Interreg CENTRAL EUROPE
European Union
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ChemMultimodal

TOOLBOX ELEMENT: CO2 CALCULATOR

DELIVERABLE 1.2.9

VERSION 2

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1. CO2 Footprint

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The purpose of the Deliverable was to develop a method to calculate CO2 footprint of chemical transport on different modes to demonstrate reduction of CO2 emission after the implementation of modal shift as contribution to sustainable development.

Initial approach:

"To fulfil the purpose, preliminary the analysis and description of different methods of CO2 emission calculation was conducted. The existing platforms have been identified and analysed in terms of methodology used and ability to implement for Project's goal fulfilment. At the same time the analysis of tools for CO2 emission measurement by chemical companies and LSPs have been done."

1.1. Analysis and description of different methods for CO2 calculation

To fulfil the purpose, preliminary the literature review was conducted to identify approaches and available methodology that was already developed. Then the analysis and description of different methods of CO2 emission calculation was conducted. The existing platforms have been identified and analysed in terms of methodology used and ability to implement for Project's goal fulfilment. At the same time the analysis of tools for CO2 emission measurement by chemical companies and LSPs have been done.

There are numerous EU-wide studies on calculation of GHG emissions, e.g. CEN Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers), Greenhouse Gas (GHG) Protocol, G4 Sustainability Reporting Guidelines, TREMOVE Economic Transport and Emissions Model, Alan McKinnon Report. Developing a methodology for CO2 measuring, the distinction between two main approaches should be drawn:

- A more general calculation method, called activity-based method, which uses the average CO2 emission factor per tonne-km by transport mode, transport volume and average transport distance by transport mode.
- An energy-based approach which estimates the actual amount of work done and the energy consumed per unit of output. The 'output' of freight transport operations is generally measured by tonne-kms and energy consumption by litres of fuel or kilowatt-hours of electricity used per tonne-km and fuel/energy CO2 emission conversation factor.

The activity-based calculation method is recommended for use by chemical companies, as most of their transport operations are outsourced, they have no direct access to energy fuel consumption data. A challenging step in the approach is establishing the

most appropriate freight emission factor for each transport mode and a particular country (in accordance with the EN 16258 standard). There are broad international differences in the nature and efficiency of freight operations (i.e. the load factor, the share of empty running, the energy efficiency of the vehicle or train), particularly in the average carbon intensity of the energy source (e.g. a source of electricity for rail transport or the nature of fuel types being obligatory used by vehicles – percentage of biofuels within the fossil fuels) and in the condition of transport infrastructure. So companies should differentiate used parameters of CO2 emissions according to the country and transport modes. The energy-based calculation method is the more accurate way of CO2 estimation for logistics companies, as they have direct access to fuel consumption data. The scope of CO2 calculation methodology is limited to transport operations. The energy consumption of handling or transhipment activities is not covered.

1.2. Description of available platforms providing CO2 emissions calculators

The calculation of energy consumption and emission data of a worldwide chemical transport chain can be done with the help of Internet platforms for CO2 calculation. There are customised CO2 calculators offered by consulting companies as well as a few free-of-charge tools available on the market (Tab. 1).

Tab. 1 Selected global, free-of-charge, Internet platforms for CO2 freight calculation

CO2 calculator	Mode of transport	Energy-based approach	Activity-based approach	Extra features	Standards
Eco TransIT World[1]	- road - rail - sea - inland - air	yes	yes	Customisation is available and extra charged	EN 16258
NTMCalc Freight[2]	- road - rail - sea - air	no	yes	Advanced version with energy-based approach is charged	EN 16258
Climate care[3]	- road - sea	yes	yes	NA	NA

