Technological assessment and planning of a 10.000 t/a PtL demonstration plant

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The reduction of greenhouse gas (GHG) emissions and non-CO_2 climate effects within the air transport sector is crucial to reduce global warming. Several disruptive propulsion technologies are being proposed, such as battery electric or fuel-cell electric propulsion, or the direct combustion of hydrogen. While these concepts are promising for selected applications on short range with low payload, long-haul air transport, which is the main contributor to the GHG emissions in the air transport sector, will rely on liquid hydrocarbon fuels for the foreseeable future, as other energy carriers lack the necessary energy density.

Thus, Power-to-Liquid (PtL) fuels are a key factor for reaching the climate goals for long-haul air transport. They can also be used for the reduction of GHG emissions in other applications, such as shipping, or road transport based on internal combustion engines.

Several technologies that are needed for the large-scale production of PtL fuels have been tested and demonstrated on the component level. However, their interplay and the demonstration of the entire process chain is still a challenge.

The focus of the current study is to present an outline and configuration of a PtL demonstration plant and to perform a detailed analysis of the required components and operation strategies. The results are based on a conceptual study for the German Federal Ministry for Transport and Digital Infrastructure (BMVI). The anticipated PtL plant aims at a scale of up to 10,000 t/a PtL fuels. Here, a buildup of the entire process chain – from carbon and hydrogen sources to fuels conforming to the given standard – is conceived. Once implemented, such a demonstration plant could lay the foundation to gain experience and fundamental information for a later subsequent scale-up to commercial plants, which would be in the order of 100,000 t/a or more.

Within the current study, the technical, legal and organizational concept of a Power-to-Liquid (PtL) demonstration and research facility is developed. The assessed platform setup includes a modular PtL demo plant with a scale of up to 10,000 t/a PtL fuels as well as a much smaller and more flexible research plant. In a first step, a technology screening study was performed to assess the ideal components for a continuous and robust operation of the demonstration plant. Furthermore, a techno-economic process simulation was performed to investigate different scenarios for energy supply and fluctuating renewable energy as well as CO_2 supply cases.