

Energy Conversion

The area of Energy Conversion is concerned with ensuring a secure supply of electricity and heat from renewable energies. For this purpose, the electricity generated from renewable energies must be stored chemically, e.g. in the form of hydrogen, over a longer period of time. Within the CDS, the development of computer-aided system designs and the optimisation of energy storage is pursued.

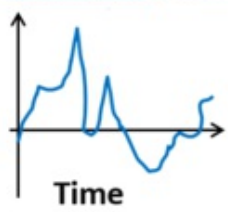
The implementation of the energy revolution in Germany requires the **efficient storage of energy** in particular by converting electrical energy into hydrogen by means of electrochemical water splitting. Hydrogen can be converted into synthetic energy carriers ("eFuels"), e.g. methane and methanol, by hydrogenating CO₂. These substances are not only the key to the efficient storage of renewable energies, but also represent central nodes in the value-added creation chains of the chemical industry. The aim of the CDS's research work is to design, simulate and optimise novel "Power-to-x" processes taking into account dynamically varying supply of electricity.

Furthermore, **energy sources from biological production** ("biofuels"), in particular biomethane, are becoming increasingly important. Its production requires efficient biogas plants for the anaerobic fermentation of energy crops as well as residual and waste materials from agriculture. In these plants, microbial communities transform the raw materials into methane and CO₂. A major goal of the research work is to gain a basic understanding of the complex degradation mechanisms in order to optimize the operation of biogas plants and to make the co-product CO₂ usable for "Power-to-X" processes. The CDS is developing innovative adsorption and absorption processes for the efficient separation of methane and CO₂. The feeding of e-methane and biomethane into existing gas distribution networks causes dynamic variable flow and pressure distributions, which are simulated and optimized with advanced mathematical methods.

In view of a fluctuating hydrogen supply, it is desirable to perform CO₂ hydrogenation in catalytic reactors which can be operated with dynamically variable feed streams. However, so far there are hardly any reliable design methods for dynamically operated reactors and there are no tailor-made catalytic material systems which can withstand temporal fluctuations of gas composition and temperature. A consistent multi-scale analysis of the system dynamics covering the reaction and transport processes on the relevant time and length scales is mostly not available. This is another important topic area which the CDS is working on in close cooperation with regional, national and international partners from science and industry.

Power-to-X

Dynamics of Electricity Price



H₂

CH₄, CO₂

MeOH Synthesis

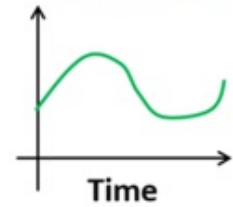
DME Synthesis

DME

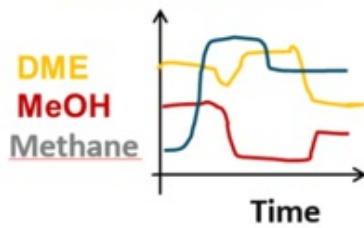
MeOH

CH₄

Dynamics of Biomass Composition



Dynamics of Product Demand



Goal:
Computer-aided Process Development, Optimization & Control

Research

- ▶ Energy Conversion
- ▶ Chemical Production
- ▶ Active Substances
- ▶ Key Technologies