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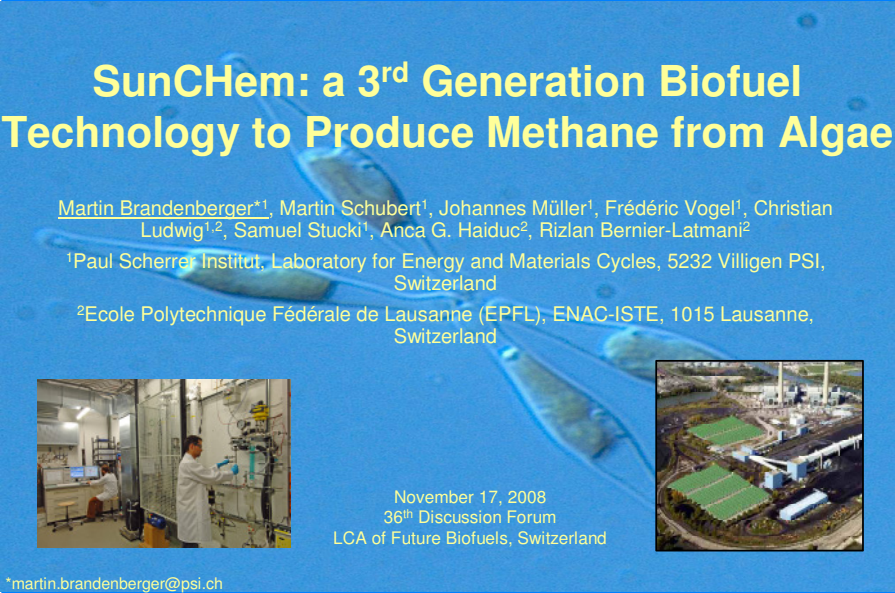


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SunChem: a 3rd Generation Biofuel Technology to Produce Methane from Algae

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Content

- Introduction **SunChem** process
- The **technology** behind the process
- PSI's **catalytic hydrothermal SNG** process
- Summary & Conclusions

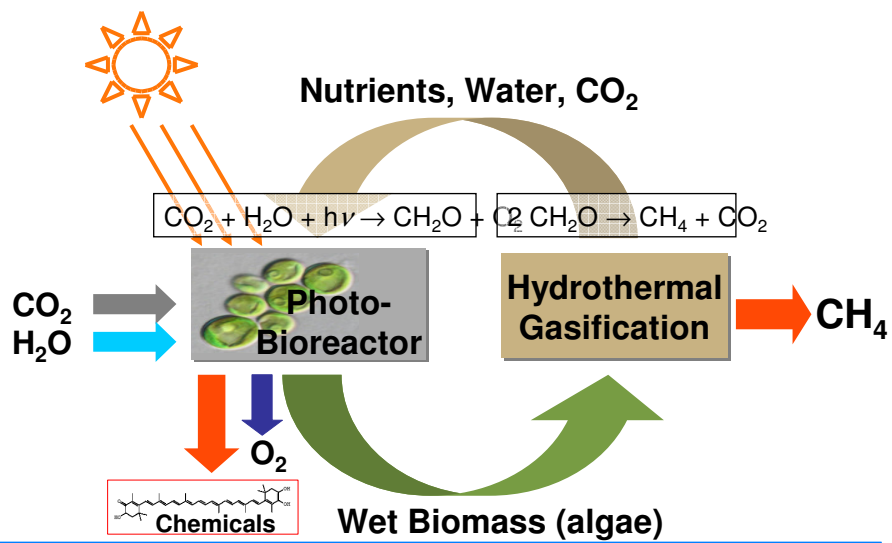
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SunChem: Green Gas "Hors Sol"




SunChem: Green Gas "Hors Sol"





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Why Hydrothermal Gasification ?



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Chemical efficiency of conventional gasification vs. water content in feedstock


feed type

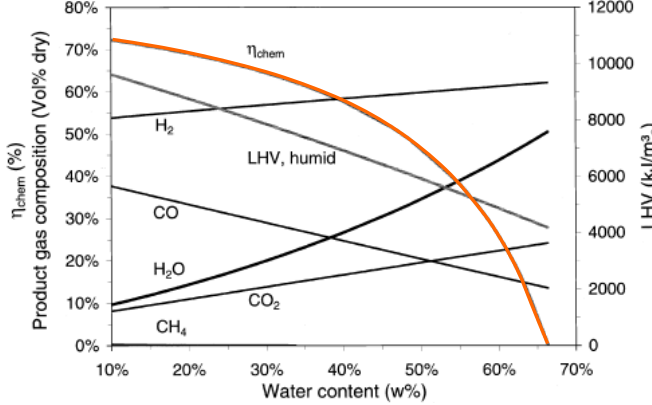
thermal efficiency (biomass to H₂)

science time

technological readiness







G. Schuster, G. Löffler, K. Weigl, H. Hofbauer, *Bioresource Technology* 2001, 77, 71-79

2010)

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[1] A. Duret et al., *Journal of Cleaner Production*. 13(15), 2005: p. 1434.


