Karlsruhe Institute of Technology

Division I – Biology, Chemistry, and Process Engineering

Engler-Bunte-Institut (EBI)

Chair of Combustion Technology (vbt)

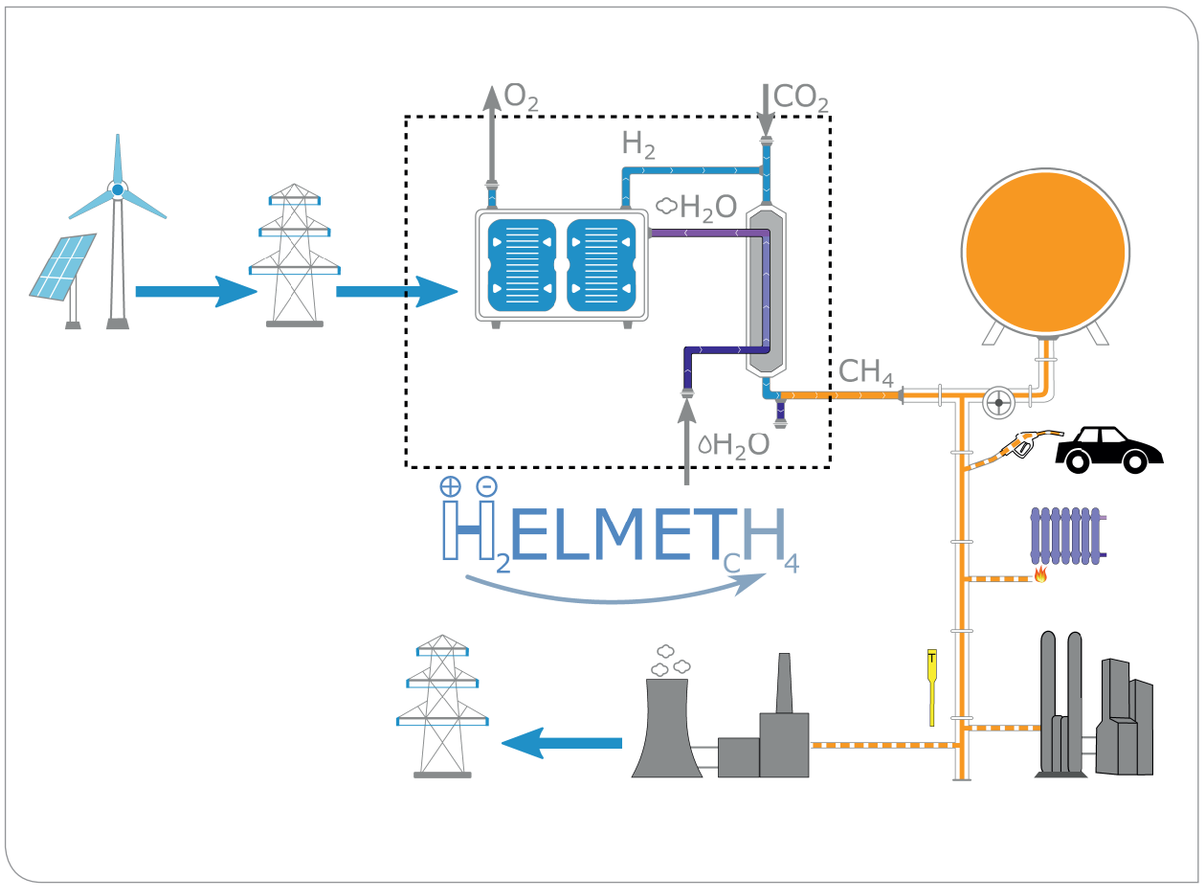
HELMETH – Power-to-SNG with High Efficiency

Production of Substitute Natural Gas by Means of Renewable Energies

The increasing share of renewable energies leads to fluctuations in electricity production, which must be compensated for in the future. The generation of Substitute Natural Gas (SNG) from renewable energies enables electricity to be stored in the existing infrastructure and the use of SNG without fossil CO_2 emissions. The EU project HELMETH (Integrated **H**igh-Temperature **EL**ectrolysis and **METH**anation for Effective Power to Gas Conversion) coordinated by the Karlsruhe Institute of Technology (KIT) has shown that high-temperature electrolysis and methanation can be operated in a prototype with efficiencies for the chain from electricity to SNG of over 75 percent.

The HELMETH Project

The objective of HELMETH was the proof of concept of a highly efficient Power-to-SNG process. For this purpose, pressurized high-temperature steam electrolysis was combined for the first time with CO_2 methanation. The heat of reaction from methanation is used to generate steam for the electrolysis module. Since the produced substitute natural gas has a hydrogen content of less than two percent and is thus compatible with the existing grid and storage infrastructure, there are no feed-in capacity restrictions. In addition to coordinating the overall project, KIT was responsible for the design, manufacturing and character-



Schematic HELMETH Power-to-SNG Process

ization of the methanation module. Project partners were Sunfire GmbH, the technical universities of Turin and Athens, the European Research Institute of Catalysis A.I.S.B.L., Ethos Energy SPA, and the DVGW - German Association for Gas and Water e.V. with its research centre at the Engler-Bunte-Institute of KIT.

Prototype Successfully Tested

In the first step, the two modules of the HELMETH prototype were individually characterized and optimized. The methanation module was tested at reactor pressures of 10 to 30 bar and a load modulation of 20 to 100 percent (60 kilowatts) at the KIT. The optimal temperature for boiling water cooling was determined to be 250 °C. The substitute natural gas produced has fulfilled all quality criteria. Sunfire GmbH operated the world's first high-temperature electrolysis module under pressures of up to 15 bar and at a temperature of 850 °C. The targets for the rates of degradation were achieved with less than 0.5 percent in 1,000 hours. Final coupling of the modules in the partial load range at pressures of up to 15 bar was realized in terms of steam supply from the methanation module to the electrolysis module and the transfer of hydrogen in the opposite direction.

High Efficiency

With the HELMETH prototype, efficiencies of 76 percent from electricity to SNG were achieved by the consistent use of synergies from electrolysis and methanation. This is a significant increase compared to the usual 54 percent for existing Power-to-SNG plants based on low-temperature electrolysis. However, further development steps are necessary to achieve a higher level of technological maturity. Provided further optimization, larger plants on an industrial scale could achieve efficiencies of over 80 percent.

Prototype consisting of the methanation module (container on the left) and the electrolysis module (container on the right)

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