAS/IWW (2004): External Costs of Transport, Zürich, Karlsruhe.

Lakshmanan, T.R. et al (2001): Benefits And Costs Of Transport, Classification, Methodologies And Policies, Papers in Regional Science 80, 139-164.

Lindberg, G (2002): Marginal External Accident Costs in Stockholm and Lisbon, UNITE Deliverable 9: Accident Cost Case Studies, Case Study 8b, UNITE (UNIfication of accounts and marginal costs for Transport Efficiency) Interim Report 8.3. Funded by 5th Framework RTD Programme. VTI, Borlänge, March 2002.

Lindberg, G (2006a), Marginal cost case studies for road and rail transport Deliverable D 3, GRACE. Funded by Sixth Framework Programme. ITS, University of Leeds, Leeds, November 2006

Lindberg, G. (2000) Marginal Cost Methodology for Accidents. UNITE (UNIfication of accounts and marginal costs for Transport Efficiency) Interim Report 8.3. Funded by 5th Framework RTD Programme. VTI, Borlänge, October 2000.

Lindberg, G. (2006): Case study 1.4: State-of-the-art of external marginal accident costs, Annex to Deliverable D 3 Marginal cost case studies for road and rail transport. Funded by Sixth Framework Programme. ITS, University of Leeds, Leeds, March 2006

Lindberg, G. (2006): Case study 1.4: State-of-the-art of external marginal accident costs, Lindberg, G., Annex to Deliverable D3 Marginal coast case studies for road and rail transport, GRACE (Generalisastion of Research on Accounts and Cost Estimation), funded by sixth Framework Programme, University of Leeds

Lindberg, G. (2006): Marginal cost case studies for road and rail transport - Deliverable D3, Lindberg, G. (VTI) with contribution from partners, GRACE (Generalisastion of Research on Accounts and Cost Estimation), funded by sixth Framework Programme, ITS, University of Leeds

Lindsey, C.R. and E.T. Verhoef (2001): Traffic congestion and congestion pricing' in D.A. Hensher and K.J. Button (eds.) (2001) Handbook of Transport Systems and Traffic Control, Handbooks in Transport 3

Link H. and M. Maibach (eds) (1999): Calculating Transport Infrastructure Costs. Final report of the expert advisors to the high level group on infrastructure charging (Working Group 1). [Available on-line at http://www.transport-pricing.net/1999reports/FR1.doc]

Link, H., Stewart, L. (DIW), Doll, C. (IWW), Bickel, P., Schmid, S., Friedrich, R., Krüger, R., Droste-Franke, B., Krewitt, W. (IER) (2002): The Pilot Accounts for Germany. UNITE Deliverable 5 - Annex 1, Leeds (UK) 2002. http://www.its.leeds.ac.uk/projects/unite/downloads/ D5_Annex1.pdf.

Link, Heike and Markus Maibach (1999): Calculating Transport Infrastructure Costs, Final Report Of The Expert Advisors to the High Level Group On Infrastructure Charging (Working Group 1), April 28.

Marler, N et al (2003). Marginal Cost Pricing Implementation Paths to Setting Urban and Interurban Road Transport Charges. MC-ICAM Deliverable 4.

MC-ICAM (2004): Implementation of Marginal Cost Pricing in Transport – Integrated Conceptual and Applied Model Analysis, Final Report for Publication, FP6, Contract No: GRD1/2000/25475-SI2.316057, Leeds.

Nash, Chris et al (2002):The Environmental Impact Of Transport Subsidies, Paris

Nellthorp, J., Mackie, P.J. and Bristow, A. (1998): Measurement and valuation of the impacts of transport initiatives. Deliverable 9 EUNET – Socio Economic and Spatial Impacts of Transport. Project funded by the EC RTD Fourth Framework Programme. Marcial Ecehnique and Partners, Cambridge, UK.

Odgaard, T., Kelly, C.E. and Laird, J.J. (2005): Current practice in project appraisal in Europe – Analysis of country reports. HEATCO D1 WP3, HEATCO – Developing Harmonised European Approaches for Transport Costing and Project Assessment. Funded by the 6th Framework RTD Programme. IER Stuttgart, Germany.

Peter, Benedikt (2004): Rail Infrastructure Charging in The European Union, TU Berlin, Fachgebiet Wirtschafts- und Infrastrukturpolitik (WIP). Berlin.

