

# External Cost Calculator

## Methodology report



**Report**  
Delft, September 2011

**Author(s):**  
Arno Schroten (CE Delft)  
Huib van Essen (CE Delft)  
Ralph Anthes (IVE mbH)



# Publication Data

## Bibliographical data:

Arno Schroten, Huib van Essen, Ralph Anthes  
External Cost Calculator  
Methodology report  
Delft, CE Delft, September 2011

Traffic / Emissions / Climate / Accidents / Costs / Measuring instrument  
FT : External Costs

Publication code: 11.4212.67

CE publications are available from [www.cedelft.eu](http://www.cedelft.eu).

Commissioned by: International Union of Railways (UIC).

Further information on this study can be obtained from the contact person, Huib van Essen.

© copyright, CE Delft, Delft

CE Delft  
Committed to the Environment

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



# Contents

	<b>Summary</b>	<b>5</b>
<b>1</b>	<b>Introduction</b>	<b>7</b>
1.1	Background	7
1.2	Objective and scope of the tool	7
1.3	Objective and structure of this report	8
<b>2</b>	<b>Methodology framework</b>	<b>9</b>
2.1	Introduction	9
2.2	Traffic and emission data	9
2.3	External cost data	10
<b>3</b>	<b>Parameter values</b>	<b>15</b>
3.1	Introduction	15
3.2	Climate change costs	15
3.3	Accident costs	15
<b>4</b>	<b>Further development of the tool</b>	<b>19</b>
4.1	Introduction	19
4.2	Additional cost categories	19
4.3	Extension to passenger transport	20
	<b>Literature</b>	<b>21</b>





# Summary

Internalisation of the external costs of transport is a way to give transport users the right incentives. Previous UIC studies on external costs of transport (INFRAS/IWW 1995, 2000, 2004) are widely known and cited in the scientific and political area and provide a comprehensive comparison of transport modes in Europe based on their economic impact on society. In 2010-2011, an update study has been carried out. However, there was also a wish for presenting external costs in a more dynamic way. Therefore, CE Delft, INFRAS and IVE mbH were commissioned by the International Railway Union (UIC) to develop an IT calculator tool to assess the external costs per transport mode on selected routes. In this report the methodological framework of the tool is explained.

The tool that was developed covers climate and accident costs of road, rail, inland waterway, maritime and combined freight transport. There are various options to extend the scope of the tool to other cost categories. This report explains how this could be done.

The tool is a web application. It is closely related to the EcoTransIT World tool, which provides for freight transport on origin/destination routes traffic (vkm, tkm) and emission data. In the External Cost Tool the same routing mechanism, logistical parameters and emission factors are used as in EcoTransIT World, such that traffic and emission data are the same for both tools. In an additional step the external costs of climate change and accident costs are calculated.

The tool provides a standard mode, which uses external cost estimates from the IMPACT Handbook (CE/INFRAS/ISI, 2008). In addition it contains an extended mode. In that mode the user can choose various cost estimates ranging from low, medium to high estimates which are all based on the latest 2011 update study on external costs, which was carried out in parallel to the development of the tool (CE Delft/INFRAS/ISI (2011)). In addition the user can in the extended mode use own cost values.





# 1 Introduction

## 1.1 Background

The existence of external costs in transport creates many distortions in the transport market. Transport users are not given the right incentives as a result of which they are not taken socially optimal decisions. As a consequence scarce resources like energy and infrastructure are not used in an economic efficient way. Moreover, the level playing field between transport modes is adversely affected. The competitiveness of modes that cause relatively few external costs, like railways and inland waterways, is harmed by the existence of external costs.

By internalising the external effects of transport the efficiency of the transport market could be improved. For that reason internalising the external costs of transport was one of the main focus points of the EC Greening Transport Package from 2008. This resulted in a revision of the Eurovignette Directive allowing Member States to charge Heavy Goods Vehicles for the external costs of air pollution and noise, on top of the infrastructure costs which could already be charged for.

Against this background CE Delft, INFRAS and IVE mbH were commissioned by the International Railway Union (UIC) to develop an IT calculator tool to assess the external costs per transport mode on selected routes. In this report the methodological framework of the tool is explained.

