Overview of Emission Calculators to Support Transport Sustainability

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Abstract The increase in both passenger and freight transport has been enormous during last years and the situation will not change in the near future. This growth can be attributed to many factors, such as the increase in global trade or the rise of e-commerce which led to more goods and cargo movement and the amount of passenger traffic in all modes of transport. The consequence is increasing emissions, resulting in massive environmental degradation. Emission calculators are used to estimate the amount of greenhouse gases that are emitted into the atmosphere from various sources. They help better understanding of the process of emission formation to take steps to reduce them. This article's aim lies in comparing available free emission calculators in transport. The comparison is oriented on various transport modes, input and output parameters, and methodologies used to calculate emissions. On the basis of this research review own emission calculator has been designed.

Keywords:
greenhouse gas emissions, emission calculator, freight transport, sustainability in transport, SDGs

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1 Introduction

Everybody knows that global warming and the increase of greenhouse gas emissions (GHGE) aspires to one of major problems facing global society. Several scientific studies describe and analyze relationships among various emission sources, air pollutant concentrations and human health (Rahman et al., 2022). One of the most significant sources of pollution is the transport sector. It is considered to be the second largest contributor to global pollution after industry (Rungskunroch et al., 2021) which produces almost the half of all GHGE. And its share is still growing (Saboori et al., 2014). The negative influence on environment which comes from the transport sector has two basic reasons – the improperly designed infrastructure and the harmful impact of traffic itself (Danish et al., 2018). Nowadays, there is a growing inclination towards improving the effectiveness of traffic while simultaneously minimizing its adverse effects. Among the concerns pertaining to the environment, the emission of greenhouse gases, particularly carbon dioxide, is the most widely debated issue.

In this paper, the comparation of available free emission calculators is described. The emphasis lies on using of various transport modes, the data entered and produced, and the approaches utilized for determining emissions. Based on this research analysis, a customized emissions calculator has been developed.

2 Theoretical Background

Most developed countries have prioritized reducing greenhouse gas emissions, with a focus on carbon dioxide, as a key environmental goal (Wadud et al., 2019). Carbon dioxide is the most detrimental greenhouse gas, and even a small increase in its concentration can cause breathing problems for humans (Natr, 2006). Over time, exposure to high levels of CO_2 can lead to severe health problems and even death.

In order to be able to reduce GHGE, we must first have and use detailed monitoring and evaluation of their quantity. In 2012, the European Committee for Standardisation has set the standard EN 16285 – Methodology for the calculation and declaration of energy consumption and greenhouse gas emissions of transport services (freight and passengers) (Petro & Konecny, 2017).

There are three main approaches defined how to measure energy consumption and produced CHGE. Well-to-Tank (WtT), Tank-to-Wheel (TtW) and Well-to-Wheel (WtW) (CSN EN 16258, 2012):

- Well-to-Tank – indicates the amount of consumed energy and produced CHGE during all activities from the extraction of raw materials through the production of energy or fuel, up to the delivery to the distribution network, from which the transport means takes their fuel or energy.
- Tank-to-Wheel – energy consumption and GHGE production associated with the operation of the transport means.
- Well-to-Wheel (the sum of Well-to-Tank and Tank-to-Wheel): An approach monitoring the energy consumption and GHGE production which covers the whole lifecycle from the retrieving and production of electricity or fuel, through its way over the distribution network, to the consumption associated with the operation of the transport means.

3 Methodology

These approaches, together with a systematic literature review and qualitative content analysis, were the basis for developing the review of available emission calculators. At the beginning of the research aimed at creating a review of freight transport emission calculators, the method of systematic literature search was used. This method is a well-structured and rigorous approach that consists of steps to identify, evaluate, and synthesize the findings of various research studies, academic papers, and practitioner reports. These steps typically include selecting the relevant research areas, identifying appropriate sources of information, defining specific search terms and criteria, conducting a thorough and systematic review of the selected literature, synthesizing the results using a pre-defined methodology, and producing a descriptive review of the findings (Fink, 2014). Then the method of content analysis is used as a research technique for making valid conclusions from expert articles or other meaningful sources in the context of their use (Krippendorff, 2003).

The method of qualitative comparative analysis is used to compare the freight transport emissions calculators obtained using the method of a systematic review. This method explores causal relationships between observed parameters by systematically comparing them in order to find combinations of conditions that lead to the desired outcome, the minimization of which can explain the phenomenon under study (Fang-Yi et al., 2020). In this case, the inputs, outputs and emissions calculator's methodologies were compared and significant parameters were found. The key questions that formed the basis of the literature review were: What are the most common parameters of transport emission calculators? Is the methodology used by emission calculators sufficiently described? Does the methodology use standardized WtT, TtW and WtW metrics?

4 Results

Most of the emissions calculators analyzed in this study shared a similar set of basic input data, such as the starting and ending points of the transport, distance or way of transport (one-way / reverse two-way). Additional input data, when available, are typically dependent on the weight or volume of the cargo. Some calculators offer the option to input more specific data like orientation or fragility of the cargo, gross / net weight, option of special containers etc. In terms of output data, all the calculators provide information about CO_2 emissions, though the units used by each calculator varied. Some calculators also offered additional output data such as energy consumption, the amount of other pollutants such as CO, HC, NO_x, SO_x, NMHC or particles emitted during the transport, or even the possibility of offsetting emissions through carbon credits or similar mechanisms.
The final selection included five emission calculators:

1) EECA Business – CO2 emission calculator (EECA Business, 2023)
2) ClimateCare – Business CO2 emission calculator (Climatecare, 2023)
3) EA Logistics – Freight Emissions Calculator (EA Logistics, 2023)
4) EcoTransIT World – Calculation (EcoTransIT, 2023)
5) Canadian National Railway company – Carbon Calculator (Canadian National Railway company, 2023).