Preiss, P., Gressmann, A., Droste-Franke, B., Friedrich, R. (2004): Revision of External Cost Estimates. In European Commission: New Elements for the Assessment of External Costs from Energy Technologies (NewExt), European Commission DG Research, Energy Environment and Sustainable Development Programme, 5th Framework Programme, Brussels.

Requirements for Demand Management, Final Report, FP6, CONTRACT N° : UR-97-SC.2258, Helsinki.

Rothengatter, Werner (2001): How good is first best? Marginal cost and other pricing principles for user charging in transport, Transport policy 10, p121-130

Schmid, S., Bickel, P., Friedrich, R. (2001): The External Costs of Road Transport in the Federal State of Baden-Württemberg, Germany. In R. Friedrich and P. Bickel: Environmental Costs of Transport, Springer-Verlag, Berlin.

UNITE, (2003): Unification of accounts and marginal costs for transport efficiency, Final report for publication, C. Nash with contribution from partners, Leeds : UNITE, 2003

Van Essen et al (2007): Methodologies for external cost estimates and internalisation scenarios, Discussion paper for the workshop on internalisation on March 15, 2007, Delft.

Verhoef, Erik (no date): Marginal Cost Based Pricing in Transport, Key Implementation Issues from the Economic Perspective, Free University Amsterdam, Paper prepared for IMPRINT

Vermeulen, Joost et al (2004): The price of transport - Overview of the social costs of transport, CE, Delft

9. ANNEXES

List of Annexes

Annex 1: Transport Cost Coverage in Europe

Source: FACORA 2004

EXTERNAL AND INFRASTRUCTURE COSTS AND COST COVERAGE (MILL. EURO)

Category	Mode	Selected countries AT	FR	DE	IT	NL	SE	CH	UK	Total
Environmental externalities [1)]	Road	15018	74147	129147	86594	21716	11488	10008	79095	427213
	Rail	273	1278	3737	1554	414	275	396	2385	10312
	Air	1255	111764	14909	7086	7262	1923	3441	21133	168773
	Water	28	169	1175	4	1076		0	175	2627
Infrastructure costs [2)]	Road	4374	25520	29100	13645	4411	2172	4030	12728	95980
	Rail	1933	4790	10277	5605	1095	856	2762	3288	30606
	Air	509	1080	3488	571	98	447	804	2236	9233
	Water	22	2377	2225	58	3694	0	10	175	8561
Total transport related revenues	Road	4319	27870	37151	29340	9429	4320	4290	38529	155248
	Rail	260	987	4817	0	155	98	774	3439	10530
	Air	454	2804	3936	1007	225	320	810	1347	10903
	Water	20	76	85		221		0	0	402
Accountable revenues [3)]	Road	1799	13527	14903	10318	2611	1459	3265	15943	63823
	Rail	258	967	4692	0	155	89	774	3439	10374
	Air	429	2804	3888	995	224	303	810	1347	10800
	Water	20	76	85		221		0	0	402
Cost coverage ratio 1: Acc. reven. / Infrastr. costs	Road	41%	53%	51%	76%	59%	67%	81%	125%	66%
	Rail	13%	20%	46%	0%	14%	10%	28%	105%	34%
	Air	84%	260%	111%	174%	229%	68%	101%	60%	117%
	Water	91%	3%	4%	0%	6%	0%	0%	0%	5%
Cost coverage ratio 2: Acc. reven./ total costs	Road	9%	14%	9%	10%	10%	11%	23%	17%	12%
	Rail	12%	16%	33%	0%	10%	8%	25%	61%	25%
	Air	24%	2%	21%	13%	3%	13%	19%	6%	6%
	Water	40%	3%	3%	0%	5%	0%	0%	0%	4%
Cost coverage ratio 3: Total reven. / total costs	Road	22%	28%	23%	29%	36%	32%	31%	42%	30%
	Rail	12%	16%	34%	0%	10%	9%	25%	61%	26%
	Air	26%	2%	21%	13%	3%	14%	19%	6%	6%
	Water	40%	3%	3%	0%	5%	0%	0%	0%	4%

Remarks: 1) Accidents, noise, air pollution, climate change, nature and landscape and up- and downstream effects. Source: INFRAS/IWW 2004. - 2) Source: UNITE 2002a, 2002b, 2002c. - 3) Infrastructure user charges plus 50% of fuel tax revenues. Electricity tax revenues are not available for most countries and are thus omitted.

