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EFORWOOD

Tools for Sustainability Impact Assessment

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Thematic Priority: 6.3 Global Change and Ecosystems

Deliverable PD3.3.4
Data collection of transport processes to ToSIA at case study and EU level

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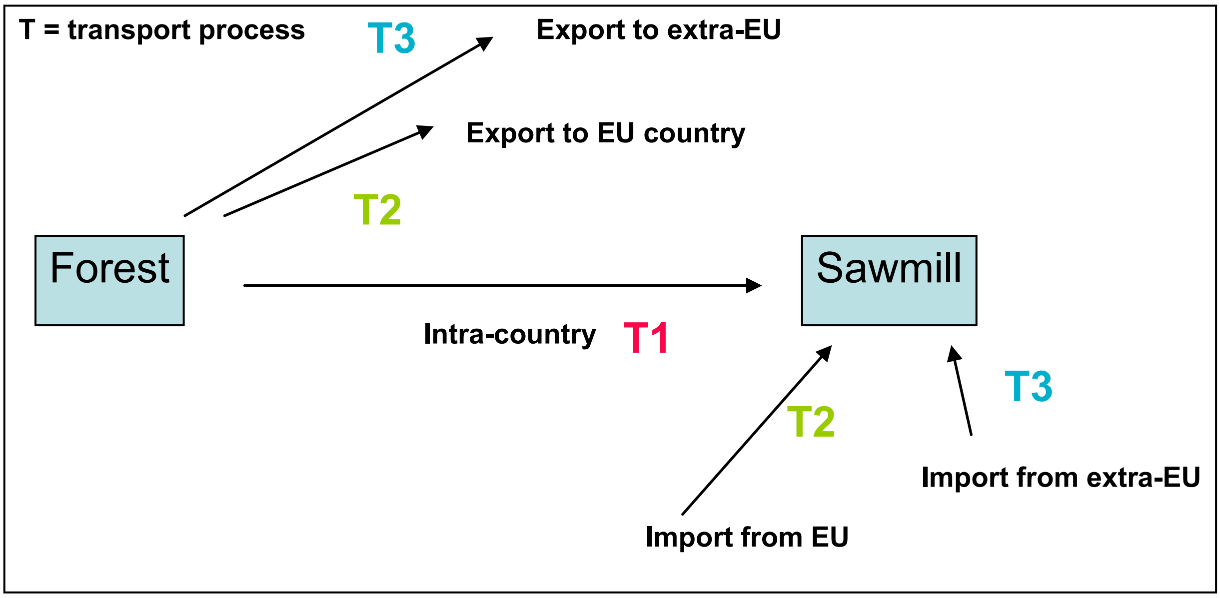
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	X
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Introduction

Data collection for transport processes was possible due to long preliminary work which designed how transport should be approached within the Forest wood chain (D 3.3.3). More precisely, transport within the EFORWOOD project can be defined as the movement of a product between two points integrating several logistic variables which can be estimated at a macro level. In order to provide indicator data in line with this approach, two types of transport tools were developed[1]. Three types of flows can be distinguished within the forest wood chain: intra-national (T1 in fig1), intra-European (T2 in fig1) and extra-European (T3 in fig1) flows. Measuring the sustainability impact of transport involves then to set up three tools for intra-national (one for 2005, one for A1 and one for B2 reference future) and another three for intra and extra-European flows (one for 2005, one for A1 and one for B2 reference future). The methodology is a cross-modules one and the tools were used for all transport processes along the chains. The methodology is not precisely presented in this document as it is the subject of the PD 3.3.6.

Figure 1 : Transport processes related to intra and extra national flows



This deliverable provides a quick overview of methodologies used to estimate indicators for each transport mode: road, rail, inland waterways and short sea shipping[2]. It mainly focuses on data sources, case studies and European Union Forest Wood Chain (EU-FWC) differences

[1] First category:
FCBA_transport_tool_3modesV3.xls for 2005
FCBA_transport_tool_3modesV2_2015-25_A1_V2.xls for 2015-2025 ref future A1
FCBA_transport_tool_3modesV2_2015-25_B2_V2.xls for 2015-2025 ref future A1
Second category:
FCBA_Transport_Tool_Extra_Nat.xls

2 Maritime transport does not have to be included in the transport of goods in the EU according to the definition of SSS by the European Commission: "*Short Sea Shipping means the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non European countries having a coastline on the enclosed seas bordering Europe. Short sea shipping includes domestic and international maritime transport, including feeder services, along the coast and to and from the islands, rivers and lakes. The concept of short sea shipping also extends to maritime transport between the Member States of the Union and Norway and Iceland and other States on the Baltic Sea, the Black Sea and the Mediterranean*."

as well as on result robustness. All tools estimate the same kind of indicators which are described in the following table.

Table 1 : Indicators estimated by the tool

Indicator	Code	Label	Measurement Unit
Gross Value Added			€ / reporting unit
Production Cost	2.1	Average cost	€ / reporting unit
	2.1.3	Labour	€ / reporting unit
	2.1.4	Energy	€ / reporting unit
	2.1.5	Other productive costs (maintenance, administratives,…)	€ / reporting unit
	2.1.6	Non-productive costs (corporate taxes, capital charges,…)	€ / reporting unit
Employment	10.1	Employment -absolute number	Absolute number
	10.1.1	Employment male	% of total
	10.1.2	Employment female	% of total
Wages and Salaries	11.1	Wages and salaries - gender	€ / reporting unit
	11.2	Average wages and salaries per	€ / reporting unit
	11.2.1	Relative to country average	%
	11.2.2	Weighted by purchasing power parity	€ / reporting unit
Occupational Safety and Health	12.1	Occupational accidents	€ / reporting unit
	12.1.1	Non-fatal occupational accidents	€ / reporting unit
	12.1.2	Fatal occupational accidents	€ / reporting unit
	12.2	Occupational diseases	€ / reporting unit
Energy generation and use	18.2	Energy use classified by origin	KWh / reporting unit
	18.2.2	*Direct fuel* use classified by origin	MJ / reporting unit
	18.2.2.1	Renewable fuel	MJ / reporting unit
	18.2.2.2	Fossil fuel	MJ / reporting unit
Greenhouse gas emissions and carbon stock	19.1	Greenhouse gas emissions in total	kg CO_2 equivalents /
	19.1.1	Greenhouse gas emission from machinery	kg CO_2 equivalents / reporting unit
Transport	20.1	Distance by mode	km
	20.1.1.1	Loaded (all modes)	km
	20.1.2.1	Unloaded for road mode only	km
	20.2.1.1	Volume : load capacity of vehicles (by mode)	ton/vehicle
Water and Air Pollution	24.2.1	CO	kg / reporting unit
	24.2.2	NO x	kg / reporting unit
	24.2.3	SO_2	kg / reporting unit

The core of the first section is on the difference between approaches used for case studies and the EU-FWC. The second section focuses on intra-national flows with a special focus on methodology, data and results robustness for road, rail and inland waterways. The third part of the document provides information on the international transport processes, on their specific methodologies, their assumptions and data source (for short sea shipping especially). In a third section the methodology and assumptions used to estimate indicators for 2015 and 2025 are developed. A guideline on how the national transport tool can be used is provided in the annexe.

1. Case studies and the EU-FWC

Table 2 : Use of transport tools

Transport tool	Iberian case study	Baden Wurttemberg case study	Scandinavian case study	EU-FWC
Intra-National	x	x	x	x
Extra-National				x

Extra-National flows

Since there is a large amount of flows between countries in the EU-FWC, a specific tool has been developed for the corresponding transport processes. However this tool was not used in the case studies even though some were concerned by international flows (Scandinavian and Iberian case studies). The use of the intra-national transport tool was used by default[3].

Intra-national flows

A unique methodology was developed in the construction of the intra-national transport tool as there was no clear distinction between case studies and the EU-FWC. However, the tool, as it is described below, allows the use of macro default values or the use of other data which can be provided by users. The main difference remains in the use of data which are specific to case studies and can be used by the tool.

2. National transport processes (T1)

National transport is represented by road, rail and inland waterways.

Road

Road transport within the EU is the main freight transport mode and represents around 50% of total freight when international flows are integrated[4] (Panorama transport, 2007).

