FRESHWATER ASSESSMENT IN LCA: A CASE STUDY OF SPECIFIC AUTOMOTIVE COMPONENT

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ABSTRACT

An assessment of consumptive water use was implemented for a compact vehicle supporting tube composed of aluminium from three different sources: primary, secondary and aluminium produced from renewable energy. The aim of the study was to show the possible potentials and limits for a future water assessment of a whole vehicle. Primary manufacturing data, as well as published studies modeled in the software GaBi 4.4 were employed to draw up the life cycle inventory. Characterization factors based on local scarcity were applied, in order to obtain midpoint indicators. The results show the supporting tube composed of primary materials as the most water intensive alternative. A further practical approach for a comprehensive assessment of freshwater in automotive industry is under development.

INTRODUCTION

Water is one of the most fundamental conditions for survival, therefore, safe and clean drinking water and sanitation is recognized as human right for securing an adequate standard for living (UN, 2010). Identifying, measuring and addressing impacts arising from water use in BMW Group operations are anchored in the Group strategy. The Life Cycle Assessment (LCA) can provide transparency on the consumption of resources, emissions and potential environmental impacts of a product (ISO 14040, 2006) along its life cycle, from the design stage of product itself. Several methods to quantify and assess freshwater use of products throughout their life cycle have been developed (Kounina et al., 2013). Experts from the LCA scientific community are collaborating in a water working group of the UNEP-SETAC (WULCA, 2013) and an ISO standard for Water Footprint is under development. The developed methods should be implemented for industrial products in order to prove their applicability. Berger and colleagues published in 2012 (Berger et al., 2012) a study assessing the water consumption of three whole vehicles under different methods. Concurrently, in 2011, BMW Group completed a study with the aim to understand the impacts of its products related to water scarcity. This work is described in this short paper; it was focused on the assessment of freshwater consumption of a selected automotive component with different material alternatives. The supply chain of the three scenarios where analyzed in detail, in order to identify the site of every process step and the corresponding variability of the water scarcity at a local level. It allowed a quantitative comparison between material and processes in terms of their potentials to contribute to water scarcity. Limitations in the implementation of the assessment for the automotive products were identified.

MATERIALS AND METHODS

Functional unit, scenarios and cut-off rules

The supporting of the instrument panel of a BMW Group compact vehicle was chosen as the functional unit for this assessment in order to complete the conventional LCA impact categories. The study compared the results of freshwater consumption of the component composed of aluminium from three different sources: primary, secondary and aluminium produced from renewable energy. The component was assessed from the raw material extraction up to its manufacturing (cradle to gate). The water consumption of the product in the use phase and at end-of-life was neglected due to the low impact of less that 1%.

Water inventory

For the evaluation of water use in the raw material extraction stage of the product life cycle, the contacting of the specific suppliers involved globally was a challenge. Therefore, information from the European Aluminium Association served as input (EAA, 2008) and various sources were consulted in order to perform a sensitivity analysis of the obtained data (Hutter, 1999). For the assessment of the semi-finished production and component manufacture phases, no average data was available. Therefore, a detailed inventory with primary data sourced from the BMW Group manufacturing processes for the year 2011 was compiled. . These processes were subsequently modelled with the software Gabi 4 (PE International AG, 2011).

Consumptive water use and impact assessment

As practitioners of the Water Footprint methodology (Hoekstra et al., 2011) and LCA experts (Bayart et al., 2010) pointed out, the analysed volume of water consumed refers to the fraction of water use in the process that is not returned to the same river basin from which it was withdrawn due to evaporation, product integration, or discharge into other watersheds or to the sea. To obtain the midpoint indicator water deprivation, the water stress index (WSI) developed by Pfister and colleagues (Pfister, Koehler and Hellweg, 2009) was applied to each producer identified for each process step. The site of every life cycle of the component was defined as precisely as possible, based on international production data. Initially, information on weighted import countries was obtained from the international associations (EAA, 2011 and IAA, 2011). Subsequently, the producers' site for the different process steps was identified with Google Maps and the respective WSI layer developed with Google Earth (Google, 2011).

RESULTS

Water inventory and impact assessment

The results are shown in Fig.1 for the three material scenarios: scenario I for the primary aluminium alternative, scenario II for secondary aluminium and scenario III and aluminium from renewable energy sources. The diagram allows the differentiation of direct process freshwater and indirect freshwater consumed at the inventory level. The indirect freshwater consumption covers the background processes: water consumed by the production of energy and auxiliary processes. The impact assessment results at the midpoint level are represented as freshwater deprivation in litre freshwater equivalent (depicted black lines) and as volumetric water consumption in litre freshwater (depicted in bars). The scenarios considering the supporting tube composed of primary material show that the raw material extraction and preparation as well as the semi-finished production phases were the most water intensive life cycle stages in the life cycle. For all scenarios the biggest impact on water resources takes place during raw material extraction and preparation as well as the semi-finished production life cycle phases.

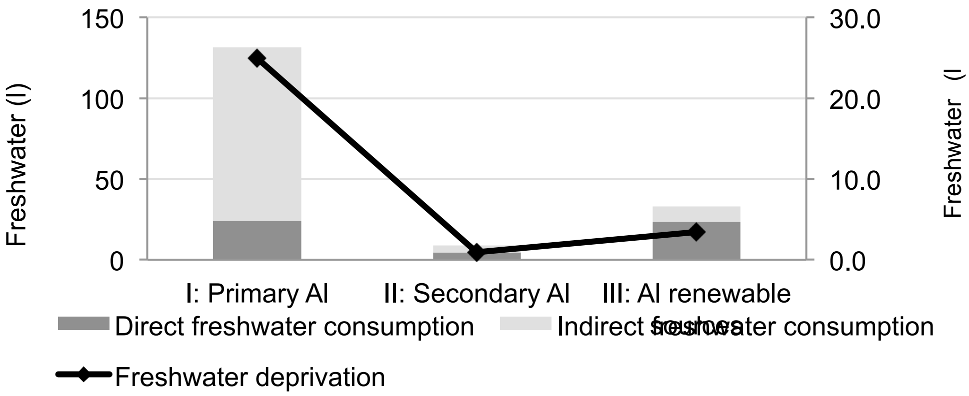

Fig. 1: direct and indirect water consumed (l) and water deprivation (l eq) for the supporting tube of the different scenarios.

DISCUSSION AND CONCLUSIONS

This study demonstrates that water use assessment can be applied for an automotive industrial product. A supporting tube of a compact vehicle was assessed. The results show that the main water intensive steps are non-renewable energy intensive processes and clearly demonstrate the correlation between water and energy consumption. Limitations such as data availability were identified representing a challenge for such a complex and globally manufactured product such as an entire vehicle. For a comprehensive assessment of an entire vehicle analysis of further materials and processes with respect to their consumptive water use is initially necessary. Therefore, the BMW Group is currently working on a more comprehensive approach covering environmental and socioeconomic aspects related to water use impacts. The concept comprises the environmental assessment of water consumption and degradation use according to Boulay et al. (Boulay et al., 2011) however, specifically developed for the automotive industry. For the comprehensive approach, various components of a conventional vehicle are selected in order to enable a future consistent assessment for the whole vehicle. The local conditions, on which the environmental, economic and social impacts of freshwater use strongly depend, are considered. In order to identify this impact currently an assessment is performed of components by varying the site of production. BMW Group plants located in Germany, South Africa and China with different freshwater stresses, freshwater qualities and supply chains are taken herby into account. Furthermore, different economic and social conditions at local and technology level will be considered.

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