biosweet
Biomass for Swiss Energy Future
Swiss Competence Center for Energy Research

In cooperation with the CTI

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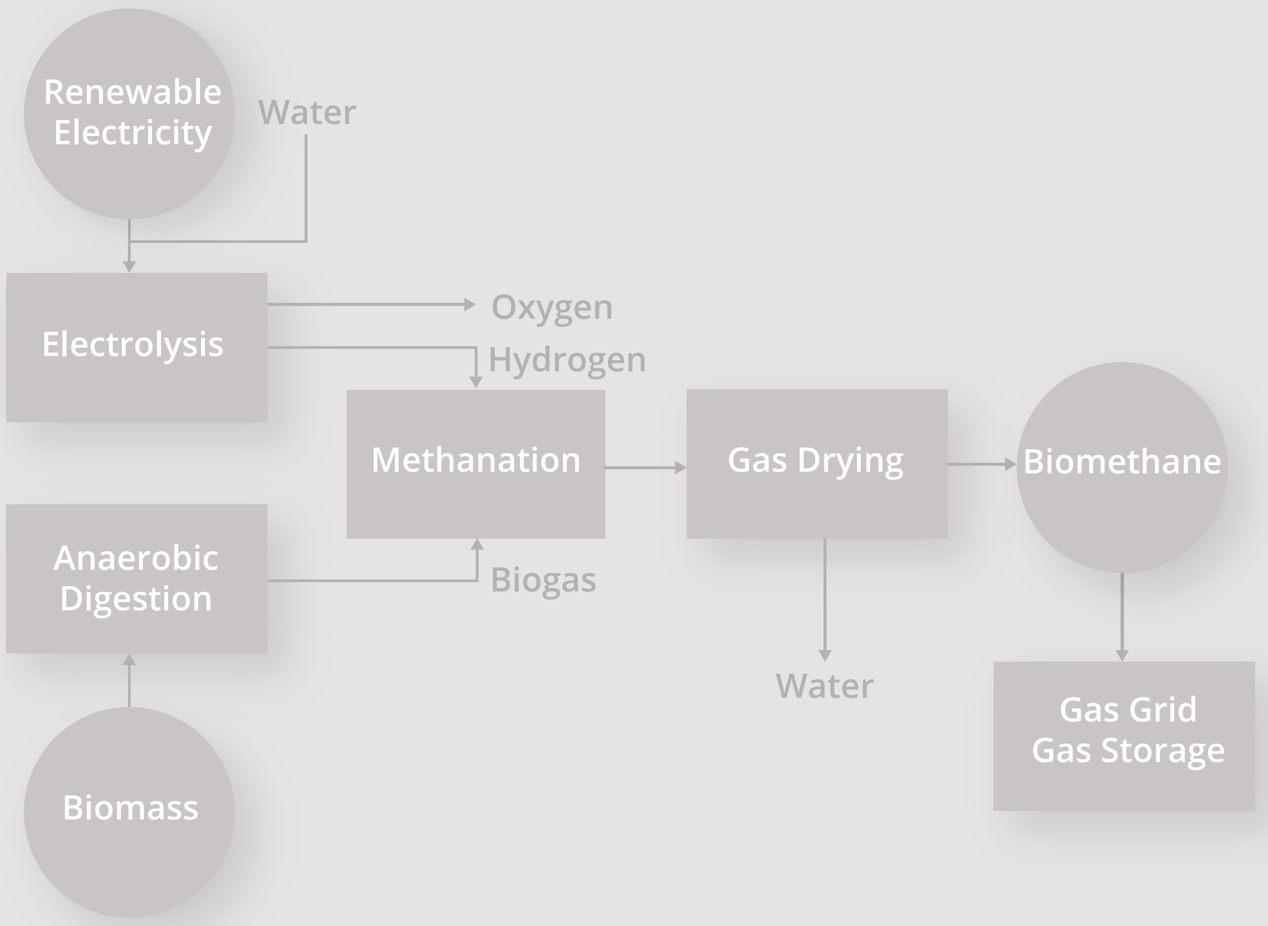
Methanation

Enrich biogas to biomethane and get grid quality



Basic Principles of Biogas Methanation

Biogas + Renewable Electricity = Gas Storage + Flexibility

Biogas from anaerobic digestion consists of roughly 60 % methane and 40 % CO_2. The CO_2 can be converted into additional methane by utilizing surplus electricity from renewable generation and water. This way, the biogas can be upgraded into 100% biomethane which can be fed into the gas grid for consumption on demand and flexible storage.

