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An Ecological & CO_2 Avoidance Cost Assessment of Liquid Energy Carrier Production – Power-to-Methanol and Oxymethylene Ethers

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Time is tight to meet increasingly stringent Green House Gas Emission (GHGE) targets for sectors such as mobility (*ca*. 23% (6.7 Gt-(CO_2)) of energy-related GHGE).[1] These sectors have to adopt new technologies and production pathways to deliver the required energy carriers and fuels. In this respect, the Power-to-Liquid (PtL) concept is based on captured CO_2 (e.g. from waste sources) and its catalytic hydrogenation (e.g. with H_2 from H_2O electrolysis) to produce liquid energy carriers. In this scheme, Methanol (CH_3OH) is a potential product, which can also be viewed as a C-1 building block (e.g. for the chemical industry), as a clean fuel, fuel additive or basis for other fuel syntheses such as alkanes, dimethoxy ether (DME), or oxymethylene ethers (OME).[2-4] The latter class of oxygenates is receiving increasing interest as potential “tailorable” diesel fuel substitutes/additives and solvents. However, the business case for electricity based production of these liquids under current market conditions (e.g. *vs*. conventional fossil methanol or fuel) and the appropriate implementation scenarios to increase platform attractiveness and adoption remain to be sufficiently addressed.[5]

Accompanied by ongoing techno-economic evaluation, a comprehensive ecological review based on Life Cycle Assessment (LCA) of potential PtL products is underway at Fraunhofer ISE. In this context, the presented work will highlight our latest research and results regarding the techno-economic and ecologic feasibility of the PtL production scheme with the target products methanol and its downstream conversion to OME. The presented results are based on simulations performed with Matlab®/Simulink and CHEMCAD for the techno-economic evaluation and a holistic Life-Cycle-Assessment, based on a well-to-wheel approach, for the environmental impacts evaluation. Different scenarios for electricity and CO_2-supply are included and the possibilities for the PtL concept becoming a ‘truly CO_2-neutral’ process are examined. Besides CO_2 capture from biogas and atmospheric air the scenarios will also examine the possibility of “Top Gas” (a mixture of CO_2/CO/H_2) utilization, as sourced from steel production waste streams. The latter approach is currently being investigated in a large national research entitled “Carbon2Chem®”.[6] The presented results will show methanol and OME production costs based on the aforementioned different scenarios. Likewise, the corresponding environmental impacts of these production pathways will also be presented based on a combined economic and ecological approach, including the important CO_2 avoidance cost parameter. The presentation will provide a glimpse into the potential of PtL concepts and its contribution to sustainable chemical production pathways based on CO_2, H_2 and renewable energy.

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