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L0 | Handling of Multi-Functionality in Life Cycle Assessments for Steel Mill Gas Based Chemical Production

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Life cycle assessment is needed for quantifying potential greenhouse gas savings through material utilization of steel mill gases. However, methodological guidance for this purpose is lacking. Therefore, different approaches to handle multi-functionality are presented. The investigation of steel mill gas (SMG) based-methanol shows varying impacts on climate change due to handling multi-functionality differently. System expansion is recommended for assessing cross-sectoral cooperation and substitution as well as economic allocation for product-specific analyses.

RESEARCH CHALLENGE

For the material utilization of SMG the production of methanol via coke oven gas (COG) and basic oxygen furnace gas (BOFG) is one option (figure 1).
Using COG and BOFG for chemical production leads to the challenge of distributing the environmental burdens within the coke oven and basic oxygen furnace to the main products and the respective gases. Different approaches to handle such multi-functionality issue can be applied. In order to answer the question if methanol should be better produced separately as done today or through an integrated production route, system expansion (1) can be applied as shown in figure 2. In order to calculate the global warming impact of steel (2.1) or to calculate the global warming impact of methanol produced from steel mill gases (2.2), substitution can be applied. Alternatively, environmental burdens can be given to COG and BOFG by applying allocation keys for energy, exergy, mass, monetary value or even no burdens are given to the gases.

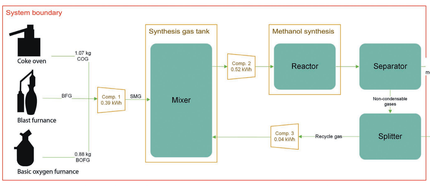

Figure 1: Methanol production process from COG and BOFG; Abbrev.: comp. (energy demand for compression)

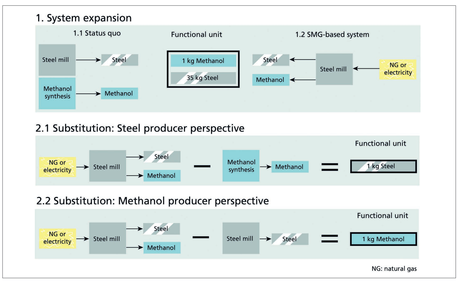

Figure 2: Different handling of multi-functionality

RESULTS AND CONCLUSION

The results presented in figure 3 reveal that handling multi-functionality differently has a strong influence on the GWI. When applying the "Zero burden SMG"-approach low GHG emissions of 0.23 kg CO_2-eq./kg methanol are obtained. However, "Zero burden SMG"-approach does not reflect the reality since SMG are conventionally used for energy generation and hence should have a burden.
In summary, different research issues require different functional units and methods to handle multi-functionality. If there is a need to give burdens to SMG which are used as a raw material in the chemical industry, economic allocation seems to be the most appropriate way. For an unbiased approach the system expansion is favorable and should be used for avoiding allocation.

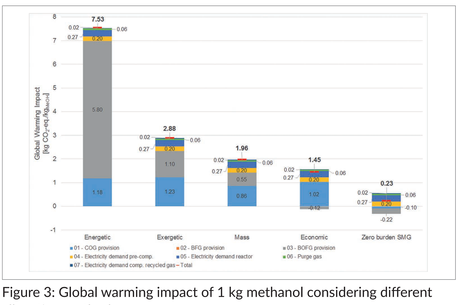

Figure 3: Global warming impact of 1 kg methanol considering different allocation methods

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CO_2 reduction through cross-industrial cooperation between the steel, chemical and energy industries