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Biological Methane Conditioning

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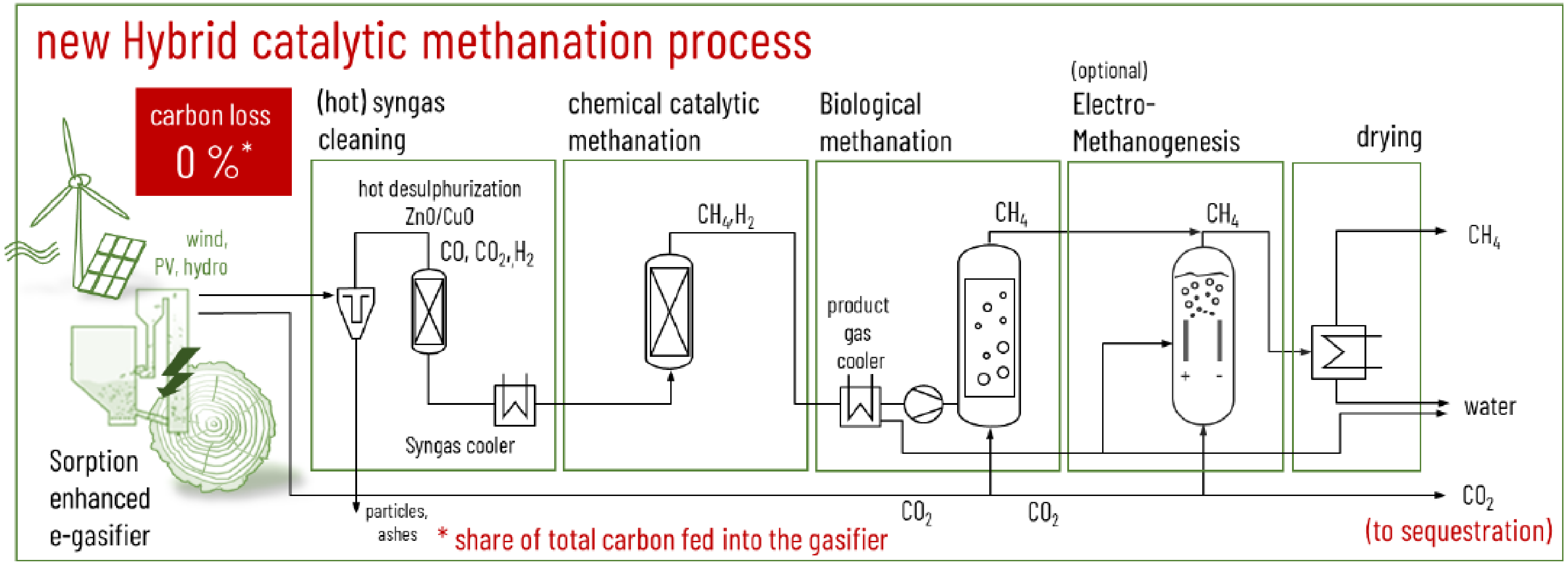
Outlook on biological methane conditioning