## 1.2 Objective and scope of the tool

The tool provides users the possibility to calculate the monetary value of climate change and accident costs on selected origin/destination routes for freight transport. In the current version of the tool other external costs (i.e. air pollution, noise and congestion) are not included as well as passenger transport. However, in Chapter 4 we briefly discuss the methodology to include these additional external cost categories as well as passenger transport in the tool.

The tool is closely related to the EcoTransIT World tool. EcoTransIT World provides for freight transport on selected origin/destination routes traffic (vkm, tkm) and emission data. In the External Cost Tool we use the same routing mechanism, logistical parameters and emission factors as in EcoTransIT World, such that traffic and emission data are the same for both tools (for a further explanation, see Section 2.2). In an additional step the external costs of climate change and accident costs are calculated.

The tool contains both a standard and extended mode. In the standard mode the external costs are calculated based on default parameters in the tool (e.g. marginal external accident costs). The extended mode provides users the opportunity to change some of the parameters by themselves and run the tool based on the adapted parameters. In Chapter 2 the additional opportunities provided by the extended mode are discussed for both the calculation of climate change and accident costs.

As mentioned before, the tool covers only freight transport. It includes the following modes: road, rail, inland waterway, maritime and combined transport. Air transport is not included, since the share of air transport in total freight transport is negligible.

The 20 countries covered by the tool are: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and UK.

All external costs calculated in the tool refer to 2008 and are also expressed in the price level of 2008.

### 1.3 Objective and structure of this report

The aim of this report is to present the methodology and parameter values used in the tool to estimate the climate change and accident costs on specific origin/destination routes.

The methodology to calculate necessary traffic and emission data as well as climate change and external accident costs is discussed in Chapter 2. In this chapter also the additional options of the extended mode will be discussed. In Chapter 3 the main parameter values used to calculate the external costs are discussed. For the parameter values used to estimate traffic and emission data we refer to the methodology report of EcoTransIT World (see IFEU et al., 2010). Finally, in Chapter 4 possibilities for further development of the tool will be discussed (i.e. the possible inclusion of other external costs as well as the extension of the tool to other freight transport modes or to passenger transport).

# 2 Methodology framework

## 2.1 Introduction

In this chapter the methodological framework of the tool will be discussed. The estimation of the monetary value of climate and accident costs on specific trips selected by users for freight transport consists of two steps:

1. Calculate trip specific traffic and emission data; based on trip characteristics traffic (vehicle and tonne kilometres) and emission (CO<sub>2</sub> emissions) data will be calculated. The applied calculation approach will be discussed in Section 2.2.
2. Calculate trip-specific climate change and accidents costs. Based on the results of the first step the monetary value of climate change and accident costs will be estimated. In Section 2.3 the approach to estimate these values will be discussed. The marginal external costs parameters necessary to estimate these values are discussed in Chapter 3.

## 2.2 Traffic and emission data

To calculate trip specific traffic and emission data, the same methodology will be used as in EcoTransIT. For an extended overview of this methodology we refer to the Methodology and Data report on EcoTransIT (IFEU et al., 2010). Here we will present a brief overview of the methodology applied.