In general, studies on transport processes do not estimate economic, social and environmental costs simultaneously. Additionally, studies comparing transport processes at an international level are often limited to one type of vehicle and one type of product. Data collected are not obviously based on similar definition and similar years, thus preventing clear international comparison.

This tool allows the estimation of 29 sustainability indicators of transport processes for 6 types of vehicle and 16 types of solid wood products in 27 European countries.

<u>Data</u>

The part of the tool estimating indicators for road transport is based on data specific to vehicles, countries and products carried. The following subsections describe these data and their sources.

[3] The extra-national transport tool was developed too lately too be used in case studies.
[4] Maritime transport is therefore included, that is rarely done.

Vehicle data

Data related to 32 variables (table 1) are provided for 6 types of vehicles (table 3). Vehicles have been identified because of their representativeness of the forest wood chain transport processes. Vehicle variables cover economic and environmental issues.

Table 3 : Type of vehicle listed linked by module and country/geographic area of reference

Vehicle (Maximum Gross Vehicle Weight)	Module	Country
60 tons	3	Scandinavian
40 tons	3-4-5	Europe
26 tons	3-4-5	Europe
13 tons	4-5	Europe
9 tons	5	Europe
2,7 tons (Van)	5	Europe

Table 4: Data provided by the tool for each vehicle

Source	Label	Type of cost
CNR www.cnr.fr	Maximum Gross Vehicle Weight	Lorry information
	Yearly km (per driver) / vehicle	
	Hours driven (per driver) / year	
	Number hours (per driver) / day	
	Number of working day (per driver) / year	
	Number of effective hours / day	
	Number of average km / day / vehicle	
	Tank provision	
CNR/ADEME	Gasoil consumption in average (l/100km)	Fuel consumption
LIPASTO http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/tieliikennee/tavara_tiee.htm	Fuel consumption Unloaded	
	Fuel consumption loaded	
CNR www.cnr.fr	Tires	Maintenance costs
	Maintenance	
	Toll	Vehicle costs
	Tractor cost	
	(Semi) trailer cost	
	Crane cost	
	Insurance	
	Taxes (incl. axle tax)	
	Wages and other compensations	Crew costs
	Labour charges	
	Other fees: hotel, restaurant…	
	Daily structural (overheads) costs (€/day)	Structural costs
ADEME (Bilan Carbone) www.ademe.fr/bilan-carbone	Load capacity (normal practices)	Lorry information
VTI/Ford/VW/FCBA/Own Assumption	Vehicle Volume capacity (m^3)	
LIPASTO http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/tieliikennee/tavara_tiee.htm	CO Emission (Empty loaded) - kg/km	Environmental impact
	CO Emission (full loaded) - kg/km	
	NOx Emission (empty loaded) - kg/km	
	NOx Emission (full loaded) - kg/km	
	SO_2 Emission (empty loaded) - kg/km	
	SO_2 Emission (full loaded) - kg/km	

Country data

The following table indicates which countries are covered by the tool. In the EFORWOOD context, we can observe that only Malta is not covered.

Table 5 : countries covered by the tool

Austria	Germany	Norway
Belgium	Greece	Poland
Bulgaria	Hungary	Portugal
Cyprus	Ireland	Romania
Czech Republic	Italy	Slovakia
Denmark	Latvia	Slovenia
Estonia	Lithuania	Spain
Finland	Luxembourg	Sweden
France	Netherlands	United Kingdom

Elaborating the methodology demonstrated that each indicator (except gender distribution in employment) was related directly or indirectly to country specificities. The table below describes input values for which there are some country level data. Most of the vehicle data are not country specific (generally they are collected at the French level). Furthermore, some country levels were used to adjust "vehicle data" to each country (See annexe 3 for more details).

Table 6 : Data provided by the tool at a country level

<table>
<tr><th>Source</th><th>Variable</th><th colspan="2">Details</th></tr>
<tr><td rowspan="5">CNR/EIROS, 2005</td><td>Hours driven per year</td><td colspan="2" rowspan="5">Lorry drivers average values</td></tr>
<tr><td>Hours worked per year</td></tr>
<tr><td>Number of km/year per vehicle</td></tr>
<tr><td>Number of days a year</td></tr>
<tr><td>Number of hours a day</td></tr>
<tr><td>Eurostat, 2005</td><td>Annual wages and salaries / employee (€ / employee) -</td><td colspan="2">Transport sector in average</td></tr>
<tr><td rowspan="3">CNR, 2005
Eurostat, 2005
CCT, 2006 (labour charges)</td><td>Daily labour comp (€ / employee) / type of vehicle</td><td colspan="2">Lorry drivers, average values</td></tr>
<tr><td>Daily labour charge (€ / employee) / type of vehicle</td><td colspan="2">Lorry drivers, average values</td></tr>
<tr><td>Labour charges* (% of total wage)</td><td colspan="2">Average data</td></tr>
<tr><td>Eurostat, 2005</td><td>Value added at factor cost (mio_€)</td><td colspan="2">Transport sector</td></tr>
<tr><td>Eurostat, 2005</td><td rowspan="2">Number of occupational accidents for 1000 employees- Land transport -</td><td>Fatal</td><td rowspan="2">Road transport sector</td></tr>
<tr><td>CNT, 2004/Eurostat, 2005</td><td>Non-fatal</td></tr>
<tr><td>Eurostat</td><td>Frequency of occupational diseases cases (1/100 000)</td><td colspan="2">Transport & communication sector</td></tr>
</table>

<table>
<tr><td>DCP/DCP Annex 3</td><td>Purchasing power parity</td><td colspan="3">National average</td></tr>
<tr><td>DCP/DCP Annex 4</td><td>National average wage</td><td colspan="3">National average</td></tr>
<tr><td rowspan="4">Eurostat, 2005</td><td>Gasoline Price (pump provision)</td><td colspan="3">National average</td></tr>
<tr><td>Diesel Price (pump provision)</td><td colspan="3" rowspan="2">National average</td></tr>
<tr><td>Gasoline Price (Tank provision)</td></tr>
<tr><td>Diesel Price (Tank provision)</td><td colspan="3">National average</td></tr>
<tr><td rowspan="3">Eurostat, Statistics in focus</td><td>Empty Backhaulage rate</td><td colspan="3">National average</td></tr>
<tr><td>Empty Backhaulage rate</td><td>M3-M4</td><td colspan="2">National average</td></tr>
<tr><td>Empty Backhaulage rate</td><td>M5</td><td colspan="2">National average</td></tr>
<tr><td rowspan="5">Eurostat, 2005</td><td rowspan="5">Average Distance (National)</td><td>Label group</td><td>NST/R code</td><td>Module</td></tr>
<tr><td>Wood and cork</td><td>5</td><td>3</td></tr>
<tr><td>Construction Materials</td><td>64, 69</td><td>4-5</td></tr>
<tr><td>Pulp & Paper</td><td>84</td><td>4-5</td></tr>
<tr><td>Manufactured goods</td><td>96, 97</td><td>4-5</td></tr>
<tr><td>CNT, 2004/Eurostat, 2005</td><td>Number of occupational accidents - Land transport All-</td><td colspan="3">Non fatal</td></tr>
<tr><td>EIROS, 2005</td><td>Average collectively agreed normal annual working time, 2005 (holidays excluded)</td><td colspan="3">National average</td></tr>
</table>

Product data

Densities of products carried (in ton of wood per m^3 of product) come from FCBA life cycle assessments and FCBA tests. Some caution has to be taken for several solid wood products, especially furniture. As we are dealing with products composed with other materials, it is basically impossible to give a value that is 100% accurate. The wood density is used to estimate indicators per m^3 of wood carried. The product density is used to estimate the volume carried per lorry in order to avoid a loading bigger than lorry's volume capacity. Product density is only used for final products (furniture & joinery) involving important packaging for which the lorry's volume capacity can be reach before the lorry's weight capacity (explained by a low product density).