[2] Y. Yoshida et al., *Biomass & Bioenergy*. 25(3), 2003: p. 257

[3] J. Luterbacher et al., *Environ. Sci. & Technol.*, 2008 (submitted).

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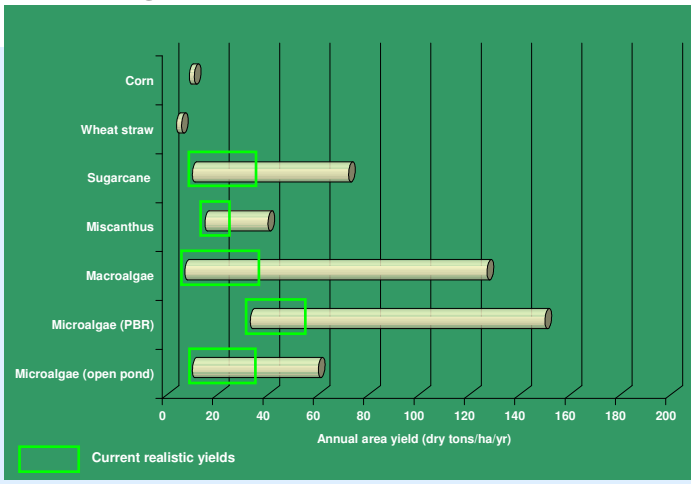


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Why Microalgae?



Source: Outputs from the EPOBIO project, cpl press, September 2007

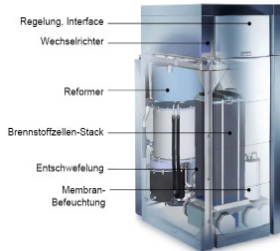
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Photobioreactors



Algomed - IGV in Klötze (Germany)

Why Methane?