[1] http://www.ecotransit.org/calculation.en.html

[2] https://ntmcalc-fb.transportmeasures.org/Milan/milan.jsf

[3] https://climatecare.org/calculator/

	- air				
LOG-NET[4]	- road - rail - sea - inland - air	no	yes	NA	NA

Eco TransIT World (ETW) is one of the most popular CO2 calculators in Europe. It is an independent industry driven platform for carriers, LSPs and shippers, developed by a consortium of different companies, with the scientific support of IWE Hannover, IFEU Heidelberg and INFRAS Zurich. ETW is a free of charge application, which shows the environmental impact of freight transport for any route in the world and any transport mode. Therefore, it allows the user to analyse and compare different transport chains with each other, and to eventually choose the solution with the lowest environmental impact. The ETW application offers two levels: (a) standard for a rough estimate, and (b) extended for a more precise calculation. The extended calculation requires the input of more information on the shipment such as: freight characteristics, route characteristics and distance, vehicle size and engine type, load factor and empty trips.

For professional users, ETW offers dedicated services that allow them to calculate large number of shipments at once without manual handling effort. This business solution could be customised what is paid extra 5. ETW application and methodology behind it are applied by: DB Schenker, Gebrüder Weiss, Gefco, Greencarrier, Group7, Hamburg Süd, Hapag-Lloyd, Kühne+Nagel, Marquard & Bahls, Mediterranean Shipping Company (MSC), Austrian Railways (ÖBB), Panalpina, Posti, Rhenus Logistics, SBB, SNCF, System Alliance Europe (SAE), Trenitalia, International Union of Railways (UIC), Wim Bosman, Zufall Logistics Group, among others. There are also two chemical companies using ETW i.e. Beiersdorf and Henkel.

1.3. Description of approaches and solutions offered from LSP (best-practice)

According to the results of our survey, LSPs, especially big players, express higher interest in CO2 emission measurement from freight transport than chemical companies. To contribute to the creation of environmentally sustainable supply chains, LSPs started working on measuring, reducing and offsetting GHG emissions. Table 2 presents the list of selected LSPs operating in Central and Easter Europe and offering multimodal transport services, which calculate CO2 emission in accordance with EN 16258 standard

[4] http://sustainability.log-net.com/

[5] Annual fees for business customers are available at: http://www.ecotransit.org/masscalculation.en.html

and communicate their eco activities and strategies to the public in easily accessible CSR statements or reports. Many of them are awarded for being responsible and sustainable businesses.

Tab. 2 Selected LSPs offering multimodal transport and calculating CO2 emission

Logistics company	CO2 Calculator	User	Mode of transport	Standards
DB Schenker	Eco TransIT World[6]	- shipper - LSP	- road - rail - sea - air	EN 16258
Kühne + Nagel	K+N Global Seafreight Carbon Calculator based on Eco TransIT World[7]	- shipper - LSP	- road - rail - sea - inland - air	EN 16258
Dachser	LogEC	- shipper - LSP	- road - rail - sea - air	DIN EN 16258 French Decret 1336
DHL	DHL Carbon Calculator[8]	- shipper - LSP	- sea - air - road - rail	EN 16258 GHG Protocol
GEFCO	Eco TransIT World	- shipper - LSP	- road - air - sea - rail	EN 16258
Panalpina	Eco TransIT World	- shipper - LSP	- air - sea - rail - road	EN 16258
P&O Ferrymasters	CO2 Converter[9]	- shipper - LSP	- road - rail	NA

[6] http://www.dbschenker.pl/log-pl-en/start/responsible-business/ekoschenkerchannel/ecocalculator.html
[7] https://www.kn-portal.com/seafreight/seafreight_overview/environment/calculator/
[8] http://www.dhl.com/en/about_us/green_solutions/carboncalculator.html
[9] http://www.poferrymasters.com/about-us/the-environment/co2-emission-calculator

			- sea - air	
Trenitalia	Eco TransIT World	- shipper - LSP	- rail - road	EN 16258

1.4. Status of CO2 emission measurement by chemical companies

According to the results of the empirical market research conducted in the first phase of the ChemMultimodal project, managers representing chemical companies in the region do not measure CO2 emission in transport. Among surveyed companies in the region none of them stated a frequent use of CO2 calculator – only one German company declared usage of EcoTransitWorld.

