User Manual TrIGGER Tool

User Manual
Transport Inventory and Greenhouse Gas Emission Reporting (TrIGGER) Tool
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of the Federal Republic of Germany

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Background Information on the TraCS Project

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) works on changing transport towards a sustainable pathway and facilitating climate actions in mobility. We support decision-makers in emerging and developing countries through training and consulting services, as well as by connecting stakeholders. Our ultimate goal is to keep global temperature change to below 2 degrees Celsius.

The TraCS project's objective is to enable policy makers in partner countries (Vietnam and Kenya) to specify the contribution of the transport sector to the Nationally Determined Contributions (NDCs). Detailed knowledge on mitigation potentials can furthermore lead to raising the level of countries' ambitions.

The project follows a multi-level approach:

- At country level, TraCS supports (transport) ministries and other relevant authorities in systematically assessing GHG emissions in the transport sector and in calculating emission reduction potentials through the development of scenarios.
- At international level, TraCS organises an active exchange between implementing partners, technical experts and donor organisations in order to enhance methodological coherence in emission quantification in the transport sector (South-South and South-North dialogue). The dialogue aims to internationally increase transparency regarding emission mitigation potentials and harmonisation of methodological approaches in the transport sector.

TraCS is funded by the International Climate Initiative of the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU).

This document was developed by GIZ in cooperation with the Institute for Energy and Environment (ifeu). It aims at giving an introduction on the tool including the calculation approach and most relevant data sources by guiding though all the sheets.

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Purpose of the tool

The Transport Inventory and Greenhouse Gas Emission Reporting (TrIGGER) Tool is designed to calculate the total fuel consumption as well as CO_2, CH_4 and N_2O emissions for five transport sub-sectors (aviation, road, railways, maritime, inland shipping) during one year (GHG emission inventory). It can be easily filled in and delivers a first good overview of the most crucial emission sources of the transport sector on country level.

It has been originally developed for the Ministry of Transport of Vietnam (MOT) in order to contribute to the countries' overall emission inventory compiled by the Ministry of Environment and Natural Resources of Vietnam in the context of the project "Advancing Transport Climate Strategies in Rapidly Motorising Countries" (TraCS). TrIGGER has been developed within this project in a co-operation between the Department of Environment of the MOT, a working group on GHG inventory of the MOT and the Institute for Energy and Environment (Ifeu).

Methodology

The calculation approaches for the sub sectors have been mainly developed based on the data availability in Vietnam and then been adapted to international use. Three of the tools are based on an activity based bottom-up approach (waterborne and road), two of the tools are based on an energy data based top-down approach (railway, aviation). In each sheet, the tool describes the calculation approach in more detail.

Figure 1: Sub sector tool overview

The tool does not enable full accordance with the requirements of the IPCC guidelines. For example, the categories "other transport" and "pipeline transports" are not yet included. Moreover GHG emissions of biofuels have to be excluded from the fuel used in transport (according to the IPCC methodology, these are accounted for in other sectors e.g. agriculture), but the current bottom-up approach calculating fuel use may hide a share of biofuel. The energy balance data should nevertheless avoid accounting for biodiesel.

Design of the tool

The Excel-based tool consists of different data input sheets for each sub sector (road, inland waterways, maritime, rail, aviation). Those data input sheets are marked in green. Furthermore, the tool presents the calculation results in different sheets (blue) such as the summary table, the top-down validation sheet, the GHG inventory and modal split sheet. Other sheets (yellow) contain default parameters for the calculation. Lastly, one sheet should list all references for the data input. In case of this tool, example data from Germany as well as default values from international sources have been used.