Table 7 : Default density values of products carried in ton/m^3

Product	Wood Density (ton/m^3)	Source
	Wood products	
Particle board	0,66	FCBA
External wall	0,62	
Glulam	0,46	
Window*	0,08	
Chairs*	0,3	
Kitchen furniture*	?	
	Roundwood	
Spruce	0,79	FCBA
Douglas	0,71	
Scots Pine	0,855	
Maritime Pine	0,88	
Black Pine	0,93	
Aleppo Pine	0,97	
Oak	0,95	
Beech	1,025	
Poplar	0,79	
Spanish Chestnut	0,85	

Input data (to be provided by the user)

The last type of data which are needed to estimate indicators are provided by the tool user. They were reduced as much as possible in order to simplify its use.
The tool measures 29 sustainability indicators with only input data referring to:

- the module (M3, M4, M5)
- the country (27 European countries)
- the type of vehicle (60T, 40T, 26T, 9T & 2.7T)
- the type fuel used (Diesel or Gasoline)
- the product carried (spruce, maritime pine, particle board, etc)

The distance and the load should be provided as well, but a default value is provided in case there are no data.
The tool takes into consideration country, product and vehicle specifications. For instance, labour costs estimations related to the transport of 1m^3 of maritime pine are based on[5]:

- the average wage in the transport sector of the identified country
- the average wage of lorry drivers related to the identified vehicle
- the wood density of the identified product.

Extension

As it is involved in the previous table, it is possible to extend this tool to other wood products as long as we know the density of the other wood products. Otherwise it can also be extended to other materials if their densities are known.

[5] More details on the calculation of indicators are provided in annexes.

Methodology

The methodology is based on the following assumption: economic, social and environmental impacts of transport processes grow linearly with the distance. This limitation allows the tool to be used widely and reduce the number of input data. However the linearity assumption is somehow relaxed for environmental indicators and energy costs by distinguishing loaded and unloaded distances. For instance CO_2 emissions are different if a lorry is loaded or unloaded even if they grow linearly with distances.

The choice of linearity is explained by the willingness to express costs (wage, energy, taxes, etc.) per vehicle kilometre as it has been done in several previous studies (COMPETE project, 2006). Using the volume of wood per lorry, it is then possible to estimate indicators per ton of wood carried. Most of social indicators are estimated on the basis of economic indicator values. The same approach is used for environmental indicators for which data are provided per vehicle kilometre (Lipasto & Bilan carbone). Some details on indicators estimates are provided in Annexe 2.

Example: estimation of labour cost per vehicle/km

Cost data are not uniquely provided per kilometre. Labour costs, lc_d, are expressed per driver and per day of work. For a 40T vehicle, we know that *n* km are run every year in average for *d* days of work of one worker.

Then the vehicle labour cost per km, vlc_{km}, is expressed as:

$$vlc_{km}=lc_d*(d/n)$$

We know that *m* tons of wood is carried by the lorry. Therefore, regarding to the process distance *pd*, the process labour cost, *plc*, expressed in euro per m^3 of wood equals:

$$plc=vlc_{km}*pd/m$$

Comparison of transport processes

The use of a unique methodology allows a comparison of indicators between modules and countries. Comparability was the main criteria retained for data collection.

Limits of the methodology

Linearity: The tool includes loading and unloading average costs per type of vehicle. Because of the linearity assumption, they grow linearly with the distance. However, these costs are different regarding to the distance and the type of logistics. For instance, a short distance process involves, per kilometre, more loading and unloading time (ie. costs) than a long distance process. The ratio loading + unloading cost/driving cost should be higher for a short distance process than for a long one. Then, the tool can't these differences into account[6].

These types of cost differences cannot be measured by the tool for which costs are reported uniformly per kilometre. The quality of infrastructure & the environment (eg—mountains) are not taken into account by the tool.

[6] The ratio loading + unloading cost/driving cost doesn't change with distance in the transport tool.

There is not an indicator expressing the difference of vehicle per country (a 40T vehicle in Romania may be older than one in Germany and consequently consume more fuel).

Estimations are based on two types of consumption: fully loaded and empty. There is no intermediate consumption. This may be a problem, especially for processes involving vans (it is known that the loading rate is not 100%). Generally, current methods of fuel consumption measurement do not involve product density.

Data consistency[7]

Results obtained from the Transport Tool were compared to other sources (eg—COMPETE, CNR). Countries were chosen for their representativeness of Europe.

Heavy Duty Vehicles (HDV: 40T and 26T)

Results obtained from the calculation sheet have to be compared with results from other studies in order to verify their consistency. The first table compares vehicle costs per kilometre (in euro) with the calculation sheet from the COMPETE study.[8] There is relative coherency between both estimates on Heavy Duty Vehicles. In addition, personal costs, energy costs and average costs are relatively close for each country, except Czech Republic. The calculation sheet's estimations of personal costs are slightly different. However, COMPETE results give a French wage higher than the German one which is relatively surprising considering the national averages.

Low Duty Vehicles (LDV: 2.7T and 9T)

COMPETE definition of low duty vehicles is "lower than 12T". However, the study does not mention the proportion of 2.7t in low duty vehicles. According to the table 8 it seems that the focus was on Vans (2.7T) by COMPETE. Results from both studies are very close. Yet, how can we check the quality of the 9T results by the transport tool? A CNR cost distribution has been done for France. Looking at the table 8, figures are almost similar. The slight difference can be explained by the reference year.

Table 8 : Comparison with COMPETE results (in Euros / vehicle km)

	France		**Germany**		**UK**	
	HDV / 26T					
	COMPETE	Transp. Tool	COMPETE	Transp. Tool	COMPETE	Transp. Tool
Average cost	1,26	1,09	1,10	1,17	1,18	1,23
Personnel cost	0,64	0,39	0,49	0,46	0,58	0,46
Energy cost	0,17	0,23	0,19	0,25	0,24	0,3
	LDV / 9T					
	COMPETE	Transp. Tool	COMPETE	Transp. Tool	COMPETE	Transp. Tool
Average cost	1,04	1,62	0,89	1,74	0,94	1,77
Personnel cost	0,56	0,76	0,43	0,86	0,51	0,86
Energy cost	0,05	0,15	0,05	0,16	0,08	0,2

[7] Calculation and comparison made in February 2009

[8] COMPETE Final Report : Analysis of the contribution of transport policies to the competitiveness of the EU economy and comparison with the United States. Version 2.1. October, 2006.

	LDV / 2,7T					
	COMPETE	Transp. Tool	COMPETE	Transp. Tool	COMPETE	Transp. Tool
Average cost	1,04	1,03	0,89	1,13	0,94	1,13
Personnel cost	0,56	0,7	0,43	0,79	0,51	0,77
Energy cost	0,05	0,08	0,05	0,09	0,08	0,11

Table 9 : Comparison with COMPETE results (in Euros / vehicle km)

	Spain		**Czech Republic**	
	HDV / 26T			
	COMPETE	Transp. Tool	COMPETE	Transp. Tool
Average cost	0,84	1	0,52	0,82
Personnel cost	0,32	0,33	0,10	0,15
Energy cost	0,15	0,21	0,14	0,2
	LDV / 9T			
	COMPETE	Transp. Tool	COMPETE	Transp. Tool
Average cost	0,68	1,48	0,40	1,14
Personnel cost	0,28	0,63	0,09	0,29
Energy cost	0,05	0,13	0,04	0,13
	LDV / 2,7T			
	COMPETE	Transp. Tool	COMPETE	Transp. Tool
Average cost	0,68	0,91	0,40	0,6
Personnel cost	0,28	0,58	0,09	0,28
Energy cost	0,05	0,07	0,04	0,07

Table 10 : Comparison with CNR results (in Euros / vehicle km)

France, 9T		
	CNR (2006)	Transp. Tool (2005)
Average cost	1,70	1,62
Personnel cost	119 euros/day	110 euros/day
Energy cost	0,17	0,15

Regarding these different sources, it seems that the Transport Tools provides accurate results. A similar type of comparison has not been made for environmental impacts since no proper methodology was applied.

