Methods for the Calculation of CO_2 Emissions in Logistics Activities

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Abstract. This paper outlines general methods, calculation models and some available software for the calculation of carbon dioxide (CO_2) emissions in logistics activities. General calculation formulas are presented mostly for transportation by truck, but by train as well. Listed are CO_2 emission factors (EFs) for the different types of fuels and partially average numbers for the various transport carriers. The relevance of the calculation of CO_2 emissions in the logistics sector is described to show the growing importance of sustainability in the world of logistics.

Keywords: sustainability, Carbon dioxide (CO_2), emission factors (EFs), CO_2 equivalents, CO_2 emissions, CO_2 balance, life cycle assessment (LCA), fuel-based method, distance-based method.

1 Introduction

According to the International Energy Agency (IEA) the transportation sector is responsible for approximately 23% of the global carbon dioxide (CO_2) emissions [1]. However, there is quite a big energy savings potential in those transportation activities, too. In many cases these potentials cannot be used because of economical reasons. Another problem is the identification of energy savings potentials which could often times lead to a cost reduction.

A lot of companies calculate the carbon footprint of their products and their supply chains (SCs) to identify these potentials. This paper describes which methods, calculation models or software tools are used to calculate CO_2 emissions in the SCs of industrial companies or logistics service providers (LSP). For those firms intending to calculate their CO_2 emissions this paper gives an overview of how the possible calculations.

2 Existing Methods for the Calculation of CO_2 Emissions

2.1 The Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHGP) is one of the most important standards for the calculation of CO_2 emissions. It offers the general instructions to accomplish a CO_2 balance. The GHGP distinguishes between direct and indirect emissions (see Fig. 1).

W. Dangelmaier et al. (Eds.): IHNS 2010, LNBIP 46, pp. 263–268, 2010.

Scope 1 covers all direct emissions occurring from sources owned or controlled by the company. Scope 1 does not include direct CO_2 emissions from the combustion of biomass. This kind of emissions shall be reported separately. Greenhouse Gas (GHG) emissions resulting from the generation of purchased electricity consumed by equipment or operations owned or controlled by the company is included in scope 2. Thus, these emissions account for the largest part of GHG emissions in many companies and are the best chance to reduce these emissions. Last, scope 3 covers all other indirect GHG emissions. According to the GHGP scope 3 emissions are optional and not caused directly by the company itself, but indirectly by its activities [2]. However, these are the most important activities in the logistics sector. A standard for the calculation of scope 3 emissions is still missing, but its development is in progress and will be finished in December 2010.

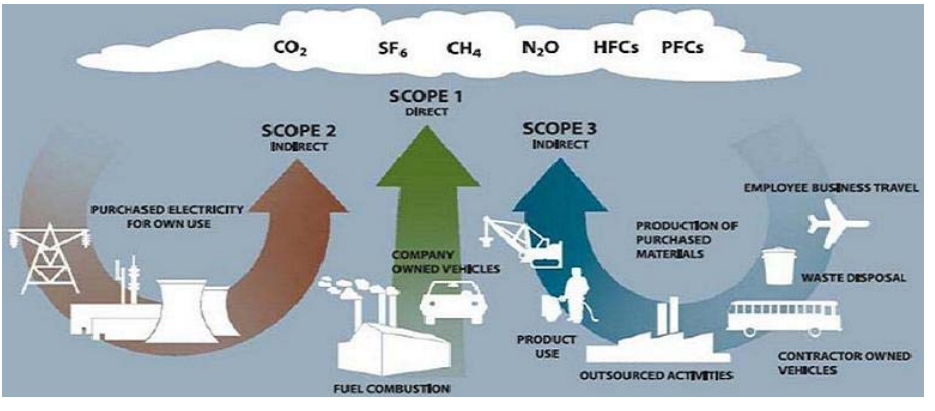

Fig. 1. Overview of scopes and emissions across a value chain [2], Fig. 3, p. 26

There are two possibilities to calculate the CO_2 emissions of mobile sources: the fuel-based method and the distance-based method. Both methods use CO_2 or CO_2 equivalent emission factors (EFs) for the calculation of CO_2 emissions. These factors express the calculated ratio between GHG emissions and activity data, for example fuel consumption and distance traveled. EFs can also include the emissions of the previous SC, for example emissions occurring during the production of diesel or its transport to the gas station.

If the absolute fuel consumption or the distance traveled and the average fuel consumption (AFC) are available the fuel-based method can be applied. The data for the distance-based method is usually available from records of odometer logs or company fleet records [3]. To calculate the absolute fuel consumption the following formula is to be deployed:

$$\text{Absolute fuel consumption} = \text{distance traveled} \cdot \text{average fuel consumption} . \quad (1)$$

The CO_2 emissions in the fuel-based method depend on the heating value of the specific fuel, the share of the oxidized carbon in the combustion (usually between 99 %