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Techno-Economic Analysis of a Highly Integrated Power-to-Liquid Process

C. Rix, G. Herz, E. Reichelt, M. Jahn
Fraunhofer IKTS, Dresden

Abstract

During the Paris climate summit, the international community declared to limit the global increase in temperature to less than 2 °C. In order to achieve this climate goal, the German government has announced that the emission of CO_2 is to be reduced by 80-95% by the year 2050. While governmental incentives have been very effective in promoting renewable energy and thereby reducing the CO_2 emissions in the energy sector, the industrial sector maintains highly dependent on fossil fuels.

A possibility to introduce renewable energy into the industrial sector while simultaneously reducing CO_2 emissions are Power-to-Liquid (PtL) processes. The products of such a process also allow for the substitution of crude oil based products in the chemical and mobility sectors. Even though the potential for the reduction of CO_2 emissions is significant, economic feasibility has not been reached at this point in time. The most significant factor is the cost for electricity, which has the highest influence on production costs and are therefore noticeably higher than those of crude oil based products.

The aim of this work is to investigate the influence of the economic and regulatory environment on the economic feasibility of a Power-to-Liquid plant. Process-related CO_2 emissions from the industrial sector were identified as a sustainable source of CO_2 as these emissions are inevitably generated. As economic feasibility has not been reached yet, the approach for the production of high-quality waxes was chosen, since higher revenues can be achieved here.

In order to estimate the production costs, an economic model based on experimental as well as on data from process simulation was derived.

The model was further expanded to include the influence of regulatory incentives. Three exemplary measures were chosen to conduct this study. The first approach was aimed at the feedstock of the process, especially to avoid taxes on electricity prices, another at the demand side of the oil market to avoid taxes on synthetic products and the third was a direct funding approach. This allowed for the design of scenarios which enable a successful market entry.