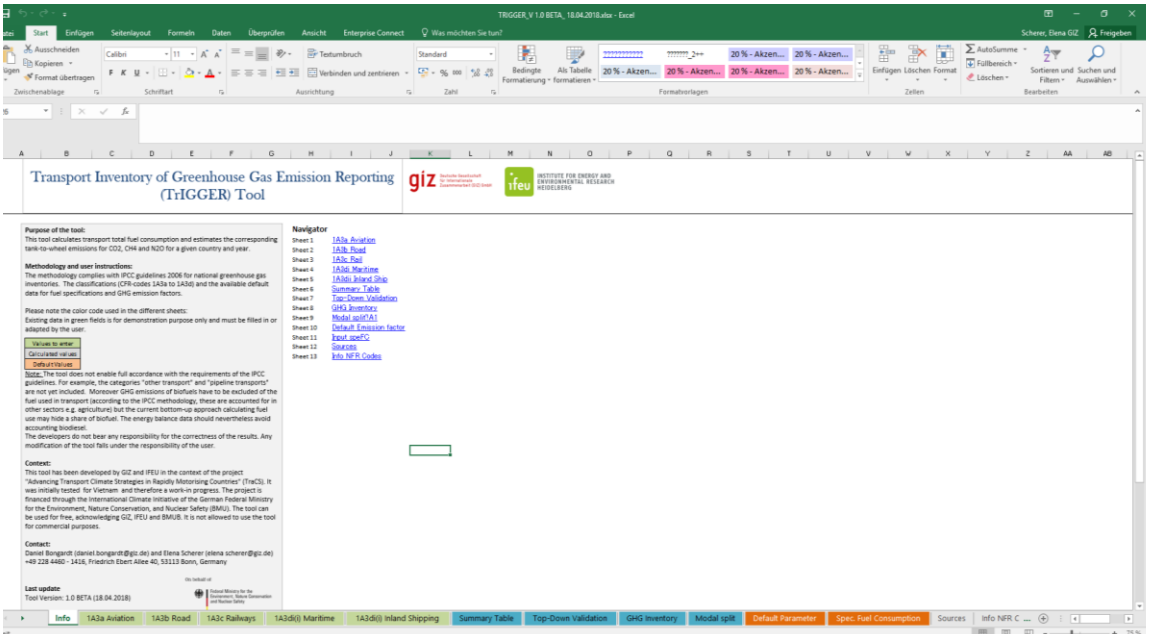

Figure 2: Screenshot of the info sheet

The tools includes a color code for the cells, which visualizes if the value in the cell is a value to be entered each year (green), is a default value that has to be updated only when better data is available (orange) or a calculated value (grey). General information is shown on white background.

Values to enter
Calculated values
Default Values

Important data sources

Most of the data in the sub sector models must be provided annually by the responsible agencies (e.g. data on vehicle stock, travel activity) most likely by the countries' Ministry of Transport and its subordinate agencies. As often country specific emission factors and data on the specific fuel consumption for different vehicle types are not available, the tool provides international default values. In case that country specific data on emission factors or real world average specific fuel consumption is available, the defaults should be substituted by those. The following international and national official sources are crucial data inputs for the tool:

- IPCC (2006) default emission and conversion factors (heating value, fuel density)
- Energy balance data (e.g. from IEA or existing national GHG emission inventories) for validation purposes
- EMEP/EEA emission inventory guidebook (2013) data on specific fuel consumption (road sector)

Each data input requires an input on the related data source to ensure transparency of the calculation.

I. 1A3a Aviation

Methodology

In the aviation sector, GHG emissions are calculated in a top-down approach: the total fuel consumption (aviation gasoline and kerosene) is multiplied with a fuel specific emission factor.
Only domestic aviation (both departing and landing taking place in the same country) is counted towards GHG emissions according to the IPCC Guidelines methodology.

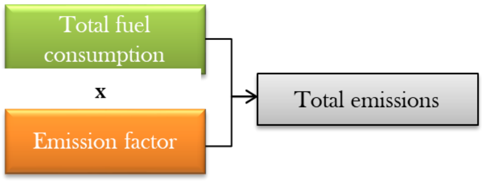

Figure 3: Screenshot of the calculation approach in the aviation sector (top-down)

Input parameter Overview

Total fuel consumption

The only required data input (column E) is the total fuel consumption by fuel for both domestic and international aviation. Usually, this data is collected by countries in order to report to international institutions such as the *International Civil Aviation Organization* (ICAO).