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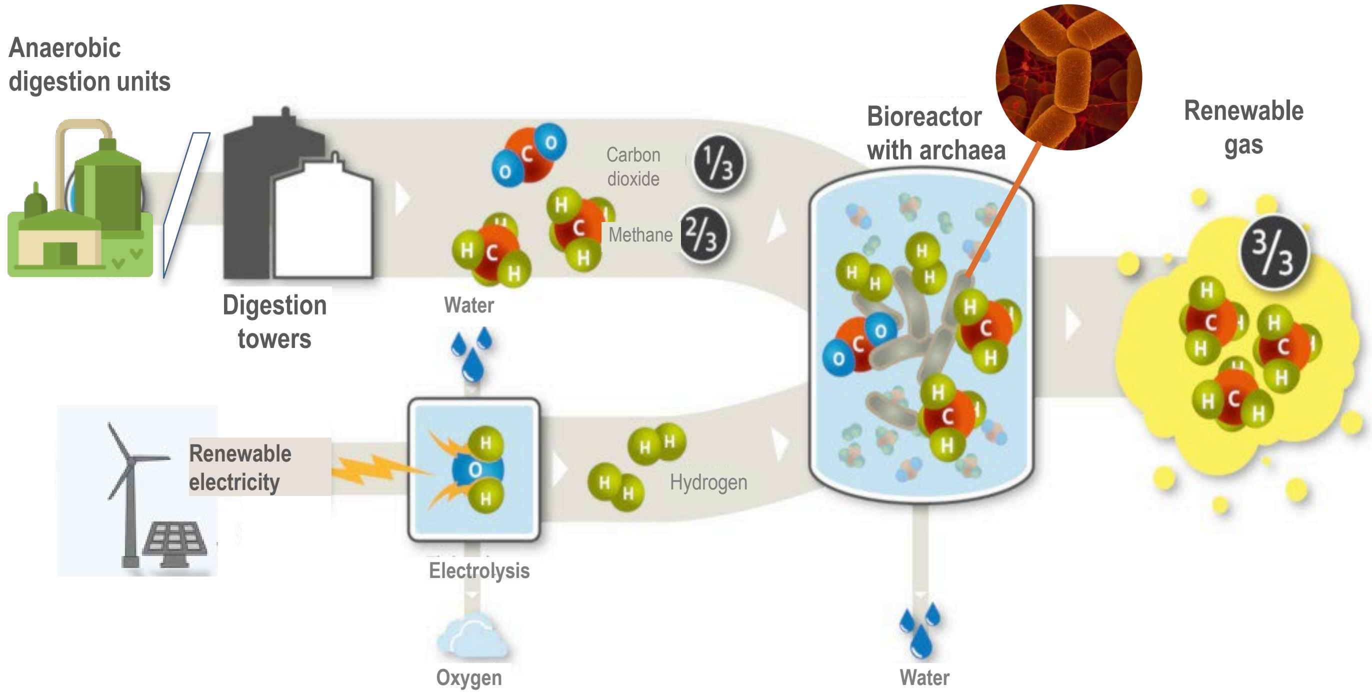
Biological methane conditioning



adapted from https://www.biomasse-nutzung.de/en

Decentral energy storage

- upgrading biogas by utilization the CO_2 share of biogas
- storage of surplus solar/wind power via H_2 electrolysis
- injection into the natural gas grid
- sector coupling

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Project ambition biological methanation

- Real time in situ monitoring system (RTIMS) of solved gas concentrations
  - Development of self-cleaning and self-calibrating probes for solved gas monitoring by means of a real time in situ monitoring system for pressures up to 10 bars
- Implementation in-situ gas monitoring in a stirred methanation fermenter
  - Testing and characterization of the RTIMS in an existing labs-scale biomethanation fermenter
  - Modelling of a digital twin for the fermenter
- Lab-scale validation and digital twin verification
  - Long-term testing and digital twin verifications during transient operation

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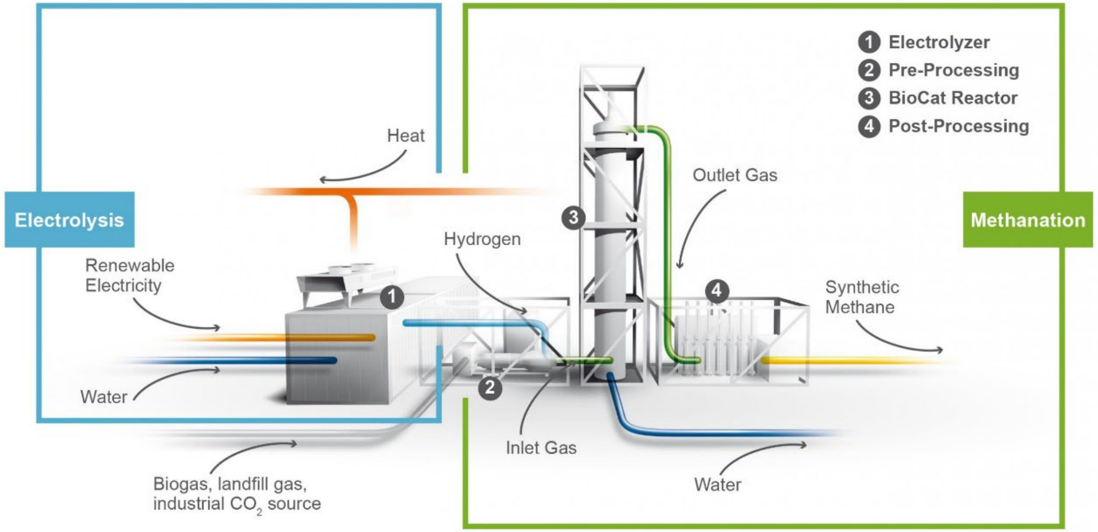
Electrochaea's BioCat Methanation System