Rail Cost

Data

Train specific

Table 11: Economic, Social and Environmental data used by the tool

<table>
<tr><th>Source</th><th>Label</th><th>Category</th></tr>
<tr><td>LIPASTO
http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/raideliikennee/tavara_raidee.htm</td><td>Electricity consumption (in kWh)
Primary Energy Consumption (in MJ)
CO_2 Emission (full loaded) - kg/km
CO Emission (full loaded) - kg/km
NOx Emission (full loaded) - kg/km
SO_2 Emission (full loaded) - kg/km</td><td>Environmental impact</td></tr>
<tr><td>CNT, 2006</td><td>Employment (Share of male/female)</td><td rowspan="2">Social</td></tr>
<tr><td>MTETM- Le bilan social annuel du TRM, 2006</td><td>Annual Wage in Euro</td></tr>
</table>

Country specific

Table 12: Economic, Social and Environmental data used by the tool:

<table>
<tr><th>Source:</th><th colspan="4">Label:</th><th>Category</th></tr>
<tr><td>Eurostat (2004)</td><td colspan="4">Share of electricity in total rail energy consumption.</td><td></td></tr>
<tr><td>Sauvant (2003)
EU-KLEMS database</td><td colspan="4">Production cost per ton/km in France.
GVA in Transport & Storage Sector (% of production costs)</td><td rowspan="2">Economic</td></tr>
<tr><td>COMPETE
http://ec.europa.eu/ten/transport/studies/doc/compete/compete_annex_01_en.pdf</td><td colspan="4">Cost distribution (labour/energy/non productive/other).

Production cost per ton/km</td></tr>
<tr><td rowspan="5">Eurostat, 2005</td><td rowspan="5">Average Distance (National)</td><td>Label group</td><td>NST/R code</td><td>Module</td><td rowspan="5"></td></tr>
<tr><td>Wood and cork</td><td>5</td><td>3</td></tr>
<tr><td>Construction Materials</td><td>64, 69</td><td>4-5</td></tr>
<tr><td>Pulp & Paper</td><td>84</td><td>4-5</td></tr>
<tr><td>Manufactured goods</td><td>96, 97</td><td>4-5</td></tr>
</table>

Methodology

As data are reported per ton km, the estimation of transport processes was easy to implement. The only necessity was to know the average distance by train for each process.

The main underlying assumption was the linearity of economic, social and environmental impacts with the distance, the absence of empty backhaulage and a loading rate always equalling to 100%.

Inland Waterways

Data

Ship specific

Table 13: Economic, Social and Environmental data used by the tool:

Source	Label	Category
LIPASTO http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/vesiliikennee/tavara_vesie.htm	Electricity consumption (in kWh) Primary Energy Consumption (in MJ) CO_2 Emission (full loaded) - kg/km CO Emission (full loaded) - kg/km NOx Emission (full loaded) - kg/km SO_2 Emission (full loaded) - kg/km	Environmental impact
CNT, 2006	Employment (Share of male/female)	Social
MTETM- Le bilan social annuel du TRM, 2006	Annual Wage in Euro	

Country specific

Table 14: Economic, Social and Environmental data used by the tool:

Source:	Label:	Category
EU-KLEMS database	GVA in Transport & Storage Sector (% of production costs)	Economic
COMPETE http://ec.europa.eu/ten/transport/studies/doc/compete/compete_annex_01_en.pdf	Cost distribution (labour/energy/non productive/other). Production cost per ton km	

Methodology
Similar to the methodology used for rail. Only one type of ship has been selected by default. Ships are equivalent to "other dried Cargo" in LIPASTO data.

Data robustness
In order to check the robustness of economic results, costs ratios from the COMPETE study and from the Transport Tool are compared in the following table:

comparison train/Lorry/Inland Waterways ratios with other studies
http://www.vtpi.org/tca/tca02.pdf

	Costs (Euro per Tkm) Source: VTPI	Costs (Euro per Tkm) Source: Transport Tool
Barge	0,0061	0,0080

Rail	0,016	0,0282
Truck	0,033	0,0444
Cost Ratios		
barge/rail	0.4	0.3
rail/truck	0,5	0.6

1 mile = 1.6 km

1 Euro = 1 USD (reference year: 2002)

Costs are not directly compared as we are dealing with US figures. However, cost difference can be used as a benchmark, even if it is far from perfect. Ratios show a relative homogeneity between VTPII and Transport Tool results.

3. International transport processes (T2 & T3)

Intra EU and Extra EU transport processes

The extra EU trade should include maritime transport relating European coasts to extra EU countries which do not have a coastline on the enclosed seas bordering Europe (See definition below). However, it has been decided for technical and timing reasons to limit the transport estimates for Extra EU trade only up to EU borders. Subsequently, the methodology in terms of indicators for Intra EU and Extra EU flows are similar.

Transport modes

Transport modes for intra-EU trade include road, rail, inland waterways and short sea shipping.

Short Sea Shipping

Definition (European Commission, 2006): "Short Sea Shipping means the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non European countries having a coastline on the enclosed seas bordering Europe. Short sea shipping includes domestic and international maritime transport, including feeder services, along the coast and to and from the islands, rivers and lakes. The concept of short sea shipping also extends to maritime transport between the Member States of the Union and Norway and Iceland and other States on the Baltic Sea, the Black Sea and the Mediterranean."

Data

Ship specific

Table 15: Economic, Social and Environmental data used for Short Sea Shipping

Source	Label	Category
LIPASTO http://lipasto.vtt.fi/yksikkopaastot/tavaraliikennee/vesiliikennee/tavara_vesie.htm	Electricity consumption (in kWh) Primary Energy Consumption (in MJ) CO2 Emission (full loaded) - kg/km CO Emission (full loaded) - kg/km NOx Emission (full loaded) - kg/km SO2 Emission (full loaded) - kg/km	Environmental impact

T. Notteboom JP Rodrigue (2007), "The next fifty years of containerization: container vessels, liner shipping and seaport terminals", ITMMA + own calculation	Operational costs of container vessels	Economic
	Manning	
	Repair and maintenance	
	Insurance	
	Stores and lubes	
	Administration	
	Fuel	
	Port charges	
COMPETE - MARCO-POLO	Average cost	

Country specific

Table 16: Economic, Social and Environmental data used by the tool

Source	Label	Category
EU-KLEMS database	GVA in Transport & Storage Sector (% of production costs)	Economic
COMPETE http://ec.europa.eu/ten/transport/studies/doc/compete/compete_annex_01_en.pdf	Cost distribution (labour/energy/non productive/other).	

Methodology

Similar to the methodology used for rail and inland waterways. There are assumptions that the empty backhaulage is null and the loading rate equals to 100%.

Indicator measures

The measure of indicators in the international flows context is based on the underlying work done for intra-national flows. The main assumption for road transport is that all international road transport is made with a 40T truck. Average values of indicators reported per tkm are used in the international transport tool. For train, inland waterways and short sea shipping, all values are already reported in ton/km.

Indicator values change for each country of reference. To manage this, a strong assumption is taken: the departure country in an international trade flow is used as a reference. For example, labour cost for a flow from France to Spain will be based on the French labour cost value.

Indicator Sums

The approach considered in the D 3.3.3 and the PD 3.3.6 is that a transport process has to describe the movement of a product from one point to another. It requires that each indicator value for each transport process must consider all transport modes.

For instance, the Gross Value Added of Transport process *p* (GVAp) will equal the gross value added generated by all transport modes used for this process (The methodology is detailed in the PD.3.3.6):

$$GVAp = GVAp_{rail} + GVAp_{road} + GVAp_{InlWat}$$

4. Estimation for 2015 2025 reference futures A1 and B2

A transport tool has been designed for each reference future A1 and B2.

Transport trend and the available literature

The long-term approach of transport is linked with evolving demand and usually the GDP level (Ruehle B., 2006). One of the main transport policy issues is to detach from the GDP trend and the transport level.

European option

EU policy "should optimise the transport system, requiring a modal merge instead of a modal shift" (COM 2006):

1. Viable and feasible alternatives to swap bodies (loading units, weights and dimensions for a European Intermodal Loading Unit, EILU)
2. Revision of the rules on access to the road transport market and encouraging a further reduction of empty runs or less-than-full capacity utilisation
3. Decreasing the number of v-km.

Different works that do not give direct answers

Different estimations were done to assess the future trend of transport. The methodologies are diverse and the results are therefore difficult to compare (EC 2003, Ruehle B., 2006, PRIMES project).

STEPS (Scenarios for the Transport system and Energy supply and their Potential effects) was a project carried out as part of the European Union Sixth Research Framework Programme, under its 'Sustainable Surface Transport' priority.

PRIMES is a model for the evaluation of energy consumption and emissions in the transport sector, as well as for the evaluation of introducing new transport technologies and their effect on emissions with a long term basis (2030). Using this model, Knockaert et al., (2004) provides information on:

1. the annual growth (in tkm) for freight for a period of 5 years,
2. technology shares, energy demand and emissions.