Data input on transport performance (columns Y; Z) is not needed for the GHG emission calculation but can be used for validation purposes

II. 1A3b Road transport

Methodology

In the road sector, emissions are calculated in a simplified bottom-up approach. This bottom-up approach is based on multiplying activity data i.e. vehicle stock and average vehicle kilometers travelled (VKT) with specific fuel consumption and emission factors. Data is disaggregated per vehicle type (4 types), size class (17 classes; see table 1), fuel type (diesel, gasoline, LPG, CNG) and technology ("before Euro 1/ no-standards/ PRE-ECE" to Euro 6). In the columns under "activity data" vehicle stock (column H) and average vkt (column J) should be given on the highest disaggregation level of vehicle type. The size classes are equivalent with the size classes in EMEP/EEA guidebook to fit to the default values on average fuel consumption (column T).

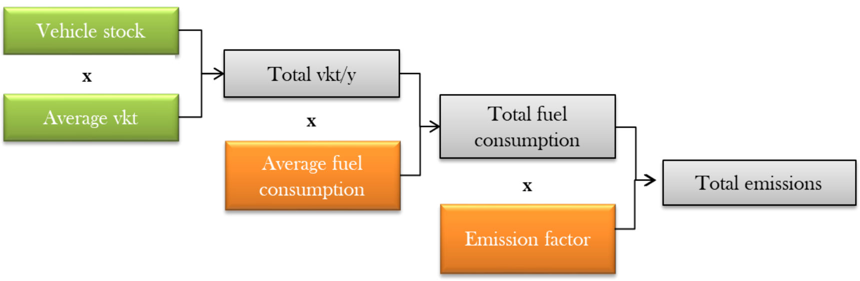

Figure 4: Screenshot of the calculation approach in the road sector (bottom-up)

Road transport includes all types of vehicles, such as passenger cars, light trucks, heavy trucks, buses and on-road motorcycles, using different types of gaseous and liquid fuels. It does not include mobile machinery used for agricultural activity.

Additional information on vehicle load and transport performance can be used for validation and projections (see below column AJ-AN) but is not part of the calculation for the inventory.

Input parameter Overview

Vehicle stock

The vehicle stock requires data input on the total number of vehicles in operation as of end of the reporting year; excluding vehicles that have expired or have not been put for examination. Usually, the authority responsible for vehicle registrations would deliver that data. However, it is a challenge for many countries with cumulative registries, as they do not have valid information on vehicles no longer in operation. Models on vehicle survival curves can then be used to estimate the operating fleet based on registry data of past years. Such estimations have to be done outside of TRIGGER.

Table 1: Vehicle categories

Vehicle Category	Size classes
Passenger cars	By engine size: < 1400cm³; 1400-2000cm³, >2000cm³
Buses	By weight: 3500kg 3500-15.000 kg >15000-18000kg
Trucks	By weight: <3500kg 3500-7500 kg <7500-16.000 kg <16.000-32.000kg < 32.000 kg
Motorcycles	Engine/ engine size: 2-stroke < 50 cc 2-stroke < 50 cc 4-stroke < 50 cc 2-stroke > 50 cc 4-stroke <50-250 cc 4-stroke 250–750 cm³ 4-stroke > 750 cm³

Source: EMEP/EEA Guidelines, 2016.
http://www.eea.europa.eu/publications/emep-eea-guidebook-2016/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-i

Vehicle kilometers of travel (VKT)

The average traveled distance per vehicle category in a given year should best come from national sources, e.g. based on specific surveys (e.g. odometer readings in regular vehicle inspections; household surveys etc.).

For more information on vehicle mileage and stock data the background paper "Approaches for Establishing In-Use Vehicle Stock and Vehicle Mileages" can give useful information. It is available here: https://www.changing-transport.org/publication/in-use-vehicle-stock-and-mileages/

Average fuel consumption

The average amount of fuel consumed in the tool refers to a 100-kilometer distance. For fuel specification and average fuel consumption, the proposed EMEP/EEA default values for each fuel and vehicle subcategory can be used. However, if more accurate or recent data is available it should be updated with country specific values. Those data can be e.g. delivered from vehicle testings and surveys (e.g. household surveys). It should not rely on manufacturer information but on proven real world fuel consumption.