Lack or minor interest in CO2 emission from transport activities measurement is mainly caused by its inconsiderable proportion in total CO2 emission of chemical companies. Additionally within the frequently underlined explanations of the reasons for such a situation respondents pointed that they did not have proper equipment, they already paid for the emissions or it was not their responsibility to measure CO2 footprint.

However statements of the chemical companies though, show potential for future use of CO2 calculators as importance of emissions will increase.

Although according to Directive 2014/95/EU (Article 19a): „*Large undertakings which are public-interest entities exceeding on their balance sheet dates the criterion of the average number of 500 employees during the financial year shall include in the management report a non-financial statement containing information to the extent necessary for an understanding of the undertaking's development, performance, position and impact of its activity, relating to, as a minimum, environmental, social and employee matters, respect for human rights, anti-corruption and bribery matters (…)*"

CO2 emissions caused by chemical companies transport activities are also influenced by the ability to meet the requirements and assumptions of corporate social responsibility. This may be an additional incentive to increase interest in the need for CO2 measurement and the use of appropriate emission calculators.

1.5. ChemMultimodal CO2 Emission Calculator

The calculation method of CO2 emissions should be useful both for chemical companies and logistics operators and provide the one-click calculation of CO2 emissions of intermodal connections from the place of origin to the cargo destination with possibility to define freight characteristics. The method recommended for ChemMultimodal project covers following factors:

- freight characteristics (the weight of goods or number of containers),

- route characteristics (transport distance from point of origin to destination, postal code, railway stations including transit stations, port, etc.)
- transport modes with predefined average CO2-emission factor per tonne-km per transport mode.

It should be mentioned that typically the road and rail distances are different. In some cases the difference could be significant (e.g. a mulitmodal container from Leipzig – DE to East Europe is often sent 500 km westwards to Duisburg first, only then eastwards because Duisburg is the location in Germany where most of the eastbound traffic is bundled).

ChemMultimodal CO2 emission calculator was developed based on McKinnon methodology[10]. It represents activity-based approach for CO2 emission calculation. According to this source the average emission factors for wide range of transport activities of the chemical industry are presented on Table 3.

Tab. 3 Average emission factors for wide range of transport activities of the chemical industry[11]

Transport mode	g CO2 / tonne-km
Road	62
Rail	22
Barge	31
Short sea	16
Intermodal road/rail	26
Intermodal road/barge	34
Intermodal road/short sea	21
Deep-sea container	8
Deep-sea tanker	5
Pipeline	5
Air-freight	602

The data presented in table 3 is based on the following assumptions:

- Road – the average load factor of 80% of the maximum vehicle payload and 25% of empty running

[10] A. McKinnon, M. Piecyk, Measuring and Managing CO2 Emissions of European Chemical Transport, Logistics Research Centre Heriot-Watt University EDINBURGH, UK, 2011.

[11] A. McKinnon, M. Piecyk, Measuring and Managing CO2 Emissions of European Chemical Transport, Logistics Research Centre Heriot-Watt University EDINBURGH, UK, 2011, p. 22.

- Rail – an extrapolation of a range of emission factors reported by reliable sources across Europe[12] + the average split between diesel and electric haulage + the average carbon intensity of the electrical power source + the average energy efficiency of the locomotive + assumptions about average train load factors
- Inland waterways – the estimates taking into account different waterway conditions (upstream, downstream or canal) and vessel sizes
- Maritime – based on data from IMO divided into short-sea, deep-sea container, and deep-sea tanker
- Intermodal – as routing is often unknown and hence the distance split between the modes, and the road share of total distance varies, thus the assumption of average road feeder distance is 10%
- Airfreight – the average of the two long haul emission factors of WRI/WBCSD and NTM

The goal for ChemMultimodal CO2 calculator is to estimate CO2 emissions in a simple, fast, and easy way to convince chemical and logistics companies to shift road transport to multimodal one.

ChemMultimodal CO2 calculator was developed based on activity-based method. It allows estimating chemical and logistics companies CO2 emissions from transport chain in an easy way. The value of CO2 emissions is approximate as it is based on average emission factors recommended by McKinnon (which do not correspond with EN 16258) described above.