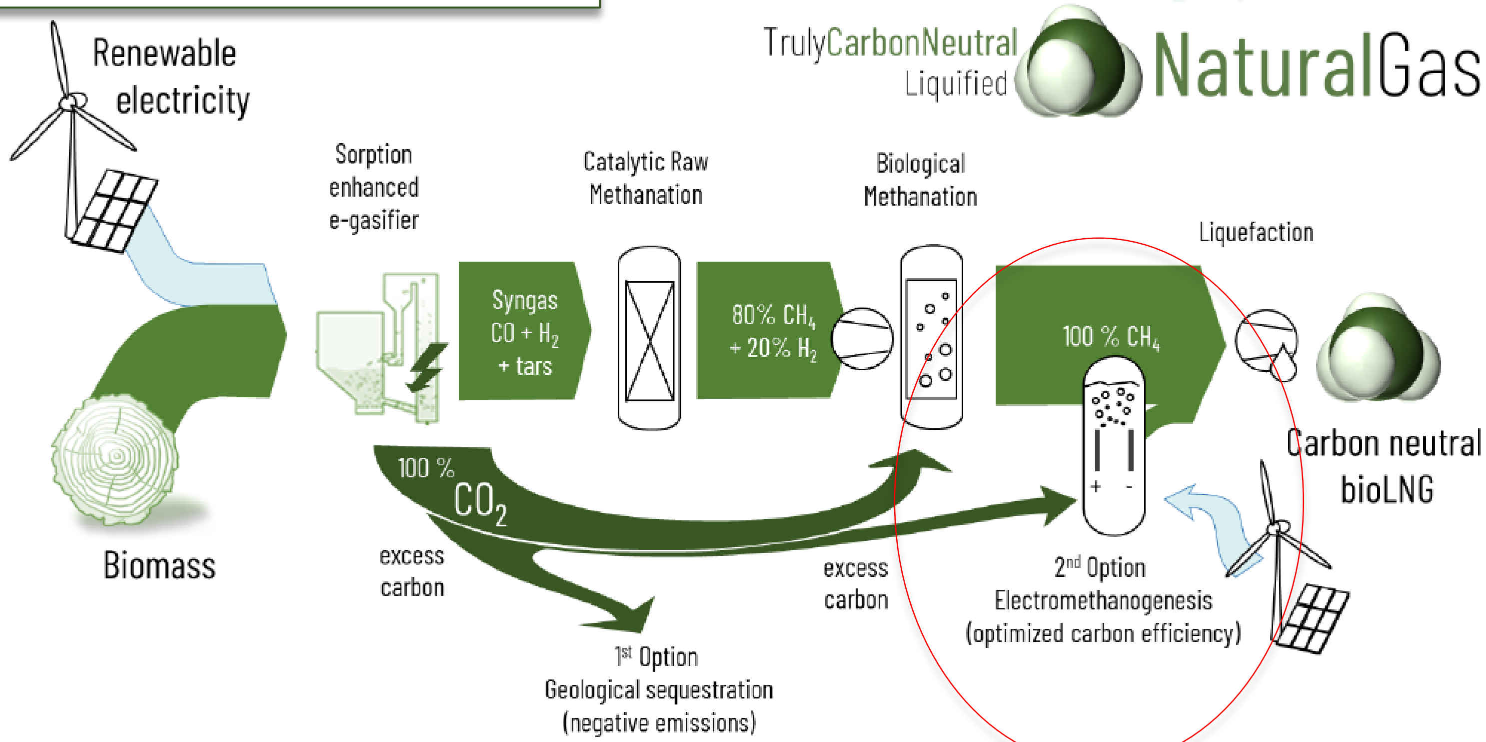
Demonstration site at the Avedøre, DK (Municipal WWTP)

