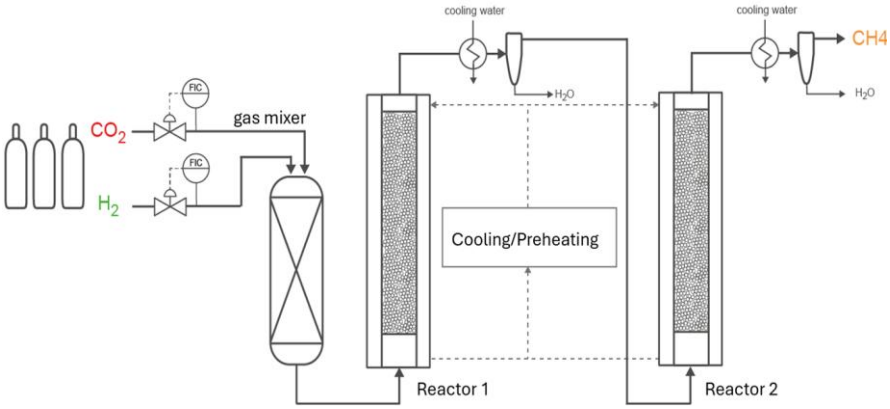
SUCCESS STORY

K1-MET SusMet4Planet Competence Center of Sustainable Digitalized Metallurgy for a Climate Neutral and Resource Efficient Planet

Programm: COMET Competence Centers for Excellent Technologies

Programme line: COMET-Centre (K1)

Type of project: Project 2.4 Work Package WP2, July 1st, 2023 to June 30th, 2027, multi-firm



Flow diagram of a pilot plant for catalytic methanation (©K1-MET)

METHANATION OF CO_2 FROM REAL OFF GAS-STREAMS

Methanation via the Sabatier reaction is a promising industrial process for reducing industrial CO_2 emissions. In this reaction, CO_2 and H_2 react to form methane and water:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

The reaction is highly exothermic and enables the utilization of CO_2 as a carbon source to produce synthetic natural gas (SNG).

A gas purification unit was used to capture CO_2 from power plant flue gas. The captured CO_2 was subsequently liquefied and stored. The captured CO_2 had a purity of 99.8%, with traces consisting of N_2, O_2, and H_2O.

The two gases were fed into a double-tube reactor. The shell side of the reactor was filled with thermal oil, which served as a heating medium before the reaction and as a cooling medium after the reaction.

The tube side of the reactor was equipped with catalyst. Temperature sensors were installed along the reactor to monitor the temperature profile throughout the reactor. The product gas composition was analyzed using an online gas analysis system.

Several operating parameters, including oil temperature, system pressure, gas hourly space velocity (GHSV), and hydrogen excess, were varied to investigate different operating conditions.

Long-term catalyst performance tests were also conducted, with continuous operation exceeding 70 hours. Dynamic tests were performed to simulate the power profile of a (PEM) electrolyzer. During these experiments, the gas flow rates were adjusted every 30 seconds according to the actual power curve of a PEM electrolysis system.

Untreated (desulfurized) flue gas was also tested at four different dilution levels. As a precaution to protect the catalyst, an SO_x adsorbent was installed upstream of the reactor.

Federal Ministry
Innovation, Mobility and Infrastructure
Republic of Austria

Federal Ministry
Economy, Energy and Tourism
Republic of Austria

Version 07/2026

SUCCESS STORY

Impact and effects

CO_2 conversion rates of up to 99.6% were achieved. Depending on the selected operating parameters, synthetic natural gas (SNG) concentrations exceeding 90 vol.% were obtained in the product gas.

Local hot-spot temperatures of up to 700 °C were measured. The resulting waste heat represents significant potential for integration into industrial processes and can be utilized to improve overall process efficiency.

Long-term investigations showed no significant deactivation of the applied bulk catalyst. Catalyst activity was evaluated based on the temperature profile within the reactor and the achieved CO_2 conversion. Dynamic operation of the methanation process was successfully demonstrated.

CO_2 conversion rates of up to 95.1% were also achieved when using raw (desulfurized) flue gas. This expands the potential applicability of the process in industrial environments.

Catalytic methanation is an effective technology for reducing industrial CO_2 emissions while simultaneously enabling the production of synthetic methane, a storable and transportable energy carrier. Another major advantage is its potential for seasonal energy storage. Surplus electrical energy generated during the summer months can be economically converted into hydrogen via electrolysis and subsequently transformed into synthetic methane through methanation. This synthetic methane can then be stored and supplied as an energy carrier during the winter months, thereby contributing to a reduced dependence on natural gas imports.

Furthermore, methanation enables the implementation of a closed carbon cycle. Emitted CO_2 is recycled back into the process in the form of synthetic natural gas (SNG).

Since CO_2 emissions from many energy-intensive industrial processes cannot be completely removed with current technologies, catalytic methanation offers considerable potential to support the transition toward a more climate-friendly and sustainable industry.

Project coordination (Story)
Andreas Niederhauser
PhD-Student
K1-MET GmbH
T +43 (0) 650 88 15 173
andreas.niederhauser@k1-met.com

K1-MET SusMet4planet
K1-MET GmbH
Stahlstraße 14
4020 Linz
T +43 (0) 732 6989 75607
office@k1-met.com
www.k1-met.com

Project partner

- Technical University of Leoben, AT
- voestalpine Stahl GmbH, AT

This success story was provided by the centre management and by the mentioned project partners for the purpose of being published. K1-MET is a COMET Centre within the COMET - Competence Centers for Excellent Technologies Programme and funded by BMIMI, BMWET, Upper Austria, Styria, and Tyrol. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet

Federal Ministry
Innovation, Mobility
and Infrastructure
Republic of Austria

Federal Ministry
Economy, Energy
and Tourism
Republic of Austria

Austrian Research Promotion Agency
Sensengasse 1, A-1090 Vienna
P +43 (0) 5 77 55 - 0
office@ffg.at
www.ffg.at