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

In cooperation with the CTI

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Commission for Technology and Innovation CTI

High-Efficiency Anaerobic Digestion

More biogas through pretreatment and process control

An Overview

Multiple improvements along the process chain

More biogas from the same amount of substrate and the same size of installations is a major topic for the SCCER BIOSWEET. An increased yield of biogas directly improves the economic viability of anaerobic digestion and makes it attractive for new applications. All innovations are based on the well-established industrial-scale process.

The SCCER BIOSWEET pursues two approaches to increase the efficiency and output. One is to enhance the digestibility of the substrates by microbial pretreatment. The other is to optimize the process flow by single step digesters combined with advanced controls and analytics.

All the innovations will be integrated in a design and calculation toolbox for easy customization of high efficient digestion systems for individual feedstock.

Further research topics along the biogas value chain are tackled by the SCCER BIOSWEET, namely thermomechanical steam pretreatment of biomass, in-situ and ex-situ biological methanation and anaerobic digestion of manure for small-scale farms. These topics are featured in separate technical factsheets.

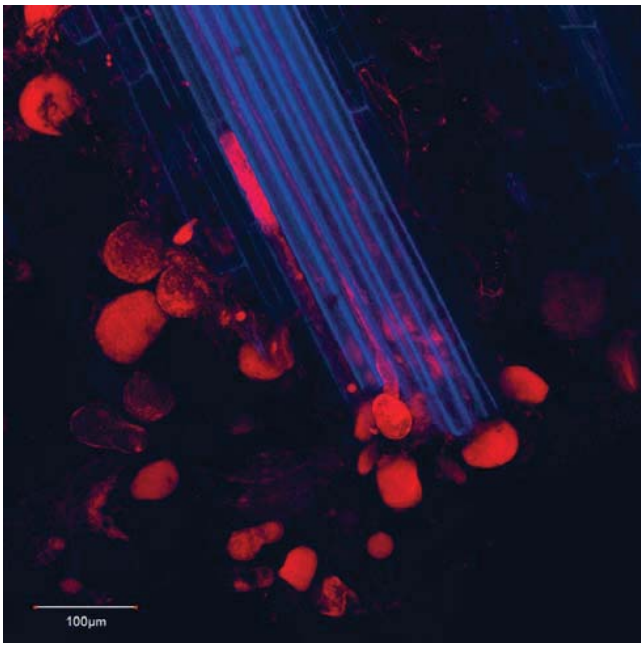
Microbial pretreatment can significantly enhance the anaerobic digestibility

Anaerobic digestion of organic substrates is a well-established microbial process to produce biogas. The bioenergy carrier in this gas is methane. Most organic substrates are converted only by some 40 – 60% into methane. This is due to the kinetic limitations in the degradation process. Substrate specific pretreatment offers a significant enhancement of the degradability and thus of the bioenergy production rate.

Microbial substrate pretreatment by acid producing bacteria, by anaerobic fungi or in microaerobic conditions are just some of the options to bring the methanogens (i.e. the methane making organisms) to their full potential. Defining substrate specific microbial consortia and process conditions as well as ascertaining sufficient residual carbon structures for soil enhancement are two of the scientific challenges which are addressed within the SCCER BIOSWEET.

Suitable feedstock

> Green waste from separate collection
> Fibrous and cellulosic waste
> Food byproducts and waste
> Agricultural byproducts and leftovers
> Wastewater sludge