And simulates the impacts of:

3. the enhanced fuel efficiency,
4. biofuel policy,
5. decrease of the sulphur content or RFO (residual fuel oil) navigation,
6. road freight tax in Germany.

The data are not given by IPCC scenarios.

Timms *et al*. (2005) do not give information for individual countries, but provide general trend for A1 and B2 scenarios for 2050 and 2100 horizons adapted from IPCC (base year = 1995).

Scenarios	Freight transport
A1	Increased mobility
B2	Decline due to use of local products

Source: From Timms *et al.* (2005), p 17.

Those general trends do not mean that A1 will lead to more t/km and vice versa.

For EFORWOOD

Do we have to make different assumption for transport trend within EU 27?

The question has been raised for European and Central countries, and the answer is that we do not have to take into account the long-term past trend of those countries but consider that West European freight demand level (and trend) can be used (Ruehle B., 2006).

For EFORWOOD, we propose to use country specific data only for the increase of freight tkm based on the BAU storyline (A0) from TREMOVE project (2007) and to adjust them for 2015 and 2025 (and baseline 2005). Otherwise, the estimations will be the same throughout Europe.

Transport freight in 2015 and 2025 in tkm for A1 and B2

According to ASTRA results presented in the STEPS report, freight transport demand is not very reactive to policies. Total ton-km sharply increases in all scenarios. In the A-1 scenario, freight demand increases by 3.2% per year which is higher than the GDP growth rate. It seems that decoupling[9] will not be prevalent in the future. In the policy scenarios, the total tons-km are higher than in the BAU scenario. This effect is largely caused by the modal shift: for a given O/D pair the average trip length of non-road modes is often larger than road trip length[10]. This effect is especially visible in the technology investments scenarios because in the demand regulation scenarios there are polices that induce a reduction of average consignment length and this effect offsets the impact of modal shift.

If we consider that the evolution of freight within the FWC (all modules) is the same for all commodities, then we may use the following table for 2015 and 2025.

Table 17 : Evolution of freight tkm for A1 and B2 in 2015 and 2025 (Ref. year=2005)

	2005	2015	2025
A1	100	158	190
B2	100	158	203
A0 = BAU	100	153	195

Source: calculated from STEPS project (page 84).

Combining BAU (considering as A0 scenario) with A1 and B2 per country, we get the following table:

Table 18 : Evolution of freight tkm for A1 and B2 in 2015 and 2025 per country

	A1		**B2**	
	2015	**2025**	**2015**	**2025**
AT	118	127	118	136
BE	120	131	120	140
BG	172	269	172	287
CH	121	134	121	143

9 Decoupling means that transport does not, anymore, grow more than the GDP growth.

10 Actually, both rail and sea shipping need that goods are moved to and from terminals and the routes linking the terminals are generally longer than the road route.

CY	112	114	112	122
CZ	135	167	135	179
DE	118	128	118	137
DK	119	128	119	137
EE	138	174	138	186
ES	130	155	130	166
FI	106	103	106	110
FR	120	132	120	141
GR	131	157	131	167
HR	167	255	167	272
HU	131	156	131	166
IE	136	168	136	180
IT	117	124	117	132
LT	149	202	149	216
LU	125	143	125	153
LV	144	190	144	203
NL	119	130	119	139
NO	144	190	144	203
MT	106	103	106	110
PL	134	165	134	176
PT	125	143	125	153
RO	184	310	184	331
SE	118	127	118	136
SI	132	159	132	170
SK	107	105	107	113
TR	145	193	145	206
UK	112	114	112	122

Source: TREMOVE & FCBA calculations

<u>Freight modal split in 2015 and 2025</u>

Tableau 19 : Modal split for freight in EU 25 for A1 in 2015 and 2025

EU 25	2005	2015	2025
A1			
Road	55	50	46
Rail + Inland Waterways	17	20	24
Ship	28	29	30
B2			
Road	55	48	42
Rail + Inland Waterways	17	20	25
Ship	28	30	33

Source: calculated from STEPS project (page 84).
STEPS data do not distinguish the rail and inland waterways freight increases. The assumption is that the increase is similar for both. This assumption matches with the PRIMES model Transport which is based on policy measures.

EFORWOOD Transport tool

The transport tool has been modified for the reference future 2015 & 2025 using figures and studies mentioned previously.
Changes include:

- Energy use
- Production costs
- National average distance per type of product and country
- Modal distribution

<u>Similar changes in A1 and B2</u>

Environmental indicators
On the basis of the PRIMES study, we assume an improvement in efficiency in terms of energy consumption of 0.5% per year. This is followed by 0.5% air pollution emission reduction (CO_2, CO, NO_x and SO_2). All transport means are affected by this technological improvement.

Economic Indicators
Wages and labour costs increase at the same rate as the GDP growth rate (see quantified drivers file).
Energy price follows light oil prices for transport use evolution (see quantified drivers file).
Labour productivity remains constant.

Social indicators
They are assumed to remain constant because of no data or relevant information.
Working time is assumed to remain similar (see quantified drivers file).

<u>Different changes in A1 and B2</u>

Average distance and *modal distribution* are assumed to change significantly in the future according to A1 and B2 storylines. TREMOVE and STEPS studies estimate evolution of transport in an A1 and a B2 context. Their results are then used to set up our own estimations.

Average distance and modal distribution are estimated in 2005 with macroeconomic data: Transport of goods (Wood & cork; Pulp & Paper; Building Material; Manufacturing articles[11]) in tons and in ton/km[12].

$$\text{Average distance} = \frac{\text{Transport of goods in Tkm}}{\text{Transport of goods in Tons}}$$

[11] NST classification

Label group	*NST/R code*
Wood and cork	5
Construction Materials	64, 69
Pulp & Paper	84
Manufactured goods	96, 97

[12] Macroeconomic data (transport in tons and transport in t/km) come from Eurostat sources.

$$\text{Share of rail} = \frac{\text{Transport in Tkm (Rail)}}{\text{Trans. in Tkm (Road)} + \text{Trans. in Tkm (Rail)} + \text{Trans. in Tkm (Inland Waterways)}}$$

In order to estimate these variables in 2015 and 2025, it is necessary to get macroeconomic values of transport in Ton and in Tkm in 2015 & 2025.

TREMOVE study provides evolution of Tkm per country (we assume changes similar across sectors) and STEPS projects gives the modal distribution in 2015 & 2025 at the European level and without sector distinction.

Average distance in 2015 & 2025 for each reference future

Transport in Tkm in 2015 and 2025 are estimated using TREMOVE index (see table 18). Transport in ton (or trade volume) is assumed to follow GDP growth even if there is a risk of imperfect coupling. The correction is done using the elasticity of trade to each country GDP growth per country (α in the example).

$$\alpha = \frac{\Delta\text{Trade (in ton)/Trade(in ton)}}{\Delta GDP / GDP}$$

Example for a country (B2):

$$\text{Average distance}_{t+10,\,j,\,B2} = \frac{\text{Transport of goods in Tkm}_{t,\,j} \times \text{Tremove Index}_{t,\,t+10,\,B2}}{\text{Transport of goods in Tons}_{t,\,j} \times \alpha \times \text{GDP growth}_{t,\,t+10,\,B2}}$$

t=year (2005)
j= 1, 2, 3, 4: Sector (1=Wood & cork; 2=Pulp & Paper; 3=Building Material; 4=Manufacturing)

GDP growth is estimated differently for OECD and Eastern European countries.
In the tool the following countries are identified as Eastern European:

- Bulgaria
- Czech Republic
- Estonia
- Latvia
- Lithuania
- Romania
- Slovenia
- Slovakia

Average distance estimation

It is possible to estimate the average distance in 2015 and 2025 for each reference future with the value of your own 2005 average distance.
Coefficient used for calculation:

$$\text{Average distance increaseCoeff}_{t,\,t+10,\,j\text{-}B2} = 1 + \frac{\text{Average distance}_{t+10,\,j\text{-}B2} - \text{Average distance}_{t,\,j\text{-}B2}}{\text{Average distance}_{t,\,j\text{-}B2}}$$

Modal Transport distribution in 2015 & 2025 for each reference future:

Assumptions used for average distance are also used for modal distribution. STEPS project (table 19) provides information on modal distribution for A1/B2 2015 and 2025 periods. However, modal distribution has to be estimated for Rail, Road and Inland Waterways by sector (Wood & cork; Pulp & Paper; Building Material; Manufacturing articles).