III. 1A3c Railways

Methodology

For the railway sector, GHG emissions are calculated in a top-down approach based on the total fuel consumption (diesel oil) and a specific emission factor.

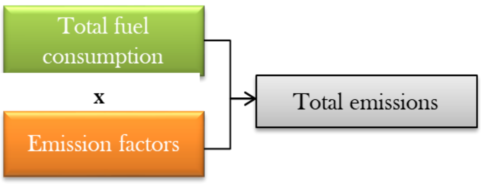

Figure 5: Screenshot of the calculation approach in the railway sector (top-down)

Input parameter Overview

Total fuel consumption

The only data input is the total fuel consumption for railways (column E).

Additional data on VKT and transport performance (columns Y to AA) can be used for comparison and calculation of specific fuel consumption.

IV. 1A3d Maritime

Methodology

The fuel consumption and GHG emissions of maritime navigation are calculated in a simplified bottom-up approach based on the total transport performance.

The total fuel consumption (heavy fuel oil (HFO) and diesel) is the product of the total transport volume (divided into passenger, bulk freight and container transport), the average transport distance and the average specific fuel consumption. To calculate GHG emissions, fuel consumption is multiplied with default emission factors.

A split of HFO and diesel oil in fuel consumption has to be estimated. The data is differentiated between domestic and international transport. Only the domestic share is included in the GHG emission inventory.

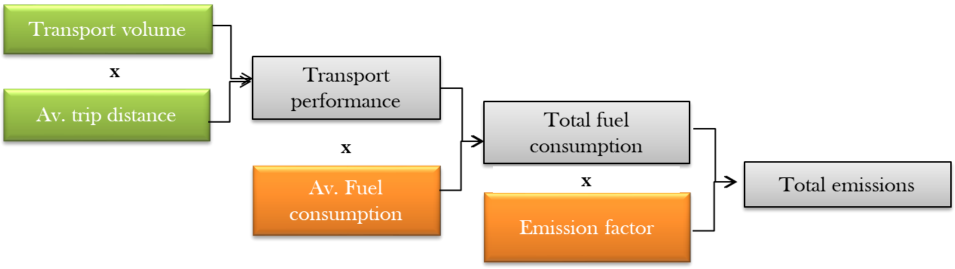

Figure 6: Screenshot of the calculation approach in the maritime navigation (bottom-up)

Input parameter Overview

Volume of passenger transport

The volume of passenger transport is measured in the number of passengers (unit = 1000 passengers).

Volume of bulk freight transport

The volume of bulk freight transport is measured in the total weight carried within the period of one year (unit = 1000 tonnes).

Volume of container transport

The volume of container transport is measured in the number of Twenty Foot Equivalent Units (TEU) within the period of one year (unit = 1000 TEU). The TEU is one of the two most common international standardised container types besides the forty foot. A twenty-foot unit measures about 6 meters, a forty foot about 12 meters (external dimensions).

Usually, those information on the transport performance can be derived from annual national transport statistics.

Average trip distance

The average trip distance is measured in kilometers per trip. The information is usually collected by port authorities. If the data is not available in the official transport statistics, this information can be estimated based on the distance of most common sea routes; vehicle tracking data or specific surveys.

Share of fuel type

Most large maritime vessels use HFO, but local regulations on low sulfur fuels may restrict the use of HFO. The percentage of the share of heavy fuel oil HFO and diesel has to be estimated, e.g. on expert guessing based on vehicle fleet information or specific surveys.

V. 1A3d Inland Shipping

Methodology

The fuel consumption and GHG emissions of inland waterway navigation is calculated in a bottom-up approach. The total fuel consumption is the product of the number of ships, average operating hour, average engine power, load factor and engine specific fuel consumption. Total fuel consumption is multiplied with default emission factor to calculate GHG emissions. The data is differentiated by ship category and size classes.