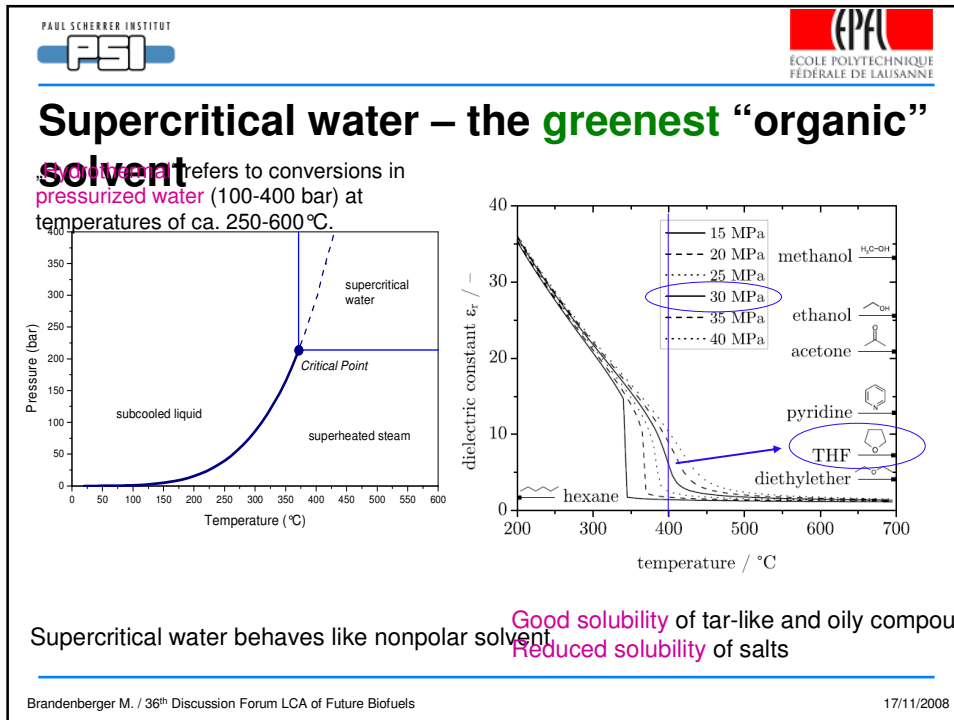
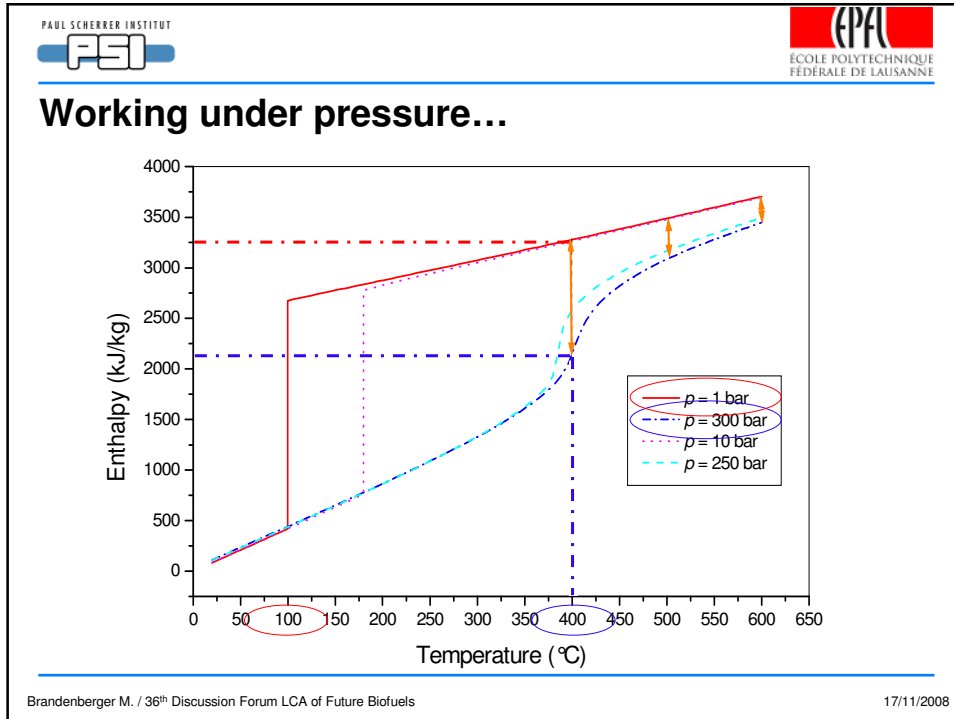
1-4.6 kW_{el}
1.5-7 kW_{th}




1 kW_{el}
2.5 kW_{th}




Already available and affordable today
138 g CO₂/km (Gasoline: 169 g CO₂/km)

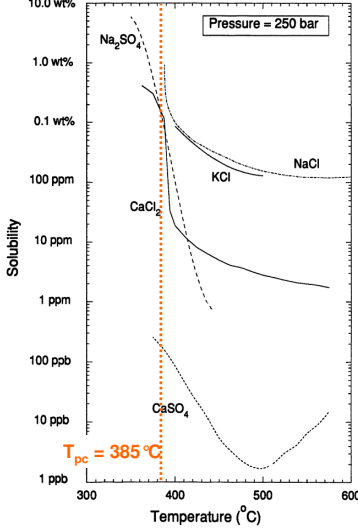


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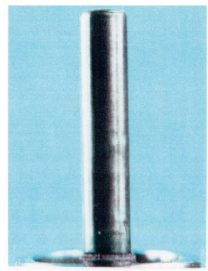


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Pressure = 250 bar

Salt solubility in supercritical water



Before Run


Precipitation of Na_2SO_4 from a 4 wt% solution on a „hot finger“. $T_{\text{solution}} = 356\text{ }^\circ\text{C}$, $p = 25\text{ MPa}$
 Hodes, M. *et al.*, *JSCF* 29 (2004)