The way of calculation is explained below:

Calculation (example year: 2015=t+10):

Please note that country specifics are dropped from the demonstration. This type of calculation is run for every country.

The objective of the calculation is to estimate $M_{t,\,I,\,j}$.

Definition of variables:

Modal share (Transport tool): $M_{t,\,I,\,j}$

Modal share (STEPS sources) in 2005 = $S_{t,\,i}$

Freight (in Tkm) increase 2005-2015 (TREMOVE source) = $fi_{t,\,t+10}$

Freight in Tkm, by year, sector & transport mean= $F_{t,\,i,\,j}$

t = year (2005)

i = 1, 2, 3: transport mean (1=Rail, 2=Road and 3=Inland Waterways)

j= 1, 2, 3, 4: Sector (1=Wood & cork; 2=Pulp & Paper; 3=Building Material; 4=Manufacturing articles)

Freight (in tkm) in 2015 by sector and transport mean:

$$F_{t+10,i,j} = \frac{F_{t,i,j} \times (fi_{t,\,t+10} \times S_{t+10,i})}{S_{t,i}}$$

Modal share in 2015 by sector (example: share of train in transport of Wood &Cork in 2015):

$$M_{t+10,i,j} = \frac{F_{t+10,i,j} \times 100}{\sum_i F_{t+10,i,j}}$$

Indicators estimations

A1 and B2 transport tools are similar to the 2005 transport tool except that they take changes mentioned in this document into account.

5. Conclusion

This overview of the methodology used to collect data for transport processes has shown that the main differences between the two transport tool categories: intra-national and the extra-national.

- The intra-national transport tool allows a measure of indicators for transport processes within a country. It deals with road, rail and inland waterways transport modes. The tool covers both case studies and the EU-FWC case as macro defaults values can be replaced by specific field data.
- The extra-national transport tool is dedicated to the international transport of wood products. Its methodology is based on the same approach as the intra-national one. However it

doesn't allow the use of data from the field and can be used only for the EU-FWC. It deals with road, rail, inland waterways transport and short sea shipping transport modes.

Focusing on indicators collection and estimation at a flow and transport mode level, the document has also shown, using comparative results with other studies, the robustness of tools' methodologies and the tools' results. Concerning references futures, the deliverable has also described how estimates of indicator values at a flow and transport mode level for 2015 and 2025 are mainly explained by a distance and a modal split change. The methodology used to estimate final indicators after aggregation (transport mode and flows) is not included in this document but is the subject of the PD 3.3.6.

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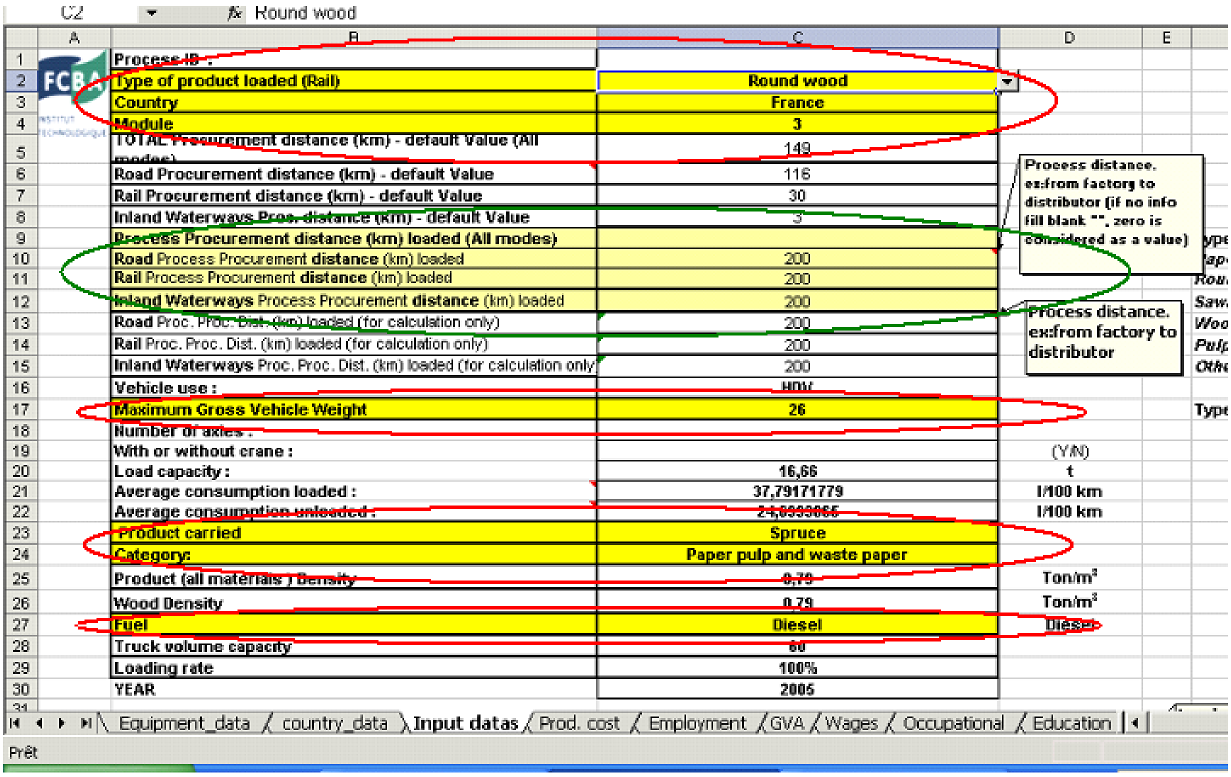
6. Annexe 1: How to use the national transport tool?

The simplicity of usage is the main objective. There are 6 compulsory data to provide (in red circle on the figure 2). Entrance data are already registered in the Excel sheet. A drop-dawn menu exists for each category with all possible choices. For example, in the fuel category, you just have to choose between Gasoline and Diesel.

Optional input data to provide (tonnage and distance) are shown within brown circles in the figure 1. If there is no data, national average distance related to the category of product carried (Wood and cork, building materials, Paper pulp and waste paper & manufactured articles - described in table 6) is used as a default value. Tonnage default value equals the lorry's weight load capacity if the volume carried is lower than the volume lorry's volume load capacity.[13]

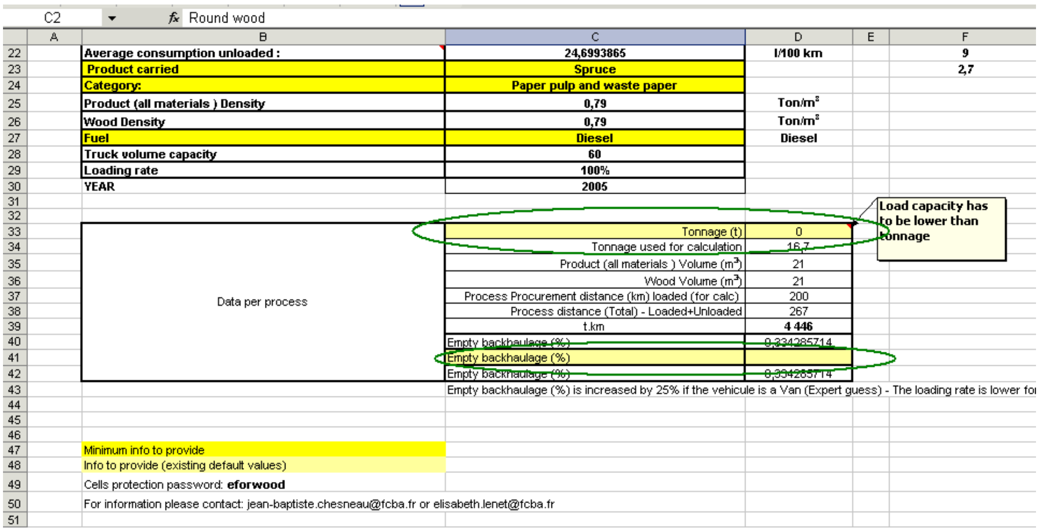
Figure 2 : Input data excel sheet :



« Input_sheet »:

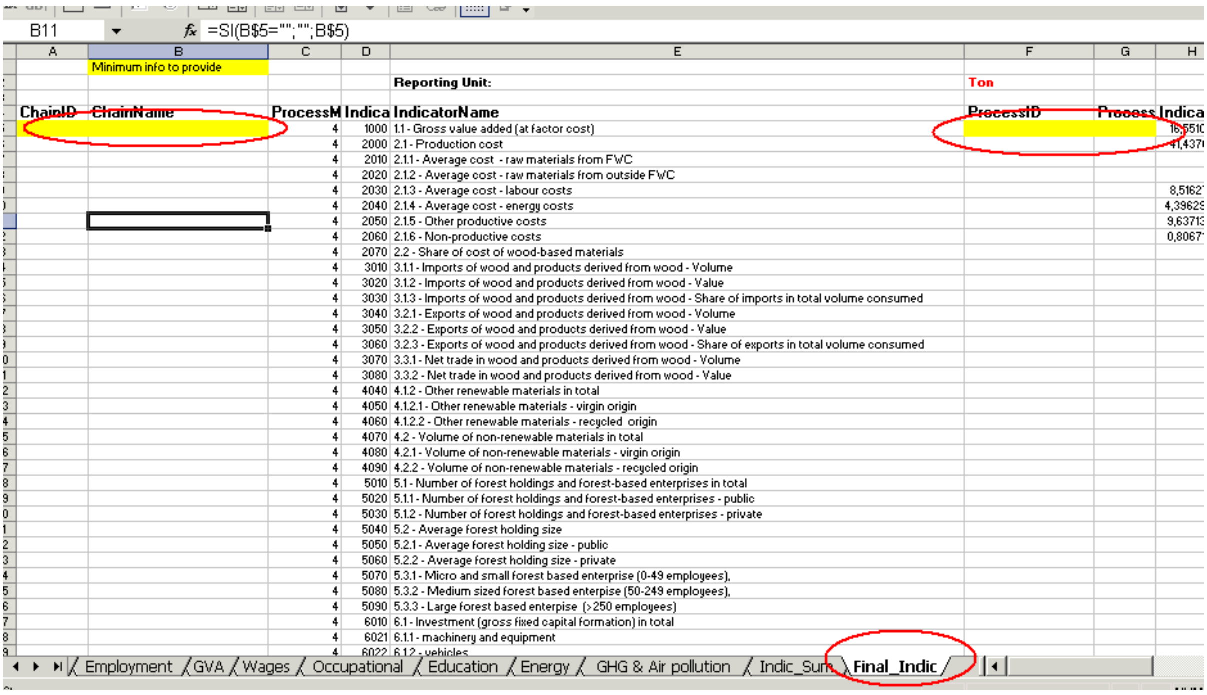
- Within the red circles, fill in the cells according to information in the drop-dawn menu.
- In green, fill in the cells manually if you have some specific information. That is optional as long as default values are already defined (national averages). Please note that if you do not provide data, these cells have to be blank.

[13] Exception for M5, 2.7T vehicles : the volume loading default value is set at 75% of the lorry's volume capacity.



For lorries only: (at the bottom of the « input_sheet ») You can provide specific information on loading and empty backhaulage. In case of no data, default values are automatically used.

Figure 3 : Output data providing information on the value of indicators

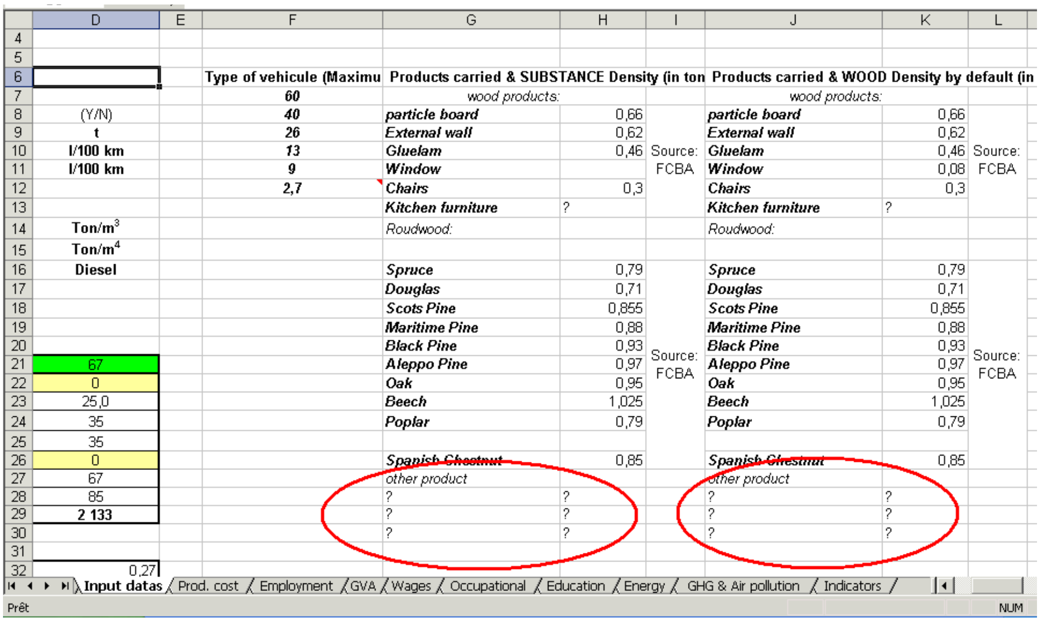


Yellow cells have to be filled according to the "Client" requirements.

Annexe 2: Indicators reported in m^3 for road transport mode

Another version of the intra-national transport tool were designed for road transport only allowing the use of m3 as a reporting unit. All indicators are reported per m^3 of wood. The density of wood per product ("input_data" sheet) allows the possibility to measure the volume of wood per vehicle. The value resulting from the following estimations (average cost, labour cost, air pollution, etc.) are divided by the volume of wood in order to get final indicator values.

Figure 4 : Products density in the « input_datas » sheet



	D	E	F	G	H	I	J	K	L
4									
5									
6			Type of vehicule (Maximu	Products carried & SUBSTANCE Density (in ton			Products carried & WOOD Density by default (in		
7			60	wood products:			wood products:		
8	(Y/N)		40	particle board	0,66		particle board	0,66	
9	t		26	External wall	0,62		External wall	0,62	
10	l/100 km		13	Gluelam	0,46	Source:	Gluelam	0,46	Source:
11	l/100 km		9	Window		FCBA	Window	0,08	FCBA
12			2,7	Chairs	0,3		Chairs	0,3	
13				Kitchen furniture	?		Kitchen furniture	?	
14	Ton/m³			Roudwood:			Roudwood:		
15	Ton/m⁴								
16	Diesel			Spruce	0,79		Spruce	0,79	
17				Douglas	0,71		Douglas	0,71	
18				Scots Pine	0,855		Scots Pine	0,855	
19				Maritime Pine	0,88		Maritime Pine	0,88	
20				Black Pine	0,93	Source:	Black Pine	0,93	Source:
21	67			Aleppo Pine	0,97	FCBA	Aleppo Pine	0,97	FCBA
22	0			Oak	0,95		Oak	0,95	
23	25,0			Beech	1,025		Beech	1,025	
24	35			Poplar	0,79		Poplar	0,79	
25	35								
26	0			Spanish Chestnut	0,85		Spanish Chestnut	0,85	
27	67			other product			other product		
28	85			?	?		?	?	
29	2 133			?	?		?	?	
30				?	?		?	?	
31									
32	0,27								

By replacing cells with the sign "?" tool users can put a new product and a new density.

Annexe 3: Complement information on data used for road transport

Data which are in the "country_data", "lorry_data" and "input_data" (only product density) sheet can be modified by users. However, it should be used cautiously in order to keep figures coherent.

Loading rate & empty backhaulage

There is a substantial difference of loading rate and/or empty backhaulage between modules and/or vehicle used. The empty backaulage difference is also substantial at an international level. All these differences have been taken into consideration in calculation using international data and assumption based on expert guesses.

60T values

60T values have been obtained from a Swedish source whereas the lorry data sheet is based on French values. Furthermore, Swedish values have been adjusted to French data using working time observations. Labour productivity of lorry drivers is assumed to be similar in France and in Sweden. Using national average working times of both countries, the French 60T is estimated in terms of:

- yearly km / vehicle
- hours driven per year
- number hours / day
- number of working day / year
- number of average km / day / vehicle

For example:
*French yearly km vehicle = Swedish yearly km vehicle * Average French working time / Average Swedish working time*

Daily structural (overheads) costs (€/day), maintenance and toll costs are estimated with 40T French values.