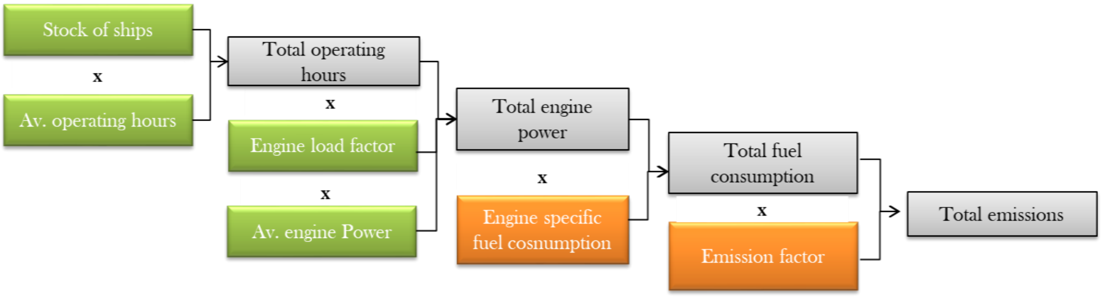

Figure 7: Screenshot of the calculation approach in the inland navigation (bottom-up)

Input parameter Overview

Stock

The vehicle stock requires data input on the total number of ships in operation as of end of the reporting year; excluding vehicles that have expired or have not been put for examination. Usually the required information will be available from the inland shipping administration or from the authority responsible for vehicle registrations. Table 2 gives an overview on the vehicle classifications based on the ship weight and category.

Table 2: Vehicle categories for Inland shipping

Ship category	Weight class
Dry bulk ship	<1500 t
Dry bulk ship	1500 - 3000 t
Dry bulk ship	>3000 t
Push convoys	all
Passenger ship	all
Ferries	all
Small private boats	< 15 t
Small private boats	< 15 t

Average operating hours

The average operating hours per year are requested for each ship category.

Engine load factor

The average engine load factor percentage is requested for each ship category.

Those values can be estimated based on survey information of expert guessing, if not available from official transport statistics.

VII. Summary Table

The summary sheet contains a summary of the total fuel consumption by fuel type and GHG emissions of each subsector, for passenger as well as freight transport. For the road sector, it shows an overview for different vehicle categories. Additional data includes the transport performance. This sheet does not require any input from the user as all fields are calculated.