- 1 MW electrical input
- alkaline electrolysis and
- biological methanation stage
- flexible operation, load following

https://www.electrochaea.com/press-resources/

Hybrid catalytic conversion process

- **thermochemical catalytic processes**, i.e. carbon efficient sorption enhanced e-gasifier
- **chemical catalytic processes**, i.e. Catalytic Raw Methanation with in-situ tar hydrogenation
- **biological catalytic processes**, i.e. Biological Methanation with advanced biological process control
- **bioelectrocatalytic processes** for excess carbon utilization by means of electromethanogenesis



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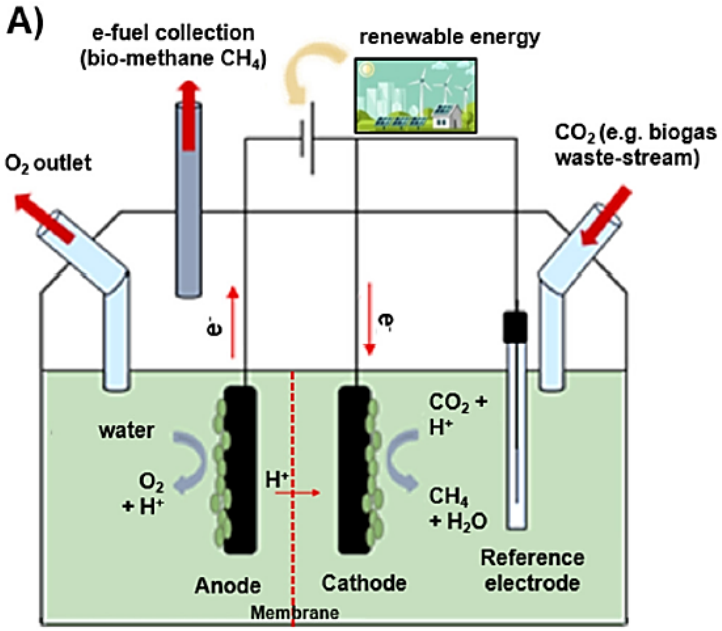
Electromethanogenesis

Bioelectrochemical methane conditioning

- decentral „electricity storage“ in methane
- decentral electro-synthesis of alternative fuels
- **biogas conditioning**



Two-compartment EMG System

Electricity-enhanced microbial methanation to in two compartment electrochemical reactor:

Electromethanogenesis (EMG)

Advantages

+ no H_2 infrastructure needed

+ 1-step synthesis

Aim Electromethanogenesis

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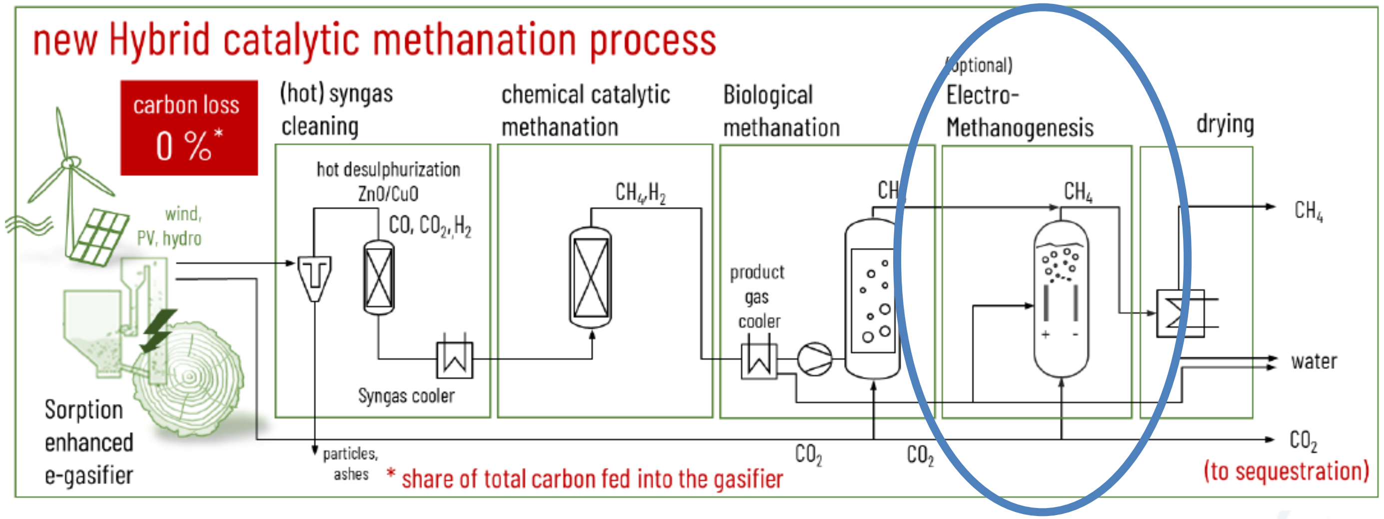