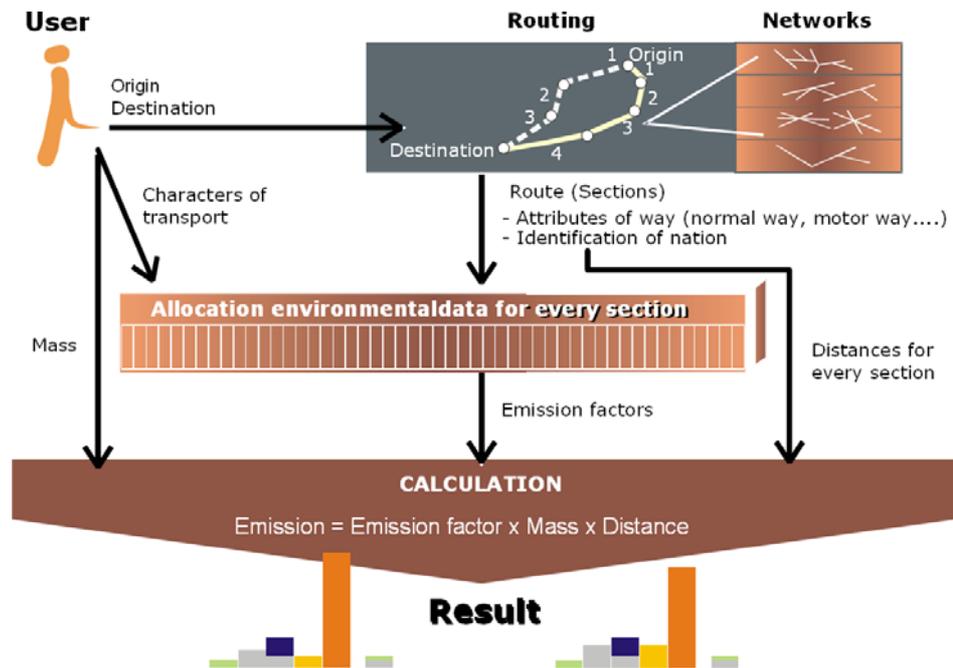
The Ecological Transport Information Tool (EcoTransIT) calculates environmental impacts of any freight transport. Thereby it is possible to determine the energy consumption, CO<sub>2</sub> and exhaust emissions transported by rail, road, ship and aircraft in any combination. Within the External Cost Calculator not all the functionalities of EcoTransIT are needed.

The calculation principle can be divided in the following stages:

- Definition of the freight transport (Standard Mode or extended mode).
- XML-Request with input data to the EcoTransIT-Server.
- Calculation of every transport chain.
  - Determination of the route.
  - Route splitted in small sections.
  - Determination of the respective emission factor for each section.
  - Calculation of the emission response.
- XML-Response with output data to the front-end.
- Presentation of the results.

The following picture shows the EcoTransIT work flow.

Figure 1 EcoTransIT work flow



Within EcoTransIT two different kinds of input mode exist. These are the standard and the extended mode. The standard mode includes a quite simple input possibility with origin, destination and freight weight. All other input possibilities are set with standard values.

The extended mode offers many more options to the user. These are an exact definition of the transport chains including via points. It is also possible to define the exact transport type with emission or vehicle classes or load and empty run factor. The external cost values like climate change cost (€/tCO<sub>2</sub>) or accident cost per traffic type can also be changed within the extended mode.

As result the user gets new graphs and tables which include the cost for every selected traffic type. EcoTransIT has world wide coverage but the External Cost Calculator only covers Europe. This difference will be handled within the cost calculation. So if the user selects parts outside of Europe there will be no output for external cost in the results.

## 2.3 External cost data

### 2.3.1 Climate change

Climate change or global warming impacts of transport are mainly caused by the emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O). These emissions could be weighted by using so called Global Warming Potentials (GWP), which indicates the impact on radiative forcing in relation to pure CO<sub>2</sub>. For CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O the GWP is equal to 1, 25 and 298, respectively. Based on this weighting procedure the three greenhouse gases could be expressed in one unit, CO<sub>2</sub> equivalents.

The climate change costs of a trip can be found by multiplying the amount of greenhouse gas (GHG) emissions by a cost factor. Due to the global scale of the damage caused, the effects do not depend on when and where in Europe the GHG emissions take place.

In the tool the estimates of climate change costs are related to well-to-wheel GHG-emissions (both exhaust GHG-emissions and GHG-emissions of fuel/ electricity production).

The cost function applied in the tool for calculating the various CO<sub>2</sub> equivalents costs are the following:

$$\begin{aligned} C_{\text{TTW}, m} &= E_{\text{TTW}, m} * MC_{\text{CO}_2} \\ C_{\text{WTT}, m} &= E_{\text{WTT}, m} * MC_{\text{CO}_2} \\ C_{\text{WTW}, m} &= C_{\text{TTW}, m} + C_{\text{WTT}, m} \end{aligned}$$

In which:

C = Costs per trip due to climate change from GHG-emissions (€/trip)  
 E = Emissions of CO<sub>2</sub> equivalents (ton/trip)  
 MC<sub>CO<sub>2</sub></sub> = Marginal costs of climate change  
 TTW = Tank-to-wheel  
 WTT = Well-to-tank  
 WTW = Well-to-Wheel  
 m = Mode

These cost functions will be applied in both the standard and extended mode of the tool.