Country	Reference year	NFR code	NFR Category	NFR Subcategory	Transport mode	Fuel type	Lower Heating Value	Total fuel consumption	CO2 emissions	CH4 emissions	N2O emissions	Passenger transport	Freight transport
							TJ/1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes	1000 tonnes	Mio PKM	Mio TKM
Aviation													
GERMANY (example)	2016	1.A.3.a.i	Civil Aviation	Domestic aviation	All	Kerosene	44,1	742,6	2.341,5	0,0	0,1	10.154,6	47,2
GERMANY (example)	2016	1.A.3.a.ii	Civil Aviation	International bunkers	All	Kerosene	44,1	8.346,8	26.318,6	0,2	0,7	216.181,2	11.711,1
GERMANY (example)	2016	1.A.3.a.i	Civil Aviation	Domestic aviation	All	Aviation Gasoline	44,3	8,9	27,5	0,0	0,0	2,2	0,0
Road													
GERMANY (example)	2016	1.A.3.b.i	Road Transportation	Passenger car	Passenger	Motor Gasoline	44,3	22.341,1	68.586,9	32,7	3,2	581.275	0
GERMANY (example)	2016	1.A.3.b.i	Road Transportation	Passenger car	Passenger	Diesel Oil	43	20.871,6	66.503,3	3,5	3,5	560.912	0
GERMANY (example)	2016	1.A.3.b.i	Road Transportation	Passenger car	Passenger	LPG	47,3	505,8	1.509,5	1,5	0,0	15.971	0
GERMANY (example)	2016	1.A.3.b.i	Road Transportation	Passenger car	Passenger	CNG	48	93,0	250,3	0,4	0,0	2.656	0
GERMANY (example)	2016	1.A.3.b.ii	Road Transportation	Light duty trucks	Freight	Motor Gasoline	44,3	166,6	511,4	0,2	0,0	0	1.162
GERMANY (example)	2016	1.A.3.b.ii	Road Transportation	Light duty trucks	Freight	Diesel Oil	43	3.884,4	12.377,0	0,7	0,7	0	19.797
GERMANY (example)	2016	1.A.3.b.iii	Road Transportation	Heavy duty trucks	Freight	Diesel Oil	43	13.262,4	42.257,9	2,2	2,2	0	596.134
GERMANY (example)	2016	1.A.3.b.iii	Road Transportation	Bus	Passenger	Motor Gasoline	44,3	0,0	0,0	0,0	0,0	0	0
GERMANY (example)	2016	1.A.3.b.iii	Road Transportation	Bus	Passenger	Diesel Oil	43	1.107,5	3.528,9	0,2	0,2	109.124	0
GERMANY (example)	2016	1.A.3.b.iii	Road Transportation	Bus	Passenger	CNG	48	17,0	45,8	0,1	0,0	1.121	0
GERMANY (example)	2016	1.A.3.b.iv	Road Transportation	Motorcycles	Passenger	Motor Gasoline	44,3	549,8	1.688,0	1,0	0,1	24.723	0
Railways													
GERMANY (example)	2016	1.A.3.c	Railways	Railways	Passenger	Diesel Oil	43	219,4	955,3	0,1	0,4	9.900	0
GERMANY (example)	2016	1.A.3.c	Railways	Railways	Freight	Diesel Oil	43	80,4	955,3	0,1	0,4	0	8.486
Maritime													
GERMANY (example)	2016	1 A.3.d.ii	Water-borne navigation	Domestic water-borne navigation	All	HFO	40,4	0,0	0,0	0,0	0,0	0,0	0,0
GERMANY (example)	2016	1 A.3.d.ii	Water-borne navigation	Domestic water-borne navigation	All	Diesel Oil	43	186,7	594,8	0,0	0,0	9.000,0	2.000,0
GERMANY (example)	2016	1.A.3.d.i	Water-borne navigation	International bunkers	All	HFO	40,4	1.890,7	5.912,0	0,5	0,2	25.200,0	598.500,0
GERMANY (example)	2016	1.A.3.d.i	Water-borne navigation	International bunkers	All	Diesel Oil	43	810,3	2.581,8	0,1	0,1	10.800,0	256.500,0
Inland shipping													
GERMANY (example)	2016	1 A.3.d.ii	Water-borne navigation	Domestic water-borne navigation	Freight	Diesel Oil	43	271,3	864,5	0,0	0,0	0,0	37.200,0
GERMANY (example)	2016	1 A.3.d.ii	Water-borne navigation	Domestic water-borne navigation	Passenger	Diesel Oil	43	63,5	202,2	0,0	0,0	1.800,0	0,0
GERMANY (example)	2016	1 A.3.d.ii	Water-borne navigation	Domestic water-borne navigation	Passenger	Motor Gasoline	44,3	0,0	0,0	0,0	0,0	0,0	0,0

Figure 8: Screenshot of the summary table sheet

VIII. Top-Down Validation

The sheet serves for validation of the calculated results based on a comparison with (official) data from the national energy balances. It requires data input on the fuel consumed by fuel type (transport sector total and for each sub sector). The differences are shown in charts and enable an easy comparison.

Energy balance data are based on the total fuel sales within the country. According to the IPCC guidelines 2006, the final energy consumption for the GHG inventory should be calculated as follow: production + import – export - international bunkers - stock change.

Differences within a range of +/- 10% are quite common and should not be considered as error but as uncertainty. Differences can derive from errors in the data input for the tool as well as in the energy balances itself.

The main uncertainties for energy balance data are:

- Allocation of fuels to the transport sector (e.g. fuel consumption from diesel generators should not be accounted for transport) or transport subcategories (i.e. road transportation vs other transports, domestic use vs. international bunkers)
- Amount of grey imports (illegally sold fuels, tank-tourism in small or transit-countries)

The main uncertainties for bottom-up fuel consumption data are:

- Activity data i.e. fleet composition, vehicle number or VKT, specific fuel consumption

The emission inventory report should try explaining gaps and analyze the possibility to minimize the related uncertainties. Based on the uncertainty analysis, data input for the modelling (e.g. on vkt) might be reviewed and adapted accordingly.