Table 4 Total cost coverage including externalities and infrastructure for selected countries 1998 (Mill. Euro)

Annex 2: Rail Revenues and Subsidies 1998, Mill Euro

	Revenues		Taxes	Explicit subsidies		Implicit subsidies	Total[1]
	Ticket and freight revenues	Track, station and other infrastructure charges	Fuel and energy tax	For the provision of services	For concession-ary fares	Lost revenues due to reduced VAT on ticket	
Austria	1277	349	5[2]	1045	619	[3]	2 946
Belgium	908	[4]	0.85	1615	[4]	69	2 524
Denmark	566	20	0	219	30	[3]	815
Finland	533	54	4.8[2]	53	9	37	600
France	6380	946	41	5678	296	[3]	12 395
Germany	8614	4566	251[2]	7175[5]	4244	[3]	20 284
Greece	126	[4]	9[2]	[4]	126	[3]	261
Hungary	84	124	27	295	[4]	[3]	406
Ireland	127	[4]	[4]	42	[4]	[3]	169
Italy	3441[6]	[4]	[4]	1740	1700	[3]	6 881
Luxembourg[7]	100	[4]	0.4	104	[4]	4	204
Netherlands	1210	155	[4]	81	81	[3]	1 372
Portugal	188	[4]	[4]	10	[4]	[3]	198
Spain	1495	[4]	0	1925	[8]	[3]	3 420
Sweden	1325	98	[4]	500	[4]	[3]	1 825
Switzerland	2191	774	[4]	1621	[4]	[3]	3 812
UK	5677	3448	[4]	43	2254	[3]	7 974

[1] Excluding infrastructure charges and implicit subsidies. – [2] Including VAT on fuel tax. – [3] Can not be calculated with the available data. – [4] None recorded within the country account. – [5] Includes financial payments to the Bundeseisen-bahnvermögen, a government body outside of the rail sector which took over past national rail debts, parts of the real estate and some of the former rail staff. – [6] Including revenues of €1517 million from public service contract, which may also be seen as a subsidy. – [7] Revenues, taxes and subsidies from rail owned buses included. – [8] Unknown level of subsidies for concessionary fares included in subsidies for provision of services.

Source: Link et al. (2002a,b,c)

Annex 3: Air Revenues and Subsidies 1988, Mill Euro

Country	Revenues		Taxes	Other charges	Explicit subsidies	Implicit subsidies
	Airport revenues	ATM charges				Revenues lost: VAT on ticket price
Austria	278	151	:	25[1)]	:	:
Belgium	255	120	:	:	:	:
Denmark	:	:	:	:	:	103
Finland	181	:	:	:	0.3	231
France	1687	1117	:	:	279[2)]	:
Germany	3121	767[3)]	:	48[3)]	:	252[4)]
Greece	767[5)]	:	34	:	:	:
Hungary	103	:	2	:	:	:
Ireland	134	:	:	:	:	:
Italy	795	200	12	:	:	:
Luxembourg	11	1.1	:	:	0	:
Netherlands	224	:	1.3	:	:	:
Portugal	114	86	:	:	:	:
Spain	501	341	:	:	77[6)]	:
Sweden	184	119	:	17	:	:
Switzerland	651	159	:	:	:	:
UK	:	137[7)]	:	1210[8)]	28	:

[1)] Security charge.– [2)] €194 million to airports, € 85 million other general subsidies. – [3)] Meteorological services charge. – [4)] For Lufthansa only.– [5)] All airport and ATM charges.– [6)] Subsidies to airlines.–[7)] Profit from these services going to general budget. – [8)] Air passenger duty.

Source: Link et al. (2002a,b,c)

