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GENERAL ENERGY

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SunCHem – A Smart Strategy to Produce Biofuels and Capture CO_2 Using an Algae-Based Process

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Why Microalgae?

The production of liquid biofuels from food crops such as corn, soya, and sugarcane are in direct **competition** with food production for human consumption.

In contrast, microalgae grown in **photobioreactors**, offer the following advantages:

- Microalgae are the most productive **photosynthetic organisms** on earth and grow several times faster than other energy crops (30-55 t/ha/yr).
- They can grow in reactors on **non-fertile land**, thus not competing with food production.
- They require **less water** for growth than land crops.
- They can directly convert **industrial CO_2 emissions** into organic matter.

Why Bio-Synthetic Natural Gas?

Wet biomass feedstocks can efficiently be converted into Bio-Synthetic Natural Gas (Bio-SNG) through **catalytic hydrothermal gasification in supercritical water (SCW)** as reaction medium. The major advantages are:

- Bio-SNG can be used in the **existing infrastructure** (natural gas grid).
- It can be sold as clean **transportation fuel** in the form of compressed natural gas (CNG).
- Technology with **high efficiency** for power production is available (CHP).
- **No** biomass **drying** or product **distillation** steps are necessary.
- Nearly **full conversion** through hydrothermal gasification.
- **Nutrient separation & recovery** possible due to low solubility of salts in SCW.

SunCHem Process: Closed-Loop System with Respect to Nutrients

CO_2, NO_X, SO_X

Photo source:
¹ http://europa.eu/scadplus/
² www.heise.de
³ Background picture © UT-Austin

1 Microalgae use sunlight energy, CO_2 and H_2O for growth. They are cultivated in photobioreactors.

4 The recovered nutrients and water are transferred back into the photobioreactor.

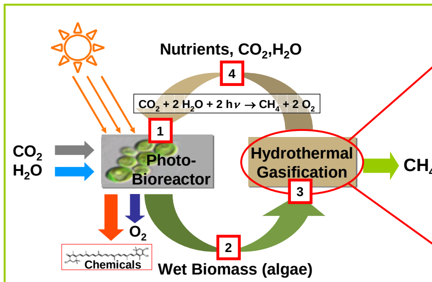


Figure 1: Closed cycle using algae as biomass (SunCHem)

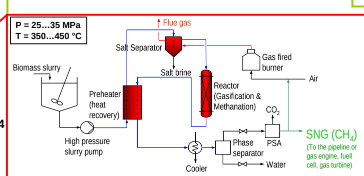
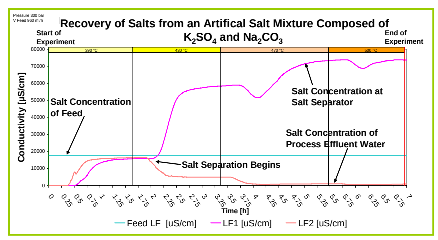


Figure 2: PSI's catalytic hydrothermal Bio-SNG process



3 The biomass is converted into Bio-SNG by catalytic hydrothermal gasification. Nutrients and water are separated during the process from the Bio-SNG.

2 High-value chemicals can be extracted from the microalgae, before feeding them into the hydrothermal process.

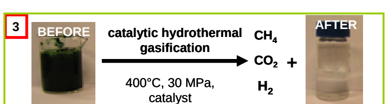
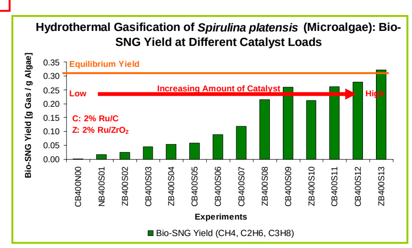
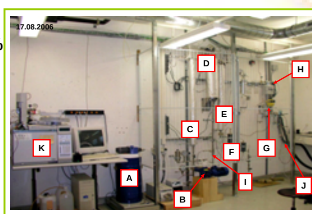


Figure 3: Liquid phase before and after hydrothermal gasification.



The Hydrothermal Laboratory Plant

- Continuous feed of **1 kg/h**
- Concentrations up to **20 wt %** organic material
- Operated almost fully by **remote** control
- The rig consists of three sections:
  - **Preheating**
  - **Salt separation**
  - **Fixed-bed catalytic reactor**
- Pressure max. **35 MPa**



A: Feed Tank
B: Feed Pump
C: Preheater
D: Salt Separator
E: Fixed Bed Reactor
F: Cooler
G: Back Pressure Regulator
H: Gas Meter
I: Salt Separator Effluent
J: Phase Separator
K: Gas Chromatogrph

Figure 4: Continuously operated laboratory plant KONTI 2

- In order to remove the **nutrients** quantitatively, the salt separator needs to be heated above the critical temperature

Conclusions

If proved feasible, SunCHem is an innovative way to produce a renewable **transportation fuel or electric power.**

Nutrients can be recovered from the microalgae feedstock in the form of a concentrated **salt brine.**

Microalgae can be produced at high specific rates in **photobioreactors**, surpassing the area yield of crops and other land plants.

Technical challenges such as the **coupling** of the biological process with the hydrothermal process need to be tackled in the future.

The **economic** feasibility of the SunCHem process has to be assessed and demonstrated.

- Project partners: Velux-Stiftung, Axpo Naturstrom Fond, BFE