Sometimes, the national energy balance data is not available for recent years. Data of the International Energy Agency or extrapolations based on existing energy balances from the past years can served as an alternative.

Transport (all categories)				
Fuel type	Energy Balance (1000 tonnes)	Source	Calculated (1000 tonnes)	Difference
Motor gasoline	16.275	UBA, 2018	23.057	42%
Diesel Oil	34.083	UBA, 2018	40.757	20%
Kerosene	9.089	UBA, 2018	9.089	0%
Aviation gasoline	9	UBA, 2018	9	0%
HFO	1.759	UBA, 2018	1.891	7%
LPG	423	UBA, 2018	506	19%
CNG	161	UBA, 2018	110	-32%
Biofuels	2.867	UBA, 2018		-100%

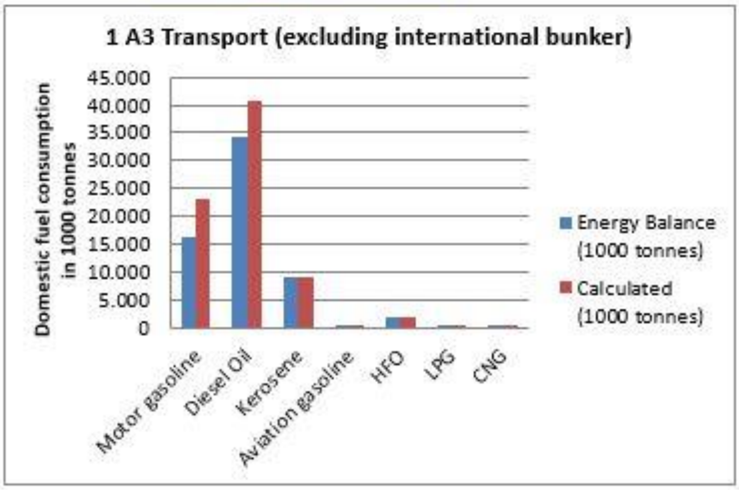

Figure 9: Screenshot of the comparison of the energy balance (top-down) and calculated (bottom-up) data in the validation sheet

IX. GHG Inventory

The GHG inventory sheet shows the results of the calculated GHG emissions in line with IPCC guidelines. Therefore, only domestic transports are included, international and bunkers excluded. This sheet does not require any input from the user as all fields are calculated and visualized automatically.

Country	Reference Year	NFR code	Subcategory	Emissions in 1000 tonnes			
				CO2	CH4	N2O	CO2-eq
GERMANY (example)	2016	1.A.3.b.i	Passenger car	136.850	38,1	6,7	139.794
GERMANY (example)	2016	1.A.3.b.ii	Light duty trucks	12.888	0,9	0,7	13.112
GERMANY (example)	2016	1.A.3.b.iii	Heavy duty trucks & bus	45.833	2,5	2,4	46.614
GERMANY (example)	2016	1.A.3.b.iv	Motorcycles	1.688	1,0	0,1	1.744
GERMANY (example)	2016	1.A.3.a.ii	Domestic aviation	26.319	0,2	0,7	26.543
GERMANY (example)	2016	1.A.3.c	Railways	1.911	0,1	0,7	2.133
GERMANY (example)	2016	1 A.3.d.ii	Domestic water-borne navigation	1.662	0,1	0,1	1.690
		1.A.3	**Transport**	**227.150**	**43**	**11**	**231.628**