The conversion process comprises two major steps: the production of hydrogen from water within an electrolyser (this is where the renewable electricity is consumed) and the combination of this hydrogen with CO_2 from the biogas into methane. While electrolysers are available off the shelf, the second step, the actual methanation reaction, needs further research. Basically, two technologies are feasible for this reaction: the biological methanation and the catalytic methanation. Their suitability depends mainly on the site conditions of the biogas plant. The SCCER BIOSWEET is looking into both of them to develop the best solutions for the various site conditions in Switzerland and for the intermittent supply of renewable electricity.

Methanogenesis – the Biological Methanation

The biological form of methanation is called 'methanogenesis'. A certain type of microorganisms, the 'methanogens', can produce methane by just consuming carbon dioxide and hydrogen. The biological process takes place at very mild conditions close to ambient pressure and temperature. In nature, the methanogens are ubiquitous. They prefer wet, anoxic (oxygen-free) environments such as sediments and muds of various aquatic habits or in the rumen of animals. In technology, they are already employed in biogas and anaerobic waste water treatment plants but not for the production of pure methane.

This new purpose requires new process designs. At the SCCER BIOSWEET we develop in-situ concepts, where the methanation happens inside the biogas fermenter, as well as ex-situ concepts, where methanation happens in separate bioreactors. The goal is to minimize over all vessel volumes and internal energy consumption but to maximize operational stability and flexibility. Another criterion is the purity of the methane in order to avoid additional gas treatment before grid feed-in.

Suitable Feedstock

> Biogas from anaerobic digestion and anaerobic waste water treatment
> Other off-gases with high CO_2-content

Marketable Product

> Biomethane
> Process heat at 65°C

Technology Readiness and Roadmap 2020

By 2020, the combined research projects on biological and catalytic methanation of biogas will provide verified recommendations to select the most suitable methanation technology for the relevant biogas sites in Switzerland and to specify the plant and process parameters. Both projects cooperate already with established industrial partners to ensure market relevance and a seamless transfer of technology.

Biological Methanation

In 2017, we describe in-situ methanation strategies for common fermenter designs and related mass and energy balances. As well, we commission an ex-situ testing facility in our lab. 2018 and 2019 are dedicated to testing and scale-up of pilot installations at a biogas plant. Analysis of the in-situ and ex-situ results will allow to finalize a validated reactor model in 2020.

Catalytic Methanation

In 2017, the robustness of the process will be demonstrated in long term operation (> 1000 h) of a 10 kW test installation at an industrial biogas site. 200 kW pilot scale tests with model gas are scheduled for late 2017. Both test series will deliver data to validate the process model and to scale-up the design for an industrial demonstration plant in 2018.

Catalytic Fluidised Bed Methanation

The research team of the SCCER BIOSWEET developed already a catalytic process to convert wood gas to biomethane. Based on this experience, we develop a process to catalytically convert biogas to biomethane.
The concept is based on the fluidised bed technology. By fluidising the catalyst particles, optimal heat transfer and a compact reactor design can be achieved. The continuous movement of the catalyst particles in the gas stream enables to minimise steam addition and to avoid the deactivation of the catalyst by carbon deposition.

The conversion of CO_2 with hydrogen to methane, the actual methanation reaction, is strongly exothermic. This heat energy can be retrieved from the catalytic reactor at a level of 200°C to 250°C. The high temperature level supports a number of heat integration opportunities like biomass hygienisation, district heating or within the anaerobic digestion.

Upstream to the catalytic methanation, the raw biogas passes a gas cleaning step contingent to the biogas source. Downstream, the biomethane needs drying to get ready for grid feed-in. The research scope of the SCCER BIOSWEET covers this entire process chain.

Catalytic methanation pilot reactor at the Paul Scherrer Institute

Marketable Product

> Biomethane
> Process heat at 200°C – 250°C

Suitable Feedstock

> Biogas from anaerobic digestion and anaerobic waste water treatment

Research Contact

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10/2016