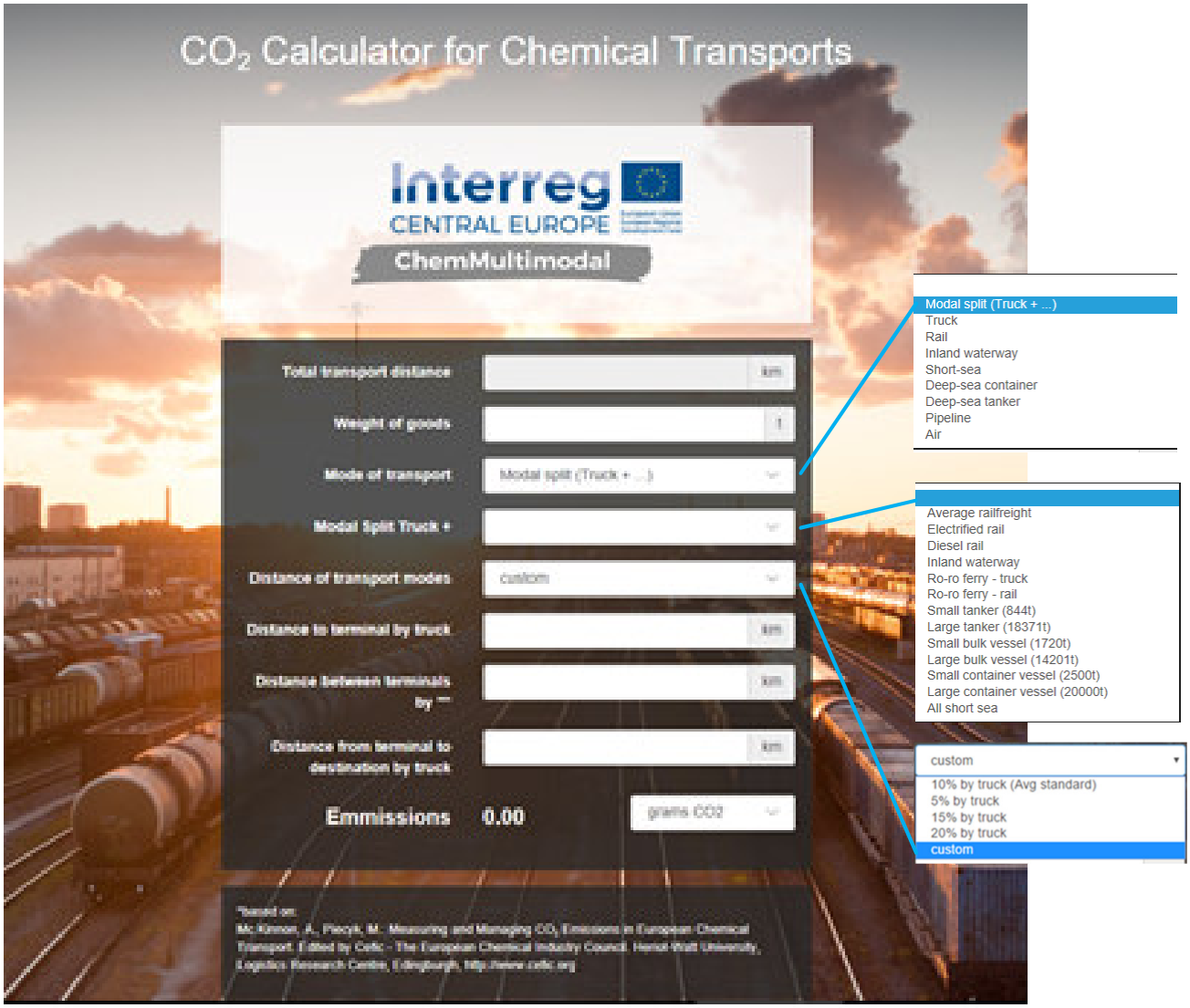
To calculate the exact value of CO2 emissions chemical company should determine:

1. The load factor.
2. The share of empty running.
3. The energy efficiency of the vehicle, train or vessel.
4. The carbon intensity of the energy source.

