LABORATORY FOR CHEMICAL TECHNOLOGY
Technologiepark 125, 9052 Gent, Belgium

Supervisor(s)	**Period**	**Funding**
Prof. Mark Saeys	4 years	CO_2MBS

Development of methanation catalysts and process integration

Aim

Design, characterize and test novel methanation catalysts and evaluate their potential in power-to-methane energy systems.

Justification

The future energy system will rely heavily on green energy molecules (e.g., H_2, CH_4, CH_3OH) for energy transport and seasonal energy storage. These molecules are derived from power-to-X (P2X) schemes connected to wind, solar or other renewable energy sources. Green H_2 is one of the possible energy carriers produced from P2X and water electrolysis. The lack of H_2 storage, the low volumetric density and low boiling point of H_2 are critical downfalls of H_2 as a strategic reserve, and the complete roll-out of H_2 prompts both technical and economic challenges. Alternatively, this green H_2 is converted to synthetic CH_4 in power-to-methane (P2M) technologies via the Sabatier reaction. CH_4 has a higher energy density and the large natural gas infrastructure (storage and pipelines) is entirely compatible with syn-CH_4 as an energy carrier. Recent energy studies indicate that the advantages of converting green H_2 to syn-CH_4 outweigh the disadvantages within the Belgian energy system. Additionally, methanation is often applied in biogas upgrading to increase the yield of bio-CH_4. For these reasons, the development of efficient methanation catalysts and processes are important building blocks within CCU.

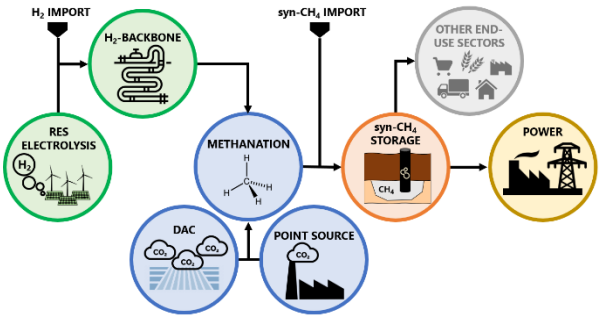

Figure 1: Methanation in the Belgian energy system.

Methanation thermodynamics favors low temperatures. Novel transition metal-based methanation catalysts demonstrate high conversion and selectivity for CH_4 at atmospheric pressure and below 350 °C. Important requirements for methanation catalysts with P2M schemes are stability and resistance to poisoning (sulfur, carbon, etc.). During the CATCO$_2$RE project, together with VITO, the Saeys group developed 3D-printed $NiAlO_x$ methanation catalysts with excellent activity and stability at 350°C, achieving 98% CO_2 conversion and 99% CH_4 selectivity.

Program

Further *experimental* exploration of methanation catalysts is needed. The following tasks are envisioned:

- **Material Synthesis & Characterization.** Design next-generation methanation catalysts and characterize the materials using XRD, TPR/TPD, N_2 physisorption, (HR/S)TEM, FTIR, etc.
- **Performance Testing.** Dedicated lab-scale fixed bed reactor set-up at the LCT allow performance testing of these materials, with a focus on stability and poison-resistance.
- **Process Simulations** to identify key material and process characteristics for optimal integration of methanation in a P2M system.
- **DFT-based micro-kinetic modeling** to guide the design of next-generation methanation catalysts.