Marketable Product

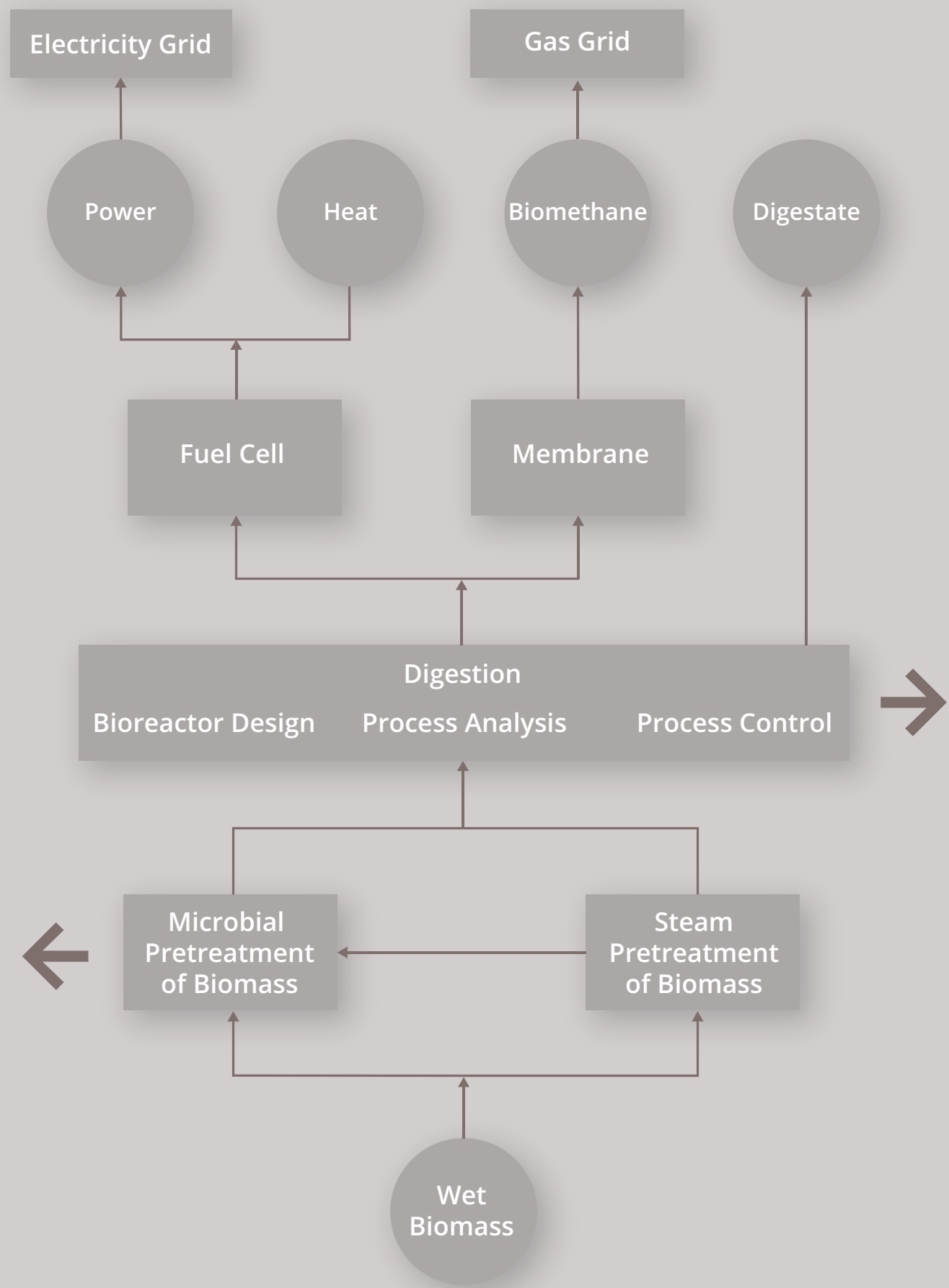
> Biogas
> Biomethane
> Digestate

Technology Readiness and Roadmap 2020

In 2015, the proof of concept has been accomplished for the microaerobic pretreatment at lab and pilot scale. This technology will now be transferred to our cooperation partners for industrial testing.

In 2016, a three year pilot study was launched to lay out the basic conditions for the sustainable exploitation of fibrous substrates.

From 2017 onwards additional pilot and demonstration units shall be initiated. Substrate specific hydrolysis conditions and the use of anaerobic fungi will the two main foci for these activities.



The main steps of anaerobic digestion process
from wet biomass to energy products and digestate

Process control, analytics and bioreactor design – keys to a better microbial performance

Traditional concepts for the anaerobic digestion of wastes rely on simple bioreactor designs and process control strategies which do not take into account the specific growth conditions of the various microorganisms present. For example, operation of single stage mixed and plug-flow fermenters is based on a feed flow and gas flow control only.

The SCCER BIOSWEET is developing new digester designs which will facilitate attached growth, uncoupled hydraulic and solid retention times and optimized growth conditions for specific anaerobic consortia. These features enable the reduction of the fermenter volumes and the increase of the substrate degradation rates. Advanced sensors for volatile fatty acids and new fuzzy logic or neural network control algorithms for the digester feeding will allow to control the different metabolic steps of the anaerobic food web (e.g. hydrolysis and methanogenesis) individually.

Suitable feedstock

> Green waste from separate collection
> Fibrous and cellulosic waste
> Food byproducts and waste
> Agricultural byproducts and leftovers
> Solid and liquid manure
> Wastewater sludge

Marketable Product

> Biogas
> Biomethane
> Digestate

Technology Readiness and Roadmap 2020

In 2016, lab scale experiments are ongoing to define the operational measurement and control parameters for the high rate anaerobic digestion.

In 2017, several initiatives will be started to establish high-efficient anaerobic digestion devices like anaerobic filter, an MBR or two stage reactors at industrial sites of collaboration partners of the SCCER BIOSWEET.
From 2018 onwards it is planned to demonstrate the technologies on several full scale AD installations.

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