F. J. Armellini, PhD thesis, Dept. of Chem. Eng., MIT, 1993


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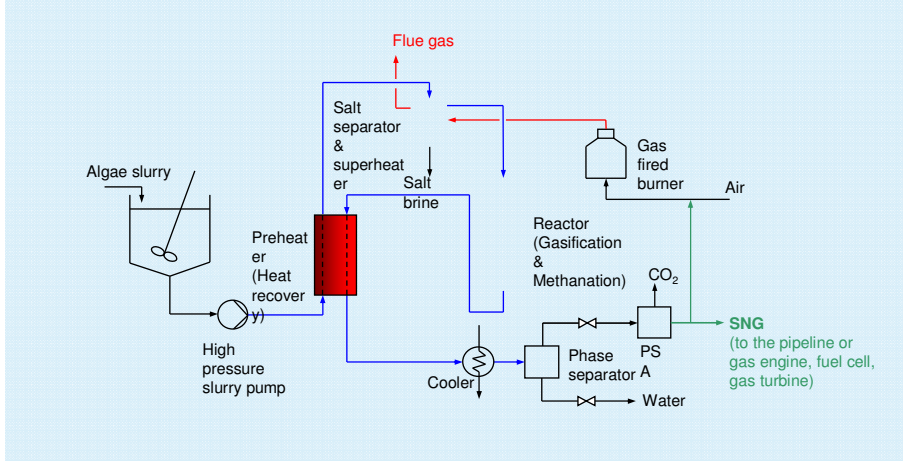








PSI's catalytic hydrothermal SNG process




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Liquefaction of *Spirulina platensis*

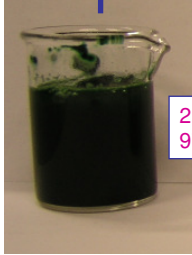


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380 °C, 30 MPa, $\tau = 15$ min.

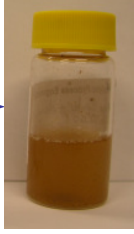
Carbon gasification: 10%
Yield: 0.02 g CH₄/g algae(dry)

Good liquefaction but only modest gasification.



2.5% Spirulina
97.5% Water


No catalyst





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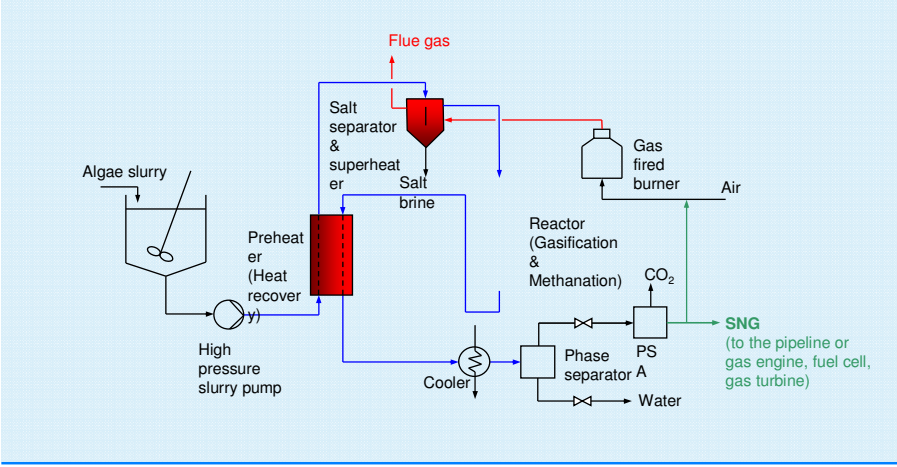








PSI's catalytic hydrothermal SNG process



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PAUL SCHERRER INSTITUT **PSI** **Experimental Hydrothermal Lab-Scale** EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

18.09.2008

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PAUL SCHERRER INSTITUT **PSI** **Recovery of Salts from an Artificial Salt Mixture Composed of K_2SO_4 and Na_2CO_3**

Pressure 300 bar
V Feed 960 ml/h
m Saltseparator (SA) ca. 2.6 g/min
Aperture 1:5 (SA to V17)

V114-K2SO4-Na2CO3-19.01.08

Salt Start

Salt concentration in feed

Salt separation starts

Salt concentration at salt separator

Salt concentration of effluent

Salt Stop Water Start

Conductivity [µS/cm]

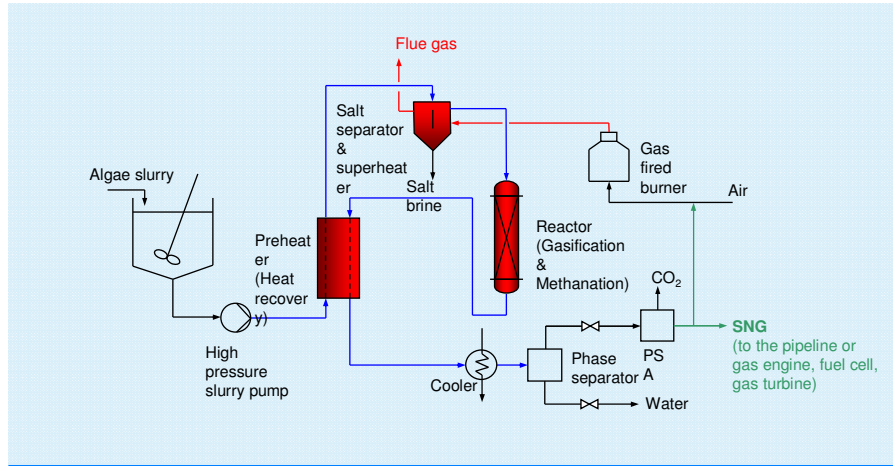
Time [h]