Annexe 4: Indicators reported in m^3 for road transport mode

All indicators are reported per m^3 of wood. The density of wood per product ("input_data" sheet) allows the possibility to measure the volume of wood per vehicle. The value resulting from the following estimations (average cost, labour cost, air pollution, etc.) are divided by the volume of wood in order to get final indicator values.

Average cost

Average cost is the sum of energy, labour, other productive costs and non productive costs.

Labour cost

Labour cost is the sum of wage, labour charge and travel fees (hotel, restaurants…). They are expressed per kilometre, summed and multiplied to the process distance (loaded+unloaded).
Data on lorry drivers' labour costs are not known for all European countries and type of vehicle. French lorry drivers' daily wages are known for each type of vehicle. French labour charges are only known for the 40T. National average wages in the transport sector are known. Lorry drivers' labour charges are known in the transport sector for some countries. Then daily labour charge per vehicle, daily European wages and daily European labour charges have to be estimated. Some data are not available for 2005, and then some adjustments were needed.

French labour charges

The calculation is based on CNR definition. CNR estimates that for a 40T in France a daily labour cost is structured by x% of wage and by y% of social contribution. The daily wage is known for all type of vehicle in France. Daily labour charges of other vehicles are estimated with the ratio *z=y/x*.

For example:

Wage 40T=129euros
Wage 26T=123euros
Labour charge 40T=47euros
Labour charge 26T = 123*47/129

European wages

In order to estimate wages and labour charges for the rest of Europe, national wage averages in the transport sector are taken from Eurostat. Average employer social contributions are provided by CNR but if not these are not available, adjustments are done using other countries figures or national employer's social security contributions).
Using these averages, a coefficient is obtained with French values (average wage and labour charge). It is then and associated daily French wage and labour charge of lorry drivers.

Illustration:

AWFr: Average wage in France (Transport sector)
AWGer: Average wage in Germany (Transport sector)
LWFr: Daily wage of a French lorry driver
LWGer: Daily wage of a German lorry driver

$$LWGer=LWFr* AWGer/ AWFr$$

European labour charge:

For some countries, lorry drivers labour charges are known (in % of the French one) without distinction of lorry types. When data are unknown the ratio national average labour charge (% of labour costs) / French average labour charge is used (% of labour cost).

Time adjustment

Note: French lorry values are known only for the year 2007. Then the ratio, *r* : hourly labour price index 2005 / hourly labour price index 2007 is applied (Source CNR).
Then we have:
$LWGer_{2005}=r*LWFr_{2008}*AWGer_{2005} / AWFr_{2005}$

Labour charge is estimated at a national level after the national daily wage estimation.
The same type of ratio with other price index has been used for maintenance, tires and travel costs (price index sources: CNR).

Travel fees

Travel fees are expressed per kilometre. They are assumed to be similar across Europe but different by vehicle type.

Energy cost

Energy cost is estimated using loading and unloading consumption, fuel pump and tank prices and loaded and unloaded distances:
*Fuel price=% Pomp fuel provision*Pump Fuel price + %Tank fuel provision*tank Fuel price*
*Fuel consumption (in litres)=Fuel cons. loaded*Loaded km + Fuel cons. unloaded* Unloaded km*

*Energy cost = Fuel price*Fuel consumption*

Other productive costs

They are assumed to be similar across Europe but different by vehicle type.
They are expressed using tires, maintenance, toll, tractor cost, (semi) trailer cost, crane cost and daily structural (overheads) costs. The cost of infrastructure is partially included through the toll. The rest of infrastructure costs are not included in the tool. In order to develop inter-modality and reduce CO2 emission, it is expected to have an increase of infrastructure cost in future through new taxes such as the “carbon tax”. All costs are expressed per km except structural costs for which a modification based on working day is necessary. Other productive costs are then estimated using the process distance (loaded + unloaded).

Non productive costs

They are assumed to be similar across Europe but different by vehicle type.
They gather taxes and insurance costs. They are both expressed per kilometres. They are then estimated using the process distance (loaded=unloaded).

Employment

Employment is based on the process working time and national definition of a full time job.
Illustration (Spanish case):
Process Employment=Process working time (in hours) / National definition of a full time job (in hours per year)

Female and male employment rate of lorry drivers is substantially different to the transport sector as a whole. French is then used as a default value because unavailable data for the rest of Europe.

Gross value Added

M4-M5: The level of gross value added *gvan* and ton kilometres *ntk* of the transport sector are known for each country. Using the ton kilometres explained by the process (from input data), *ptk*, the gross value added of the process *gvap* can be estimated:

$$gvap=gvan*ptk/ntk$$

M3: The values obtained in the results are higher than results got from field studies. Consequently, using French results[14] on wood transport, a coefficient has been estimated to correct results got from national data. The assumption is that this French overestimation is similar for all European countries. Process distance includes loaded and unloaded distance.
French Value added rate got from field data=0.42
French Value added rate got from Eurostat data=0.57
Coefficient of adjustment: 0.42/0.57=0.74
Then in M3:

$$gvap=gvan*ptk*0.74/ntk$$

Wages

See labour costs

Occupational accident and safety

Europe: Accidents (all) on the road in Country c * Number of Accident in France in freight transport / Accidents on the road in France (all)
Fatal accident per thousand of employees in the transport sector for each European country is provided by Eurostat. Similar figures are not known for non fatal accident.
Eurostat statistics provide data on non fatal accident in road transportation (professional & non professional). Assuming that the intensity of professional & non professional accidents in road transportation is proportional to only professional accident road transportation, the following calculation is used:

FP_{nfacc}= Number of non fatal accidents for 1000 lorry drivers in France.
$GerP_{nfacc}$= Number of non fatal accidents for 1000 lorry drivers in Germany.
F_{nfacc}= Number of non fatal l accidents for 1000 drivers (professional and non professional) in France.
Ger_{nfacc}= Number of non fatal l accidents for 1000 drivers (professional and non professional) in Germany.

$$GerP_{nfacc}= FP_{nfacc}* (Ger_{nfacc}/F_{nfacc})$$

Education

No data available.

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[14] Bulletins de l'Observatoire Régional des Transport du Limousin n°9. Study realised by the Banque de France & the Direction Régionales de l'Equipement.

Energy

The measure of energy consumption is based on fuel consumption.
Energy use=fuel consumption*Density fuel*Energy Conversion factor (MJ/tep)
Data on renewable energy consumption are unavailable. If the user has them, yellow pale cells can be filled in ("Density renewable fuel" & "Share of fossil use").

Greenhouse gas emission and Air pollution

Greenhouse gas emission and air pollution measurement are based on fuel consumption.
A CO_2 conversion factor (kg of CO_2 / litre of fuel) is used to express it. Diesel and Gasoline conversion factor are equal (Source ADEME, Bilan carbone). Renewable fuel conversion factor is unknown and has to be filled in by the user (depending on the share of biofuel in the mix and the biofuel density).

Air pollution is only measured for fossil fuel consumption (CO, NO_x &SO_2). The measure is based on fuel consumption.

Pollution due vehicle usage

Waste from use of the car such as oil or tyre are not taken into account in this tool.

Annexe 5: Rail

Rail costs can be divided in fixed costs and marginal costs. As such, there are high railway maintenance and construction costs as well as there are road maintenance and construction costs. We don't take all these infrastructure costs into account and then focus on marginal costs. Estimation of an average value of reference for marginal cost (in tkm) is a difficult task as it is shown in the following table:

• SMALLEST MARGINAL COSTS cents/gtkm	
Track section	
• Uimaharju-Nurmes	0.0186
• Ylivieska-Tuomioja	0.0214
• Juurikorpi-Hamina	0.0231
• LARGEST MARGINAL COSTS cents/gtkm	
Track section	
• Saarijärvi-Haapajärvi	1.3369
• Kankaanpää-Parkano	4.2251
• Parkano-Aittoneva	10.2744

Source: Suvanto, 2004
(http://www.internationaltransportforum.org/europe/ecmt/railways/pdf/Rome04FIN.pdf)

In the case of road transport, infrastructure costs through tolls. In the case of rail, Sauvant's estimates, confirmed by expert guesses are used and adjusted per country using COMPETE's figures.