Annex 4: Transport Taxes in Europe

Source: FACORA 2004

VAT-RATES

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxem-burg	Nether-lands	Norway	Portugal	Spain	Sweden	Switzer-land	United Kingdom
VAT on car sales 2003 (VAT on price including acquisition tax in I, Fin, DK, A; excluding in NL, GB, D, EL, EIR) Sources: EU-Commission 2003b																	
Road	20%	21%[1]	25%	22%	19.6%	16%	18%	20%	20%	15%	19%		17%	16%	25%	7.60%	17.5%
VAT on fuel 2003 (VAT on fuel sales price including fueltax) Sources: EU-Commission 2003b, ECMT 2003																	
Road	20%	21%	25%	22%	19.6%	16%	18%	21%	20%	12%[2]	19.0%	24%	19%[3]	16%	25%	7.6%	17.5%
Rail												0%	12%[4]			7.6%	
Air																0%[5]	
IWW																7.6%	
SSS																N/A	
VAT on user charges and tolls 2001 Sources: ECMT 2003																	
Road	20%	-			5.5-8.0%	-			19%		-			16%		-	-
Rail														7.6%			
Air														0%[7]			
VAT Domestic passenger transport 2003 (VAT on transport services) Sources: EU-Kommission 2003b; KPMG 1997																	
Road	10%	6%	Exempt[8]	8%	5.5%	16%[9]	8%	Exempt	10%[10]	3%	6%		5%	7%	6%	7.6%	0%[11]
Rail	10%	6%	Exempt	8%	5.5%	16%[9]	8%	Exempt	10%[10]	3%	6%		5%	7%	6%	7.6%	0%[11]
Air	10%	6%	Exempt	8%	5.5%	16%	8% [12]	Exempt	10%	3%	19%		5%[13]	7%	6%	7.6%[14]	0%[11]
IWW	10%	6%	Exempt	8%	5.5%	16%[9]	8%	Exempt	10%	3%	6%		5%	7%	6%	7.6%	0%[11]
SSS	N/A	6%	Exempt	8%	5.5%	7%	8%[12]	Exempt	10%	N/A	6%		5%[13]	7%	6%	N/A	0%[11]

VAT-RATES

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxem-burg	Nether-lands	Norway	Portugal	Spain	Sweden	Switzer-land	United Kingdom
VAT International passenger transport 2003 (VAT on transport services) Sources: EU-Kommission 2003b; KPMG 1997																	
Road	10%	6%	0%[15)]	0%	5.5%[16)]	16%[9)]	8%	0%	0%	0%	6%		0%	7%	0%	7.6%[17)]	0%
Rail	10%	6%	0%	0%	5.5%[18)]	16%[9)]	0%	0%	0%	0%	6%		0%	7%	0%	Exempt	0%
Air	0%	0%	0%	0%	0.0%	0%	0%	0%	0%	0%	0%		0%	0%	0%	Exempt	0%
IWW	0[19)]	6%	N/A	0%	5.5%	7%[20)]	N/A	N/A	0%	0%	6%		0%	7%	0%	?	0%
SSS	0%	0%	0%	0%	0%	0%	0%	0%	0%	N/A	0%		0%	0%	0%	N/A	0%

Table 17

Remarks: 1) Partially 6% 2) 12% on unleaded 3) Diesel partially 12% 4) 5% on electricity 5) Inland flights 7.6% 6) 6% on tolls 7) Air control 7.6% 8) Tourist bus services taxed at 25% 9) Distances minor 50km 7% 10) Urban transport is exempt 11) Means of transport smaller than 12 persons 17.5% 12) Some island links at 6%) 13) Travel to/from Azores and Madeira exempt 14) Exempt if inland flight is a direct link of an international flight 15) 0% for scheduled traffic; 25% tourist bus services 16) Transit exempt 17) On swiss part of the journey 18) Transit and specific international routes 0% 19) On lake constance 10% 20) Ferry on frontier rivers 0%

VEHICLE AND CIRCULATION TAXES

	Austria	Belgium	Denmark	Finland	France	Germany	Greece	Ireland	Italy	Luxem-burg	Nether-lands	Norway	Portugal	Spain	Sweden	Switzer-land	United Kingdom
Annual circulation tax (€/year) Sources: >Passenger cars: TiS 2002 >HGV: BGL 2002/www.bgl-ev.de/daten/steuern1a.html																	
Passenger cars (2002)	max. 2000		56-2073	84-118		max. 2600	12-73	124-1075	19-2324		66-2272					59-1008	max. 257
40-tons HGV (2003)	4080	791	705	1469	671	1521	439	1282	435	696	940	1013	1200	374	928	1966	618
Registration tax for passenger cars (in percents on car base price or in €/car) Sources: ACEA 2002																	
Road	Max. 16%	62-5000	105-180%	100% minus 1600€	none	none	7-88%	22.5-30%	150-1550€	none	45.2% [1)]		Max. 2500€	7-12%	none	4%	none
Registration fee for passenger cars in € Sources: ACEA 2002																	
Road	147-163	62	158	none	16-30	25.6	none	none	151-453	28.9	32-42		85	15.8	none		37.3