Feed CM [µS/cm] CM1 [µS/cm] CM2 [µS/cm]

T13 SA Medium top
T4 SA Marite top
T5 SA Marite bottom

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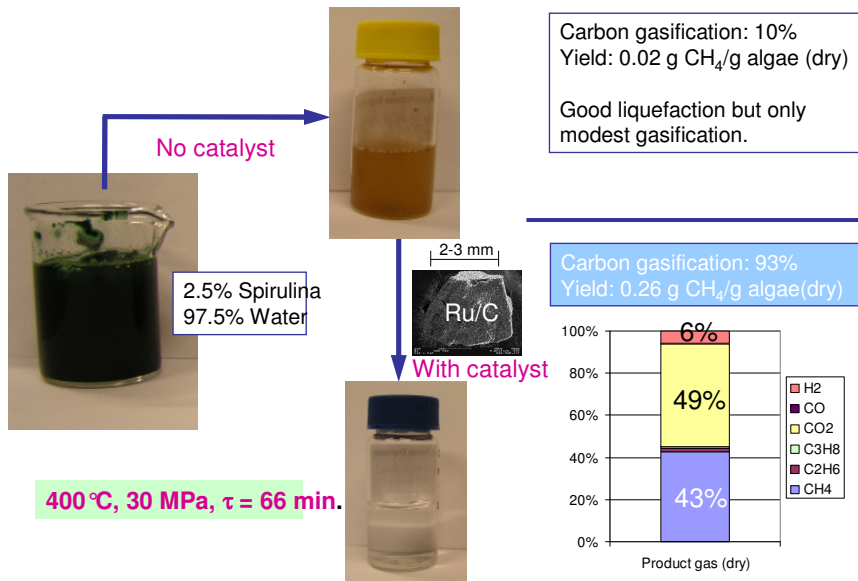
PSI's catalytic hydrothermal SNG process



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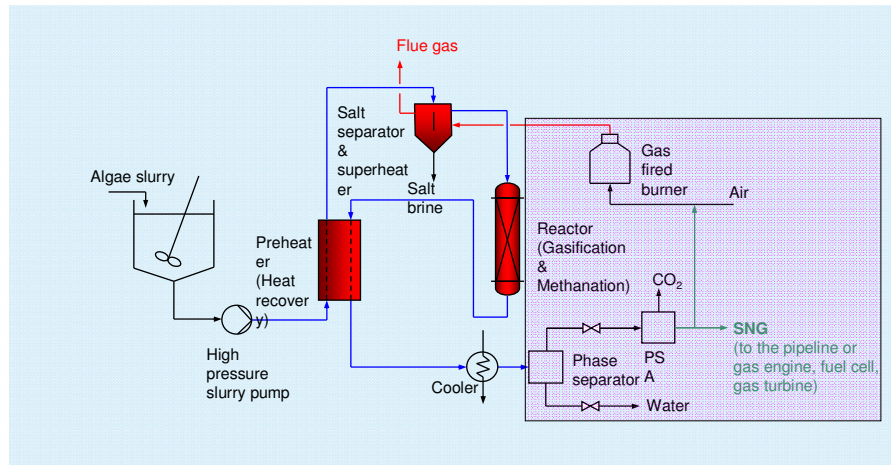
Gasification of *Spirulina platensis*



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PSI's catalytic hydrothermal SNG process



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Summary & Conclusions

- Processing **microalgae** as a wet slurry above water's critical point avoids **drying**.
- Algal biomass can be completely gasified to a **methane-rich** gas in supercritical water using a suitable **catalyst & conditions**.
- In a continuous process, **nutrient salts are separated before** the catalytic reactor and can be recovered as concentrated brine.
- A **closed bioenergy** system based on microalgae and hydrothermal gasification is a promising concept for CO₂ mitigation and biomethane production.

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Thank you very much !

