ELECTRICITY SUPPLY MANAGMENT: THE POTENTIAL OF USING X-TO-LIQUID PLANTS FOR POWER STORAGE PURPOSES

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Introduction

Currently, biofuels production methods of the second generation made from residues, waste, CO_2 rich off-gas and/or excess electricity are developed. The concepts are well-known under the acronyms Biomass-to-Liquid (BtL), Power-to-Liquid (PtL) and Power and Biomass-to-Liquid (PBtL), all consisting of a syngas generation, a Fisher-Tropsch synthesis (FTS) and a product upgrading process. However, beside sustainable fuel supply, X-to-Liquid concepts can also be used to play an active role in power demand and supply management. At the German Aerospace Center (DLR), an advanced system design has been developed with the purpose to use X-to-Liquid plants as power storage facilities.

Methods

As a first step, a PBtL system was modelled in flowsheeting software. Based on the initial simulation, options for power demand and supply management has been identified. A reversible Solid-Oxid-Electrolyzer-Cell (SOEC) as well as gas and hydrogen storage systems has been introduced to the system. The reversible SOEC is able to temporary operate in fuel cell mode (SOFC) producing electricity in case of power shortages using flammable off gases from the FTS. Plant design and plant operation mode have been optimized in terms of carbon conversion, exergy efficiency and fuel production costs. Subsequently, an extensive techno-economic evaluation has been performed with emphasis on excess electricity potentials and electricity prices.

Results/Conclusion

The system is able to absorb large quantities of cheap excess electricity. During periods with low power supply from renewable sources, electricity is produced and fed into the grid. The storage potential is only limited by the capacity of the SOEC and gas caverns. By optimizing the plant operation mode, it is possible to achieve a run factor of the SOEC close to 100%. Fuel production costs can be reduced significantly, when hydrogen is produced in hours of low electricity prices. Overall system fuel production efficiency is considerably increased and grid stabilization service is provided.

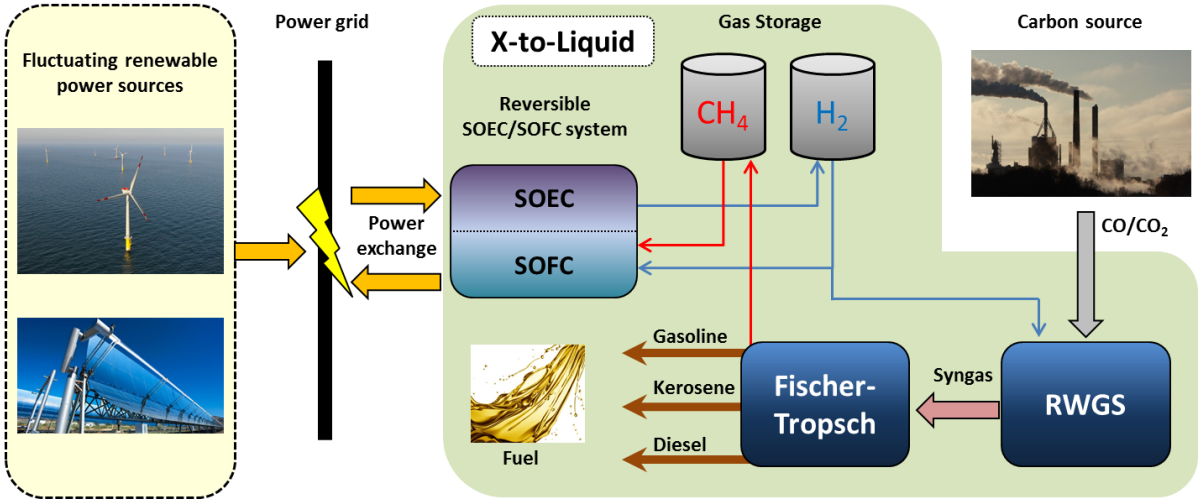

Figure 1: Schematic system design