The standard and expert mode will only differ in the marginal CO<sub>2</sub> cost values to be applied. In the standard mode marginal cost values for 2008 based on IMPACT will be applied (CE Delft/INFRAS/ISI, 2008). In the extended mode marginal cost values for 2008 based on CE Delft/INFRAS/ISI (2011) will be applied. In addition, in the extended mode the opportunity to fill in their own marginal CO<sub>2</sub> cost values will be provided to users. For a further discussion on the CO<sub>2</sub> cost values applied in the tool, see Chapter 3.

### 2.3.2 Accident costs

The number and severity of traffic accidents depends on various factors. In general, we distinguish the following groups of cost drivers:

- *Vehicle kilometres*; there is a direct and positive relationship between the number of kilometres driven and the number of accidents.
- *Transport mode*; e.g. passenger cars are more often involved in traffic accidents than passenger trains, and cyclists involved in an accident are in general more severely injured than truck drivers.
- *Location-specific factors*; such as traffic speed and traffic volumes, type of infrastructure and country (accident risks in Southern Europe are larger than in Northern Europe).
- *Individual factors*; like driving behaviour and driving experience.
- *Meteorological factors*; e.g. rainy weather increase the probability on traffic accidents.

In the tool we will take the first three groups of cost drivers into account, by estimating the accident costs of a trip by multiplying the vehicle kilometres by marginal accident cost figures which are differentiated to mode (road or rail<sup>1</sup>), type of infrastructure (only for road: urban, interurban and motorways) and country. The last two groups of cost drivers - individual factors and meteorological factors - are not taken into account.

<sup>1</sup> The external accident costs of inland shipping and short sea shipping are negligible and hence are not included in the tool.



An important issue in estimating the (external) accident costs is to determine which part of the accident cost is external. To answer this question two assumptions should be made. First, an assumption should be made on how transport users anticipate their own accident risks. Do people take their own accident risk into account in their decision to use a transport mode (and hence internalise the related accident costs)? In IMPACT (2008) three different values have been presented in order to consider the different perspectives regarding risk perception:

- *Central value*: for the central value it was assumed, that the risk of a non-responsible victim is external.
- *Lower value*: for the lower boundary it was assumed that the average accident risk is internalised by the transport user. Based on this assumption and the under proportional increase in the number of accidents and the severity of accidents with growing transport volumes this perspective resulted in negative marginal accident costs.
- *Upper value*: for the upper margin it was assumed that the average accident risk is not internalised.

For the tool we use the central value.

Secondly, an assumption should be made on which parts of the accident costs are covered by risk oriented insurance premiums and by compensation payments for immaterial damages and grief and pain, mostly as a result of lawsuits, since these costs are internalised. Since national insurance schemes differ in the costs they cover as well as legal practice differs from country to country, the size of the external part of the accident costs will differ between countries. However, no reliable data is available on these differences between national insurance companies and legal practice. Therefore we will apply the same indicator for all countries to estimate the external part of the accident costs. Insurances normally only cover material damages, whereas a specific amount of compensation payments for immaterial damages and pain and grief are paid following lawsuits. Therefore it is assumed that all material damages are internalised by insurance payments. For compensation payments to accident victims no comprehensive data on an European level is available. Therefore we did not apply a rather arbitrary factor in order to consider these compensation payments.

A final choice to be made is the allocation of accidents between various user groups of the same network, in particular between passenger cars and trucks. The various approaches are explained in the update study on external costs (CE Delft/INFRAS/ISI, 2011). We distinguish the following approaches:

- Allocation based on guilt.
- Allocation based on damage potential.