Table 18

Remarks:
1) petrol car: 45.2% minus 1540€; diesel car: 45.2% plus 328€

TAXES AND DUTIES ON FUEL																	
	Austria	**Belgium**	**Denmark**	**Finland**	**France**	**Germany**	**Greece**	**Ireland**	**Italy**	**Luxem-burg**	**Nether-lands**	**Norway**	**Portugal**	**Spain**	**Sweden**	**Switzer-land**	**United Kingdom**
Fuel duties on Diesel (September 2003) in €/l Sources: BMF 2003/ BGL 2002																	
Road	0.28	0.29	0.37	0.32	0.39	0.47	0.25	0.33	0.40	0.25	0.34	0.44	0.28	0.29	0.34	0.49 [1]	0.67
Rail	0.069	0	0	0.316	0.057	0.409	0	0.013	0.121	0	0	(0.09) [3]	0	0	0	0.112	0.06
IWW	[4]					[4]											
Fuel duties on unleaded petrol (February 2002) in €/l Sources: www.euractiv.com of 25.4.2003																	
Road	0.41	0.51	0.55	0.56	0.58	0.62	0.3	0.4	0.54	0.37	0.63		0.48	0.4	0.51	0.47 [1]	0.74
Fuel duties on kerosene (2000) in €/l Sources: EEA 2000																	
-	0.28	0.55	0.35	0.30	0.37	0.5	0.25	0.34	0.34	0.29	0.33		0.30	0.29	0.34	0.47 [2]	0.28
Fuel duties on LPG (2002) in €/Kg Sources: BMU 2003																	
Road	0.26	0	0.47	0	0.11	0.16	0.1	0.1	0.28	0.10	0.13		0.1	0.80	0.14	0.52	0.83
Electricity tax (2002) in €/MWh Sources: UIC survey, DB																	
Rail	8.72	3.00	n.a.	4.20	3.30	11.42	n.a.	n.a.	0.02	n.a.	0.06	0	n.a.	3.82	0	0	6.50

Table 19
Remarks:
1) Public transport is exempt 2) No tax on fuel on transit flights and connection flights to international connections. 0.473 €/l for inland flights 3) exempt at the moment 4) tax exemption

Annex 5: Income Statements of European Railways 2001

Source: Abegg, Peter et al (2004), p. 73

	AT	BE	CH	DE	DK	ES	FI	FR	GB	GR	IE	IT	LU	NL	NO	PT	SE	EU15
Staff costs	2,010	2,392	1,833	8,003	490	1,083	378	7,508	2,569	280	189	4,590	189	1,018	462	291	800	31,790
Non-staff costs	1,213	1,205	1,882	12,871	670	1,435	717	6,306	7,656	121	178	4,425	210	2,246	570	254	1,493	41,000
TOTAL OPERATING COSTS	**3,223**	**3,597**	**3,715**	**20,874**	**1,161**	**2,517**	**1,095**	**13,814**	**10,225**	**401**	**367**	**9,015**	**398**	**3,264**	**1,032**	**545**	**2,294**	**72,789**
Passenger & baggage traffic receipts	543	557	1,100	6,550	485	943	248	6,195	5,821	52	123	2,186	29	1,352	256	135	585	25,803
Freight traffic receipts	828	438	674	3,896	0	326	338	1,834	1,101	25	22	774	92	0	139	61	493	10,226
Other revenues	493	1,639	902	4,981	201	372	103	2,218	392	10	53	2,924	62	1,229	98	107	708	15,492
Revenues without Public Operating Contributions	**1,864**	**2,633**	**2,676**	**15,427**	**686**	**1,641**	**689**	**10,247**	**7,315**	**87**	**197**	**5,884**	**183**	**2,581**	**494**	**303**	**1,785**	**51,522**
Public operating contributions (public budget contributions for PSO and infrastructure)	1,975	1,001	1,196	5,352	862	1,372	431	3,415	2,928	0	169	3,342	218	1,044	734	16	478	22,602
TOTAL OPERATING INCOME	**3,838**	**3,635**	**3,872**	**20,779**	**1,548**	**3,013**	**1,119**	**13,662**	**10,243**	**87**	**366**	**9,226**	**401**	**3,625**	**1,228**	**318**	**2,263**	**74,124**
Financial and Exceptional Costs (Net)	-389	-216	45	-311	-19	-451	-20	-1,524	-2,316	-60	-6	-182	3	-273	-49	-198	-326	-6,287
NET RESULT	**227**	**-178**	**202**	**-406**	**368**	**45**	**4**	**-1,676**	**-2,297**	**-374**	**-7**	**29**	**6**	**88**	**148**	**-425**	**-356**	**-4,952**
Public operating contributions / operating costs	61%	28%	32%	26%	74%	54%	39%	25%	29%	0%	46%	37%	55%	32%	71%	3%	21%	31%
Revenues without public operating contributions / operating costs (Viability ratio)	58%	73%	72%	74%	59%	65%	63%	74%	72%	22%	54%	65%	46%	79%	48%	56%	78%	71%
Total	119%	101%	104%	100%	133%	120%	102%	99%	100%	22%	100%	102%	101%	111%	119%	58%	99%	102%
Commercial passenger revenue per passenger km (€ cents)	6.6	6.9	8.2	8.8	8.7	4.9	7.5	8.7	14.9	2.7	8.1	5.0	8.4	9.4	10.1	3.3	9.2	8.6
Commercial freight traffic revenue per tonne-km (€ cents)	4.8	5.4	6.4	4.8	N/A	2.8	3.4	3.6	5.7	7.1	4.2	3.1	14.6	N/A	5.7	2.8	2.5	4.2