When selecting the features of the calculators, the requirements of a significant car manufacturer in the Czech Republic were also considered.

Table 1 presents the overview of emission calculators with specified parameters.

Table 1: The overview of emission calculators with specified parameters

No.	Road Transport	Transport of FMPC and/or Material	Own Vehicle	One-Way / Round Trip Transport	Total and Average Emissions	WtW, WtT and TtW Approach	Monetization of Produced Emissions
1	Y	NA	NA	One-way only	Total only	NA	NA
2	Y	NA	NA	One-way only	Total only	NA	Y
3	Y	NA	NA	One-way only	Total only	NA	NA
4	Y	NA	Y	Y	Total only	Y	NA
5	Y	NA	NA	One-way only	Total only	NA	NA

Notes: FMPC – finished manufactured passenger cars, WtW Well-to-Wheel, Wt T Well-to-Tank, TtW Tank-to-Wheel, Y Yes, N No, NA not available
Source: Author's research.

A comprehensive tool capable of calculating emissions for multimodal transport was not identified. If necessary, the transportation must be divided into different sections based on the various modes of transport and the emissions calculation must be counted for each individual section separately. Then, total emissions are obtained as a sum of section emissions. This can be a time-consuming and complex process, but it may be necessary for accurate emissions calculations for multimodal transport.

5 Discussion

After evaluation of selected freight transport emission calculators, the EcoTransIT World calculator (No. 4) was recommended for extensive usage. It is the most comprehensive of followed tools. It can be used to calculate emissions not only from road freight transport, but also from rail, air and sea transport. The EcoTransIT World calculator also allows a significant number of input parameters and generates a large amount of output information. The calculator uses a distribution of output emissions into WtW, WtT and TtW. The methodology used is also transparent (EcoTransit, 2023)

Most of the other analyzed freight transport emissions calculators are available only for one mode of transport (usually road or air); some calculators do not have a transparently specified methodology for calculating emissions. Calculators often don't allow the specification of more than trivial input parameters and/or don't distinguish between WtT, WtW, TtW approaches, which is also a disqualifying restriction for them.

A common problem lies in the lack of support for multimodal transport. Emissions have to be calculated separately for each mode of transport (road, rail, air, sea, etc.).

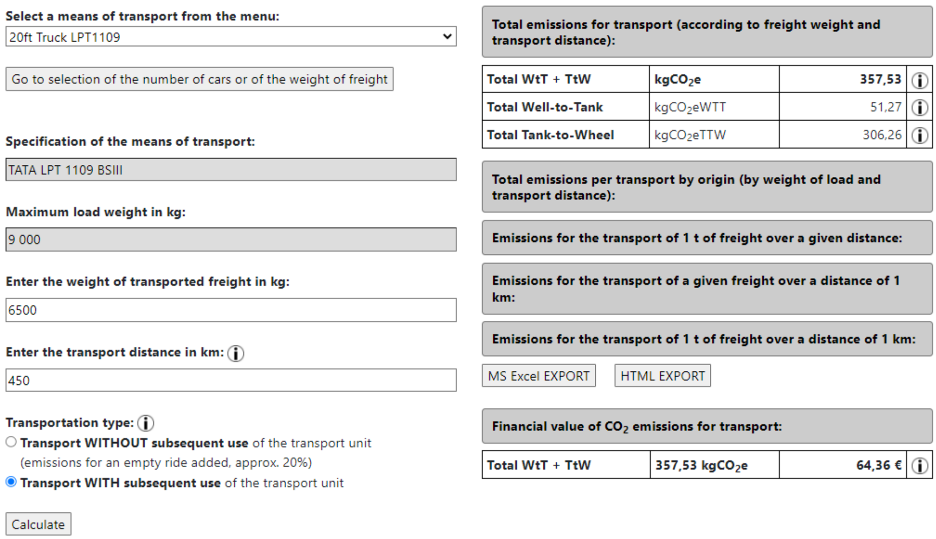

Figure 1: KALOGEMIS GHGE calculator, actually used in India
Source: Machalík (2023).

The limitation of this research is constrained by the quantity of analyzed emission calculator, given that solely eighteen such calculators (identified through Google) were scrutinized. Nonetheless, it is reasonable to speculate that a greater number of these calculators will be developed and made available in the upcoming period. Additionally, one such calculator is the outcome of this study (Machalík, 2023).

On the basis of the conducted research, a new emission calculator was designed and implemented to meet the needs of the research patron (Figure 1). Compared to the observed calculators, it allows a more flexible choice of input parameters and offers a detailed overview of GHGe produced by selected transport. This calculator is available online (Machalík, 2023) and can be viewed/used with permission of the author and patron.

6 Conclusion

The issue of GHGE from freight transport is relevant for the whole global society. Far from being just a theoretical scientific study, the issue is also being addressed by companies themselves in their logistics planning. Some companies are profiling themselves as socially responsible and taking environmental and social aspects of their activities, products and services into account in their business activities. The use of emission calculators thus contributes to reducing the negative environmental impacts of production and reduction of goods. The best-known logistics companies possess their proprietary emission calculators, whereas the majority of others use free ones.

The goal of the article, which lies in the analysis of freely available freight transport emission calculators, has been realized as a review and comparison of specified input and output parameters, modes of transport and methodologies used. The results of the analysis could contribute to the improvement or development of new types of emission calculators. There is currently no freight emissions calculator that includes all the specifics.

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