The cost function applied in the tool for calculating the accident costs of road transport is the following:

$$C_m = \sum_{c, i} (VK_{m,c,i} * MC_{m, c, i})$$

- C = Accident costs per trip (€/trip)
- VK = Vehicle kilometres (vkm/trip)
- MC = External marginal accident costs
- i = Type of infrastructure (urban road, interurban road, motorway)
- c = Country
- m = Mode



For rail transport a slightly adapted cost function is applied:

$$C_m = \sum_c (VK_{m,c} * MC_{m,c})$$

These cost functions will be applied in both the standard and extended mode of the tool. In the standard mode marginal cost values for 2008 based on IMPACT will be applied. In the extended mode of the tool there will be some extra options for the users, as summarised below.

- For road:
  - Low: marginal external accidents costs from CE Delft/INFRAS/ISI (2011) with allocation based on guilt.
  - High: average external accidents costs from CE Delft/INFRAS/ISI (2011) with allocation based on damage potential.
  - IMPACT values: marginal accident cost values from IMPACT (CE Delft/INFRAS/ISI, 2008).
  - Own values.
- For rail:
  - Low: marginal accident cost values derived from the average external accidents costs from CE Delft/INFRAS/ISI (2011), by applying a correction factor of 50%.
  - High: average accident cost values from CE Delft/INFRAS/ISI (2011).
  - IMPACT values: average accident cost values from IMPACT (CE Delft/INFRAS/ISI, 2008).
  - Own values.





# 3 Parameter values

## 3.1 Introduction

For the standard mode of the tool input parameter values are based on IMPACT marginal cost values. These cost factors are updated to 2008 values with new empirical evidence and adjusted according to real GDP/capita development. In the extended mode also marginal costs values from CE Delft/INFRAS/ISI (2011) are included.

## 3.2 Climate change costs

Marginal climate change costs will be calculated based on the emissions of greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O) and the respective cost factor. The tool provides both CO<sub>2</sub> emissions as well as CO<sub>2</sub> equivalents. The latter include the other transport related GHG emissions (esp. CH<sub>4</sub> and N<sub>2</sub>O). These emissions can be multiplied by so-called global warming potentials (CH<sub>4</sub>: 25, N<sub>2</sub>O: 298) in order to reflect their impact on radiative forcing in relation to pure CO<sub>2</sub>.

In Table 1 the marginal CO<sub>2</sub> costs applied in the tool are presented. In the standard mode the central value from IMPACT is applied. In the extended mode the upper and lower bound of the marginal CO<sub>2</sub> cost estimates from recent 2011 update study for UIC are applied (CE Delft/INFRAS/ISI, 2011). In addition, users of the tool will be provided to choose their own marginal CO<sub>2</sub> cost value.

Table 1 Marginal costs of CO<sub>2</sub> implemented in the tool

Mode	CO <sub>2</sub> price used (in €/tonne CO <sub>2</sub> )
Standard mode	25
Extended mode	
IMPACT Low	14
IMPACT Medium	25
IMPACT High	105
UIC low	25
UIC high	146
Own value	Value provided by the user

## 3.3 Accident costs

### 3.3.1 Road transport

#### Standard mode

In the standard mode marginal accident costs for freight road transport from IMPACT are applied. These values are corrected for 2008 price levels. The values are given in Table 2.



Table 2 Marginal accident costs for HGV presented by IMPACT (€/1,000vkm, price level 2008)

County	Urban roads	Motorways	Other roads
Austria	170.8	4.8	43.1
Belgium	201.4	5.6	50.8
Czech Republic	104.6	3.0	26.4
Germany	121.5	3.4	30.7
Denmark	133.1	3.8	33.5
Spain	173.3	4.8	43.7
Finland	100.2	2.9	25.3
France	201.4	5.7	50.8
Hungary	111.9	3.2	28.3
Italy	148.5	4.1	37.4
Luxembourg	347.8	9.7	87.8
Netherlands	98.9	2.8	25.0
Norway	114.9	3.2	29.0
Poland	102.5	2.8	25.9
Portugal	205.0	5.7	51.7
Sweden	79.4	2.2	20.0
Slovenia	166.6	4.7	42.0
Slovakia	97.6	2.8	24.6
Switzerland	130.6	3.6	33.0
United Kingdom	77.4	2.2	19.6

Source: IMPACT Handbook, Table 10 (central values), adjusted to 2008 price level.