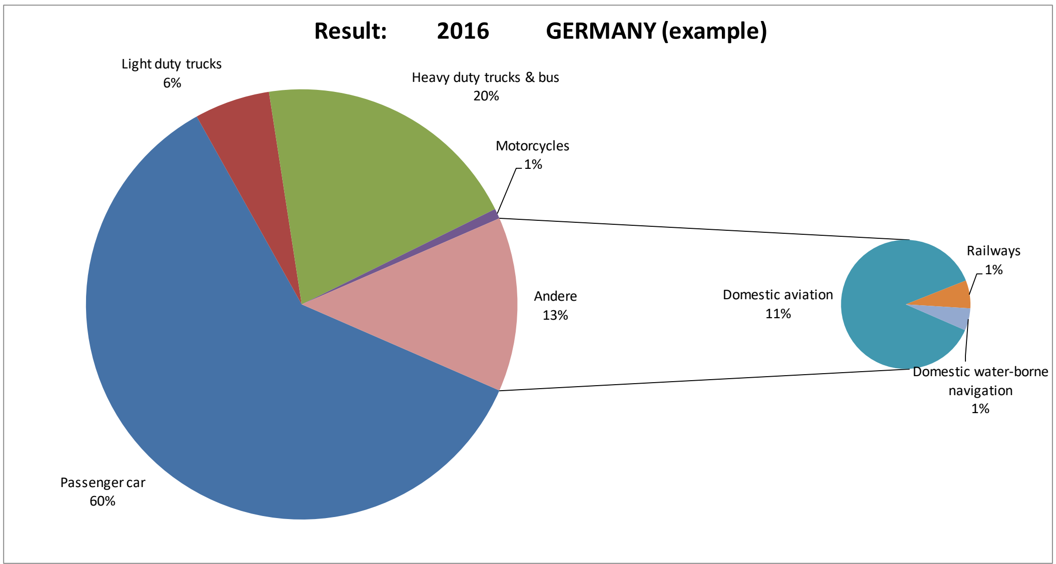

Figure 10: Screenshot of the calculation results in the GHG inventory sheet (example Germany)

X. Modal Split

This sheet gives another option for the validation of the calculated results by comparing calculated data on the transport performance with data from official transport statistics.

Ton-Kilometers (TKM) and Passenger-Kilometers (PKM) describe transport demand for freight and passenger transport. The share of TKM and PKM for each transport mode is called the modal split (note: the unit must be given, since modal split can also be obtained from the number of trips or vehicle-kilometers). Some national statistics may include the total transport performance per transport category. Such data can be compared with the results of the present calculation tool, especially for transport categories using a bottom-up approach (e.g. road).

Transport demand of electric trains or electric vehicles should be excluded because they are currently not considered in this tool, as in the GHG emission inventory according to IPCC, as their energy consumption is considered in the electricity sector.

The specific fuel consumption (g per TKM or PKM) enables comparing the fuel efficiency of different modes. It can be compared with official statistics and data from the literature - if available - in order to help identifying uncertainties.

Discrepancies can occur due to different factors: vehicle efficiency (e.g. age of the fleet), passenger or freight capacity of vehicles (size) and load factor (occupancy and empty trip rates).

High discrepancies i.e. in the magnitude of +/-50% which cannot be explained by the previous influencing factors might indicate errors in the calculation or input parameters.

Other parameters such as vehicle size, capacity and load factor can also be useful to calibrate total transport demand.

XI. Default Parameters

The given default parameters for lower heating values and emission factors for CO_2, CH_4 and N_2O used for all subsectors are based on the IPCC 2006 guidelines (available online: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf).

The defaults comply with the IPCC tier 1 approach and are not country-specific. Especially for CH_4 and N_2O emission factors underlie high uncertainty depending on country-specific traffic situations.

If country specific emission factors are available, it is recommended to update the sheet, otherwise the defaults can be used.

XII. Specific fuel consumption

The given default fuel consumption factors for specific fuel consumption of road vehicles is used for the sheet 1A3b Road. The factors are based on European data (EMEP/EEA) which is allocated to the vehicle types used in this tool. They can represent only a simplified estimation for other countries.

The default factors should be changed only if better and reliable data are available and depict the reality of the country.

XIII. Sources

When using the tool, each data input requires an information on the source to ensure transparency and enable a validation through third parties. In each sheet, it is enough to provide information on the author/ publishing agency of the source as well as the year of the publishing date. The sheet "Sources" serves as more detailed list of references, e.g. including the exact title of the document/ study and / or a link for online sources. Ideally, all original sources are collected and saved with the tool together in one folder. Another option is to save screenshots of the original sources.

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