Source: NERA database (presented and defined in Appendix C). The categories used in this table are either categories in the database or aggregations of categories.

Annex 6: Environmentally Related Taxes, Fees and Charges in Transport

Source: http://www2.oecd.org/ecoinst/queries/index.htm

Coun-try	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
Austria	Mineral oil tax	Diesel, with sulphur content below 10 mg per kg.	2004	3,594
Austria	Tax on motor vehicle in-surance	Insurance of motor cycles	2004	1,251
Austria	Vehicle registration tax	Purchase or registration of diesel-driven passenger cars with fuel consumption below 10 litre per 100 km	2004	477
Austria	Vignette for the use of highways	Use of highways by motorcycles	2002	310
Austria	Motor vehicle tax	The use of passenger cars with maximum total weight below 3.5 tonnes, engine effect larger than 134 kW.	2004	166
Austria	# -- Road transport duty	The use of lorries and trailers with a total maximum weight larger than 12 tonnes on Austrian roads, during one day	2003	86
Austria	Charge for parking of cars in limited parking zones in Vienna	Parking time spent in limited parking zones	2002	42
Austria	Safety Levy	Air transport of passengers	2004	15
Belgium	Excise duties	Diesel, with sulphur content below 50 mg per kg and completed with at least 3.37% of FAME	2004	3,734
Belgium	Road tax	Coaches and buses, less than 10 HP or 10 HP	2003	1,266
Belgium	# -- Levy on energy	Essence au plomb	2003	264
Belgium	Tax on the entry into ser-vice	Entry into service of a boat	2003	248
Belgium	Eurosticker	Eurosticker 1	2005	234
Belgium	Excise compensating tax	Motor cars, twin-purpose cars and minibuses with a diesel engine. Fiscal power : 10 HP	2005	234
Belgium	Additional road tax	All cars, twin-purpose cars and minibuses equipped with an LPG installation. Fiscal power (HP) : from 8 to 13 HP		
Cyprus	Fuel excise tax	Gas oil used as propellant		
Cz	Excises on hydrocarbon fuels and lubricants	Motor oils (diesel) and petroleum	2004	2,086
Cz	Road tax (commercial)	The use of a passenger car with cylinder capacity above 3000 ccm	2004	175
Cz	Highway fee	The use of highways by transport vehicles weighing between 3.5 and 12 tonnes.	2004	83
Cz	Motor vehicle entry fee	The entry of a motor vehicle in a given town	2004	1