### Extended mode

In the extended mode marginal accident cost values from CE Delft/INFRAS/ISI (2011) are applied. In Table 3 the various cost values in the extended mode are presented.

Table 3 Marginal accident costs for HGV from CE Delft/INFRAS/ISI (2011) (€/1,000vkm, price level 2008) - Allocation is based on guilt

County	Low (marginal cost - guilt approach)				High (average cost - damage potential approach)
	Urban roads	Motorways	Other roads	All roads	All roads
Austria	33	0.7	8	5	213
Belgium	162	3.4	41	26	258
Czech Republic	103	2.2	26	17	85
Germany	93	2.0	24	15	85
Denmark	32	0.7	8	5	108
Spain	91	1.9	23	15	97
Finland	63	1.3	16	10	133
France	118	2.5	30	19	109
Hungary	135	2.9	34	22	117
Italy	69	1.5	18	11	103
Luxembourg	218	4.6	55	35	121
Netherlands	48	1.0	12	8	74
Norway	63	1.3	16	10	146
Poland	86	1.8	22	14	81
Portugal	92	2.0	23	15	85
Sweden	62	1.3	16	10	93
Slovenia	138	2.9	35	22	66
Slovakia	99	2.1	25	16	131
Switzerland	150	3.2	38	24	109
United Kingdom	53	1.1	13	9	81



### 3.3.2 Rail transport

For rail transport only few studies on marginal accident costs exist. Therefore IMPACT presents only average accident cost figures for rail transport<sup>2</sup>. Also CE Delft/INFRAS/ISI (2011) only presents average accident cost figures. To get a rough indication of the external costs of rail transport on specific origin/destination routes the average accident cost figures from IMPACT are applied in the standard mode of the tool.

In the extended mode, average cost figures from CE Delft/INFRAS/ISI (2011) are used as low values used are a proxy for marginal external accident cost (see Section 2.3.2).

In Table 4 the accident costs applied in the tool are presented.

Table 4 Accident costs for rail transport for the standard and extended mode (€/vkm, price level 2008)

County	Standard mode (IMPACT)	Extended mode - low: proxy for marginal cost	Extended mode - high: average cost - damage potential approach)
Austria	0.15	0.06	0.11
Belgium	0.09	0.04	0.08
Czech Republic	0.08	0.04	0.08
Germany	0.11	0.03	0.06
Denmark	0.04	0.03	0.06
Spain	0.04	0.04	0.07
Finland	0.15	0.01	0.02
France	0.04	0.03	0.05
Hungary	0.29	0.13	0.26
Italy	0.06	0.04	0.09
Luxembourg	0.25	0.08	0.16
Netherlands	0.003	0.00	0.00
Norway	0.48	0.08	0.17
Poland	0.11	0.07	0.15
Portugal	0.11	0.20	0.39
Sweden	0.01	0.01	0.01
Slovenia	0.11	0.04	0.08
Slovakia	0.08	0.03	0.06
Switzerland	0.05	0.02	0.04
United Kingdom	0.09	0.01	0.02

NB: Note that these are given in Euro per vkm instead of Euro per 1,000 vkm as was used for road.

<sup>2</sup> Due to a lack of necessary data no division was made between passenger and freight rail transport.





# 4 Further development of the tool

## 4.1 Introduction

The External Cost Tool as developed in this project could be extended in various ways.

First of all additional cost categories could be added. Air pollution, noise and upstream costs could be added in a similar way as climate and accidents costs. Congestion could also be an option, but as estimates are not available for all transport modes and costs are at least partly transport mode internal, this is not recommended. In Section 4.2 the methodology and data situation for air pollution, noise and upstream costs are briefly discussed.

Finally a similar tool could be developed for passenger transport. This is discussed in Section 4.3.

## 4.2 Additional cost categories

The main cost categories that could be added are: air pollution, noise and upstream costs.