The design of ChemMultimodal CO2 emission calculator is shown on Figure 4 and it can be found at: https://ifsl50.mb.uni-magdeburg.de/chemmultimodal/

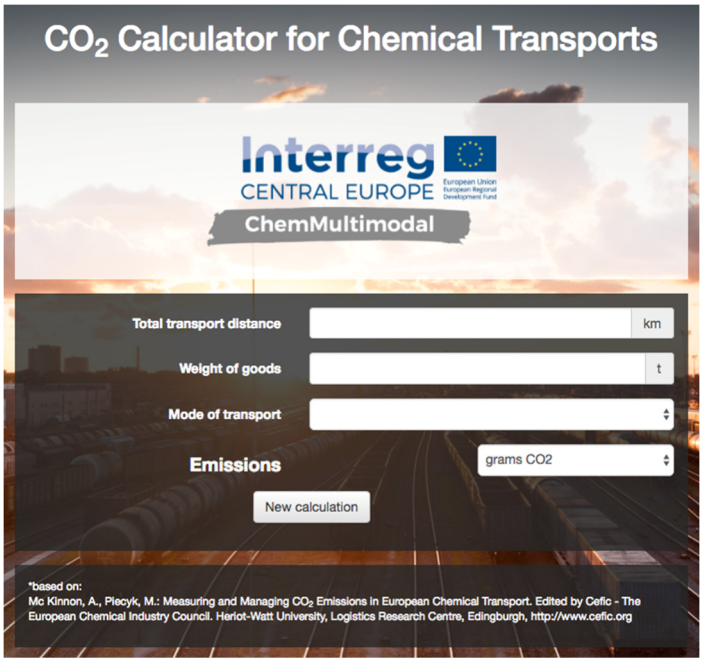
[12] *ADEME, NTM, AEA Technology, DEFRA, INFRAS, TRENDS, Tremove, IFEU, McKinnon/EWS*

Fig. 1 ChemMultimodal CO2 emission calculator



- General Information
  - All data and calculations are based on the average emission data calculated by McKinnon.

Fig. 2 Mask CO2 Calculator



- Total transport distance

User should insert the total transport distance from the shipper to the destination in kilometres. For multimodal connections there is a possibility to use Intermodal Links (https://intermodallinks.com/) to calculate the distance.

- Weight of goods

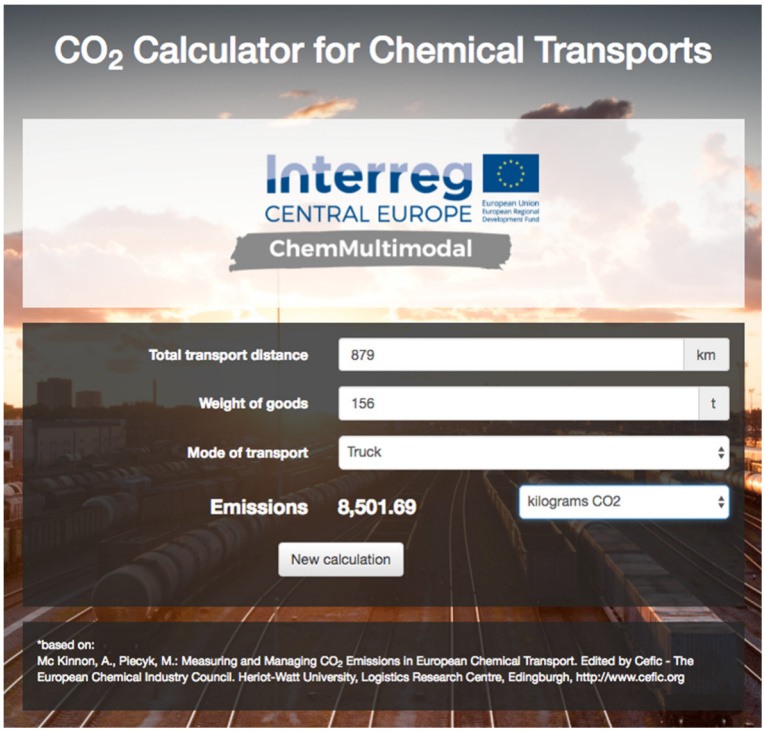
User should insert the total gross weight of all transported goods in tons.