Country	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
Denmark	Motor vehicle registration duty	First time registration of camping cars	2005	2,944
Denmark	Duty on petrol	Leaded petrol distributed from petrol stations equipped with vapour return systems	2005	1,328
Denmark	Motor vehicle weight tax	The use of diesel-driven buses with more than 2 axles	2005	1,212
Denmark	Duty on certain mineral oil products	Diesel oil with a low content of sulphur	2005	1,120
Denmark	Duty on CO2	Gasoil and Diesel oil	2005	707
Denmark	Duty on natural gas	Natural gas used as motor fuel	2005	518
Denmark	Duty on motor vehicle compulsory insurance	Commercial vehicles with maximum authorised weight below 6 tonnes	2005	284
Denmark	# -- Passenger duty	Passengers using aircraft from Danish airports - in aircraft with fewer than 20 seats	2005	91
Denmark	Road user charge	Use of heavy goods vehicles with 4 axles or more, Euro I	2005	64
Denmark	Environmental duty for passenger cars and vans	Duty on passenger cars (max 9. persons) and vans (max 3500 kg)	2004	18
Denmark	Duty on insurance on pleasure boats	Insurance on pleasure boats	2005	12
Denmark	Fee on petrol	Consumption of petrol		
Denmark	Scraping charge on passenger cars and vans	Cars registered in 2002		
Denmark	Passenger car fuel consumption tax	The use of diesel-driven passenger cars able to go 32,1 km per or longer per litre diesel		
Estonia	Fuel excise tax	Diesel	2002	116
Estonia	Motor vehicle excise tax	Diesel motors - engine capacity 1,500 - 2,500 ccm	2001	9
Estonia	Heavy goods vehicles tax	Lorries, 2 axles (maximum authorised weight from 12,000 to 12,999 kg)		
Finland	Excise on fuels and electricity	Basic tax - diesel oil, other grades	2004	2,904
Finland	Car tax	First registration of motor cycles	2004	1,235
Finland	Vehicle tax	Basic tax - vehicles registered before 1.1.1994	2004	642
Finland	Vehicle tax (Sticker tax)	Use of new passenger cars	2002	237
Finland	Motor vehicle tax (Diesel tax)	The use of lorries	2002	218
Finland	Fairway fee (Channel fee)	Cargo ships	2005	76
Finland	Strategic stockpile fee	Diesel	2004	49
Finland	Railway fee	Goods transport	2004	42
Finland	Railway tax	Goods transport (diesel-driven trains)	2005	17
Finland	Air transport supervision charge	Flight passengers aged two years or more		
Finland	Charge on abandoned end-of-life vehicles	Abandoning of an end-of-life vehicle		
Finland	Charge on tyres	Tyres (cars, motorbikes, trucks etc.)		
Finland	Fee on waste from ships	Fee for oily waste		

Country	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
France	Taxe Intérieure sur les Produits Pétroliers -- Mineral oils tax	Alsace -- Gazole - présentant un point d'éclair inférieur à 120°	2004	24,962
France	Taxe générale sur les activités polluantes -- General tax on polluting activities	Biocarburants	2004	467
France	Taxe à l'essieu -- Tax on vehicles axles	Circulation sur la voie publique d'un tracteur et d'une semi-remorque à 1 essieu avec un poids autorisé compris entre 12 et 20 tonnes - Autres systèmes de suspension	2003	223
France	Charge on production of petrol refineries	Production capacity of petrol refineries	2003	0
Germany	Duty on mineral oils	Diesel, sulphur content below or equal to 10 mg per kg.	2004	41,782
Germany	Motor vehicle tax	Diesel-driven passenger cars - Euro 1	2004	7,740
Germany	Motorway user charge	Use of motorways by lorries, permitted weight of 12 t or more, max. 3 axles, emission class S1 and lorries without emission classification		
Greece	Mineral oil tax	Diesel	2004	2,343
Greece	Tax on motor vehicle usage	The use of a motor vehicle with a cylindre volume larger than 1929cc.	2004	1,505
Hungary	Excise tax on diesel	Diesel (gas oil) used as propellant -- sulphur content below 10 mg per kg	2004	196,600
Hungary	Excise tax on petrol	Leaded petrol	2004	816
Hungary	Excise tax on other oil	Natural and other condensed gaseous hydrocarbon used as propellant	2004	798
Hungary	Tax on motor vehicles	Use of motor vehicles	2004	187
Hungary	Environment petrol tax	Diesel	2004	81
Hungary	Tax on foreign registered vehicles	Use of foreign registered lorries	2004	6

Coun-try	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
Ire-land	Duty on other sorts of oil	Higher-sulphur auto-diesel	2004	988
Ire-land	Mineral Oil Tax	Aviation gasoline	2004	971
Ire-land	Vehicle Registration Tax	Motor cycles	2004	946
Ire-land	Motor Vehicle Tax	The use of a dumper, forklift and machine contrivance	2003	669
Italy	Mineral oil tax	Diesel	2005	28,586
Italy	Motor vehicles tax	Cars	2003	5,971
Italy	Excise duty on oil/petrol	Regional co-participation in excise duty on oil/petrol	2002	2,615
Italy	Tax on insurance for civil liability (for vehicles)	Tax on insurance for civil liability - to provinces	2003	1,932
Italy	Tax for registration of vehicles	Buses and rural vehicles on road > 110 kw - Como, Matera, Milano, Sassari provinces	2003	1,126
Italy	Regional oil/petrol tax	Campania region		
Latvia	Annual motor vehicle charge	All types of motorcycles		
Latvia	Fuel excise tax	Diesel		
Latvia	Vehicle excise tax	10 years old motorcycles		