Adding upstream costs (costs from fuel and electricity production) is relatively straightforward. The methodology would be similar to the one applied for climate cost. Just the cost factors should be replaced by factors reflecting upstream emissions instead of climate costs. These factors are available from CE Delft/INFRAS/ISI (2011), with low, medium and high values reflecting various CO<sub>2</sub> cost levels.

Air pollution costs depend heavily on the emission category of the vehicle. This is already part of the EcoTransIT tools as in the extended mode various emission categories can be selected. However, these costs also depend strongly on the region type. Including this differentiation in the calculations is possible but more complicated as the emissions calculated by EcoTransIT need to be split into various region types. A little bit less accurate but much easier would be to differentiate road types as done for accidents costs. In that case, adding air pollution would be relatively straightforward.

Finally, adding noise costs could be done similar to accidents cost. One difference is that the costs also depend on time of the day (night or day time), but this could be done easily by presenting two values or asking an additional choice from the user. In addition noise costs depend on the region. Adding these could be done similarly as done for accidents.

In Table 5 we specify the various methodologies for the various external costs categories. The approaches mentioned in the third column seem a good balance between accuracy and simplicity.



Table 5 Overview of methodologies to estimate the value of various external costs categories

	Simple 'EU-averages'	Advanced 'Country specific'	Sophisticated 'Regional characteristics'	Super sophisticated 'Location specific'
Air Pollution	Emissions x EU value per kg pollutant	Emissions x value per kg pollutant, differentiated to countries	Emissions x value per kg pollutant, differentiated to countries and type of region	Emissions x value per kg pollutant, differentiated to countries and population density per link
Noise	Kms x EU-average MC of noise	Kms x MC of noise, differentiated to countries and day/night	Kms x MC of noise, differentiated to countries and type of regions and day/night	Kms x MC of noise, differentiated to countries, number of people exposed, noise levels per link, time of day
Upstream emissions	Emissions x valuation	Emissions x valuation	Emissions x valuation	Emissions x valuation

### 4.3 Extension to passenger transport

Also for passenger transport a similar tool could be developed based on EcoPassenger. The calculation approaches could be similar to the ones for freight transport, as the structure of EcoPassenger is similar to EcoTransIT.

In the case of aviation, also climate impacts of non-CO<sub>2</sub> emissions should be taken into account.



# Literature

CE/INFRAS/ISI, 2008

M. Maibach, C. Schreyer, D. Sutter (INFRAS) ; H.P. van Essen, B.H. Boon, R. Smokers, A. Schroten (CE Delft) ; C. Doll (Fraunhofer Gesellschaft - ISI); B. Pawlowska, M. Bak (University of Gdansk)

Handbook on estimation of external costs in the transport sector  
Internalisation Measures and Policies for All external Cost of Transport (IMPACT)

Delft : CE Delft. 2008

CE/INFRAS/ISI, 2011

Huib van Essen, Arno Schroten, Matthijs Otten (CE Delft); Daniel Sutter, Christoph Schreyer, Remo Zandonella, Markus Maibach (INFRAS); Claus Doll (Fraunhofer ISI)

External Costs of Transport in Europe : Update study 2008

Delft : CE Delft. 2011

IFEU et al., 2010

Ecological Transport Information Tool for Worldwide Transport Methodology and Data - 2nd Draft Report

Berlin ; Hannover ; Heidelberg : IFEU Heidelberg ; Öko-Institut ; IVE/RMCON ; 2010

INFRAS/IWW, 1995

External Costs of Transport

Paris : UIC, 1995

INFRAS/IWW, 2000

Silvia Banfi, Markus Maibach, Philippe Schenkel, Jean Zuber (INFRAS); Claus Doll, W. Rothengatter, Niklas Sieber (IWW)

External Costs of Transport : Accident. Environmental and Congestion Costs of Transport in Western Europe

Zürich ; Karlsruhe : INFRAS ; IWW (University of Karlsruhe), 2000

INFRAS/IWW, 2004

C. Schreyer, M. Maibach, W. Rothengatter, C. Doll, C. Schneider, D. Schmedding

External costs of transport : update study

Karlsruhe/Zürich : INFRAS ; IWW (University of Karlsruhe), 2004