- Mode of transport

The next step is to select the mode of transport from the list:

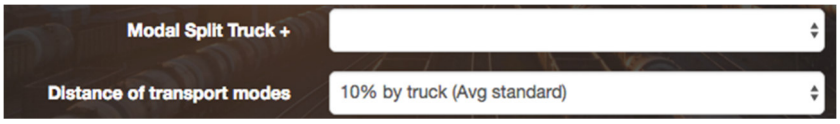
- If one selects an unimodal transport, the CO2-emissions will be calculated immediately:

Fig. 3 Exemplary use of CO2 Calculator



- If one selects “Modal Split (Truck + …)”, new input field are shown: “Modal Split Truck +” and “Distance of transport modes”:

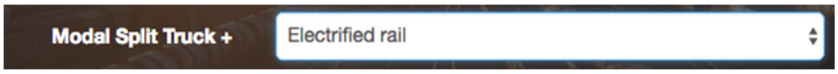
Fig. 4 Modal Split CO2 Calculator



- Modal Split Truck +

Next, user selects the second transport mode beside truck:

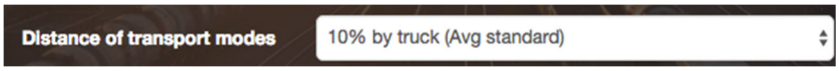
Fig. 5 Modal split truck + other transport mode



- Distance of transport modes

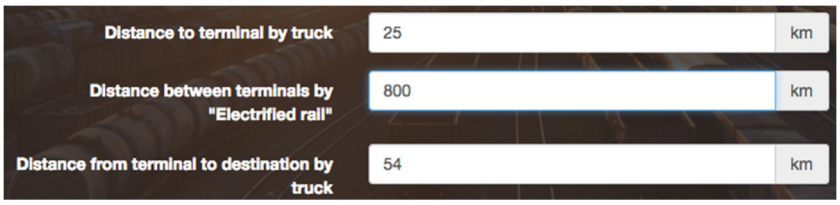
There is a possibility to choose fixed average values (5%, 10%, 15%, 20% of the total distance by truck):

Fig. 6 Predefined % of truck transport distance in relation to total distance



Or insert exact values by choosing “custom”:

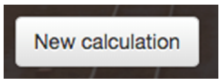
Fig. 7 Custom % of transport distance in multimodal transport chain



- New calculation

The “New calculation” button will open a new tab. This allows to compare different calculations.

Fig. 8 New Calculation Button CO2 Calculator



1.6. Obstacles and Lessons Learned

Two main methodologies were identified for CO2 emission measurement (A more general calculation method, called activity-based method and an energy-based approach which estimates the actual amount of work done and the energy consumed per unit of output). As the second method is more precise and is based on EU standards it occurred to be too difficult to implement during Project’s pilots phase and after the Project completion. After identifying major CO2 calculators on the market, the conclusion was that those calculators are very detailed and need quite some time to use them.

Measures to overcome obstacles:

ChemMultimodal calculator was developed based on activity-based method (using verified McKinnon approach and assumptions) to estimate CO2 emissions in a simple, fast, and easy way by both - chemical and logistics companies. The decision in favour of the McKinnon approach is based on the fact that time is a scarce resource and thus. It was agreed that the calculator should allow the user to grasp the CO2 emissions caused

by their transport in an easy and quick manner. Therefore, the SCG and OvGU developed the CO2 calculator in the way it is currently.

Target-Performance Comparison:

By developing a tailor made ChemMultimodal CO2 emission calculator the target of the Deliverable was met and the goal of the Project can be measured by a dedicated and sufficient tool. The calculator is available on the website for user's convenience during the project implementation and after its completion.

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