Country	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
Lithuania	Heavy-duty vehicles tax	Combination vehicles with total weight 40 - 41 tonnes (axle with pneumatic suspension)	2002	4
Lithuania	Air pollution charge for air transport	One take-off and landing cycle of an aircraft		
Lithuania	Air pollution charge for mobile sources/fuels	Diesel used for vessels		
Lithuania	Fuel excise tax	Diesel		
Lithuania	Motor vehicle import duty	Customs value of vehicles 7 - 10 years of age		
Lithuania	Turnover tax on vehi-cles	Taxable vehicle value exceeding 100,000 LTL		
Luxem-bourg	Mineral oil tax	Diesel	2004	684
Luxem-bourg	Annual vehicle tax	The permission to use a lorry	2004	30
malta	Fuel excise tax	Gas Oil falling under CN Codes 2710.19.41 to 2710.19.49	2005	67
malta	Vehicles annual road licence fee	Additional fee for commercial vehicles	2005	29
malta	Air transport charges	Departing passengers - air transport levy	2005	7
malta	Motor vehicles import duty	Agricultural vehicles	2003	5
Nether-lands	Duty on petrol	Leaded petrol	2005	3,835
Nether-lands	Motor vehicle duty (Motorrijtuigenbelast-ing)	The ownership of a delivery van by an entrepeneur	2005	3,506
Nether-lands	Car registration tax (BPM)	Registration of a motor cycle	2005	3,148
Nether-lands	Excise duty on mineral oil (other than petrol)	Diesel - used as a motor fuel - other than sulphur free.	2005	2,585
Nether-lands	Tax on heavy lorries	The use of highways by lorries with a gross weight of 12,000 kg or more, with 3 axes or less, conforming EURO-1	2005	111
Nether-lands	Tax in connection with petroleum stocks	Diesel	2001	77

Country	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
Poland	Excise tax on energy products	Diesel fuels	2004	3,741
Portugal	Tax on petroleum and energy products	Gas oil, unmarked	2003	3,072
Portugal	Motor vehicle sales tax	First time registration of a mixed light motor vehicle with a gross weight equal or higher than 2300 kgs and of a light motor vehicle for transport of goods, up to 1250 cc	2003	1,018
Portugal	Municipal tax on vehi-cles	Aircraft, maximum weight at take-off between 1000 and 1400 kg	2003	107
Portugal	Truck tax	Vehicles for the transportation of goods, between 2.5 and 3.5 tonnes gross weight	2002	42
Portugal	The Circulation tax	Vehicles for the transportation of goods, between 2.5 and 3.5 tonnes gross weight	2002	36
Slovak Rep	Excises on mineral oils	Light fuel oil	2005	851
Spain	Tax on mineral oils	Diesel	2003	10,707
Spain	Tax on vehicle regis-tration	First registration in Spain of boats more than 7.5 meters long.	2003	1,416
Spain	Tax on motor vehicle	The use of agricultural tractors with between 16 and 25 fiscal horsepower	2002	1,189
Spain	Tax on retail sales of certain mineral oils	Diesel	2003	852
Sweden	Energy and CO2 tax on petrol	Unleaded petrol for two-stroke engines, Environmental class 1a	2005	2,903
Sweden	Energy and CO2 tax on fuels except petrol	Diesel, Environmental class 1	2005	2,155
Sweden	Motor Vehicle Tax	Airplanes	2005	1,147
Sweden	Environmental differen-tiated fairway dues	Vessels emitting 12 gram NOx /kWh or more exept those that transport mineral oils in bulk	2001	101
Sweden	Road user charge	Material permitted for abstraction 5 000-9 999 tons	2001	57
Sweden	Excavation charge	Transport - Registration or use of motor vehicles, recurrent taxes	1996	5

Coun-try	Name	Specific tax base	Year	Annual Revenues
			(recent)	Mill Euro
UK	Duty on hydrocarbon oils	Gas oil (marked red)	2005	34,568
UK	Vehicle excise duty	The use of 2 axled tractive unit used with any semi-trailers, weighing between 12,000 and 16,000 kg	2005	7,121
UK	Air passenger duty	The carriage, from a UK airport, of chargeable passengers on chargeable aircraft to EEA destinations - higher classes of travel	2005	1,327