- Bioelectrochemical synthesis via electromethanogenesis→ Cathode material and reactor development for 100% CO_2 reduction properties, an optimal microbial electron transfer, and maximized faradaic efficiencies (electricity-to-methane)
- 'Digital Twins' modulated electromethanogenesis reactor → Computational fluid dynamics modulation determining zero-waste process parameters and minimal overpotential reactor geometries

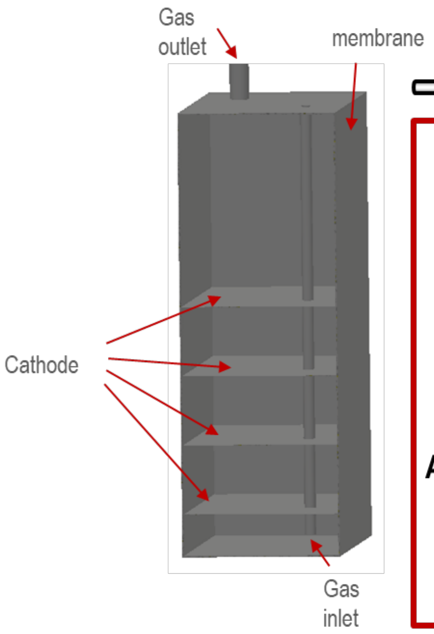
Digital Twin

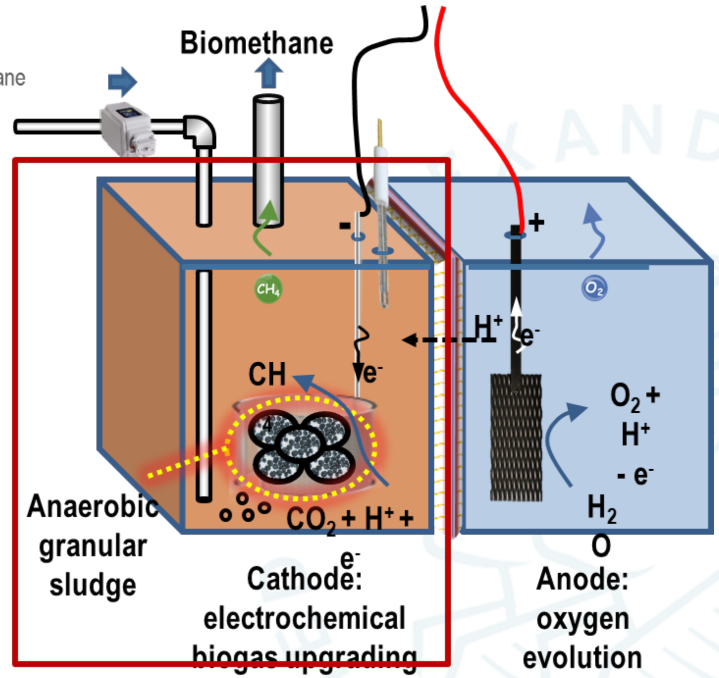
Computational Fluid Dynamics

→ Optimization of the electromethanogenesis reactor

- minimal overpotential reaction geometries
- Determining zero-waste process parameters

- Focus on the cathodic chamber→ main reaction
- Comparison of the flow in different reactor and cathode geometries and CO_2 feed streams





Carbon Neutral LNG

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Outlook Techno-economical advantages Electromethanogenesis

→ High tolerance of the microbial communities in the reactors towards feed impurities (e.g., H_2S)

→ Selective metabolic pathways towards CH_4 production, and the low thermal input requests at operating stages between 38-65°C

→ effortless adjustment of the EMG systems to varying loads (process chain feed, electricity supply)

→ broad applicability of EMG coupling, due to absent need of additional green hydrogen supply