Karlsruhe Institute of Technology

CO_2 reduction potentials of alternative fuels – Energy research at KIT

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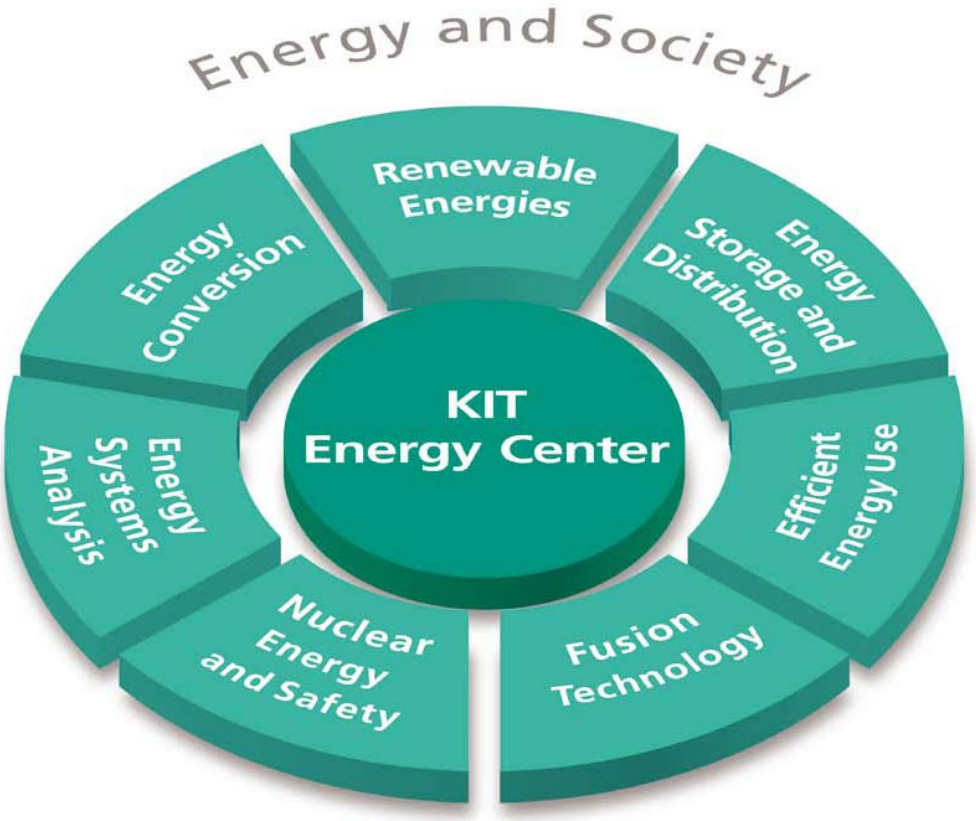


& KIT Focus Mobility systems:

Efficient use of energy in transportation

- Biomass based energy
  - (synthetic) fuels e.g. bioliq®
  - hydrogen
    - hydrothermal gasification of wet biomass
    - microalgae

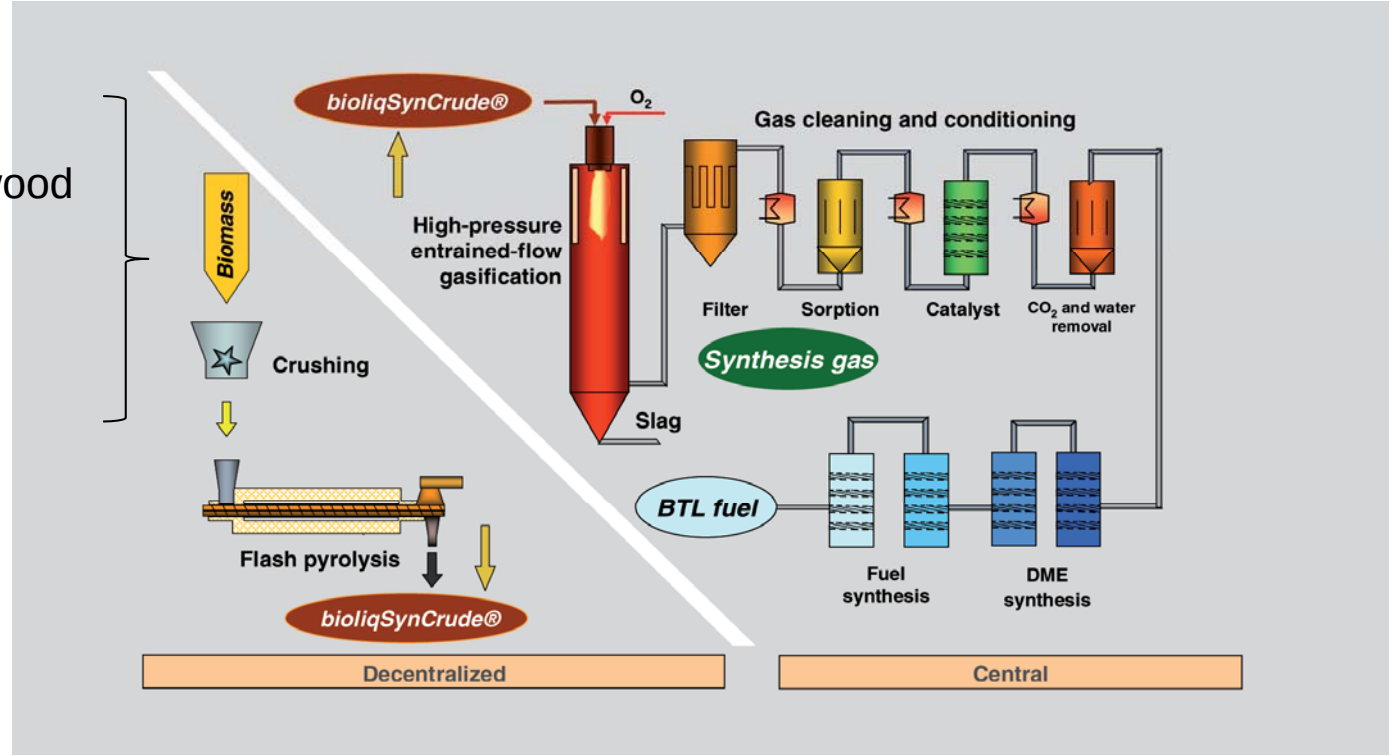
bioliq®

- Aim: Producing customized fuels from residual biomass

- Concept

- Straw
- (Residual) wood

- Bagasse
- Palm leaves
- …



Source: KIT 2010

bioliq®

- Pilot plant: Status quo

	Phase 1	Phase 2	Phase 3	Phase 4
Process	Flash pyrolysis	High pressure gasification	Gas cleaning + Synthesis I	Synthesis II
Product	BioSyncrude®	Synthesis gas	DME	Synthetic fuel
Capacity	2 MW (500kg/h)	5 MW (1t/h)	150 kg/h	100 l/h
Realization	2008	2011	2011	2011
Partner	Lurgi GmbH		Chemieanlagenbau Chemnitz CAC Mut Advanced Heating GmbH	

Source: Dinjius et al. 2010

- Expectations
  - 2013: Full operational capability of the pilot plant
  - 2015: Market entry of bioliq®

bioliq®

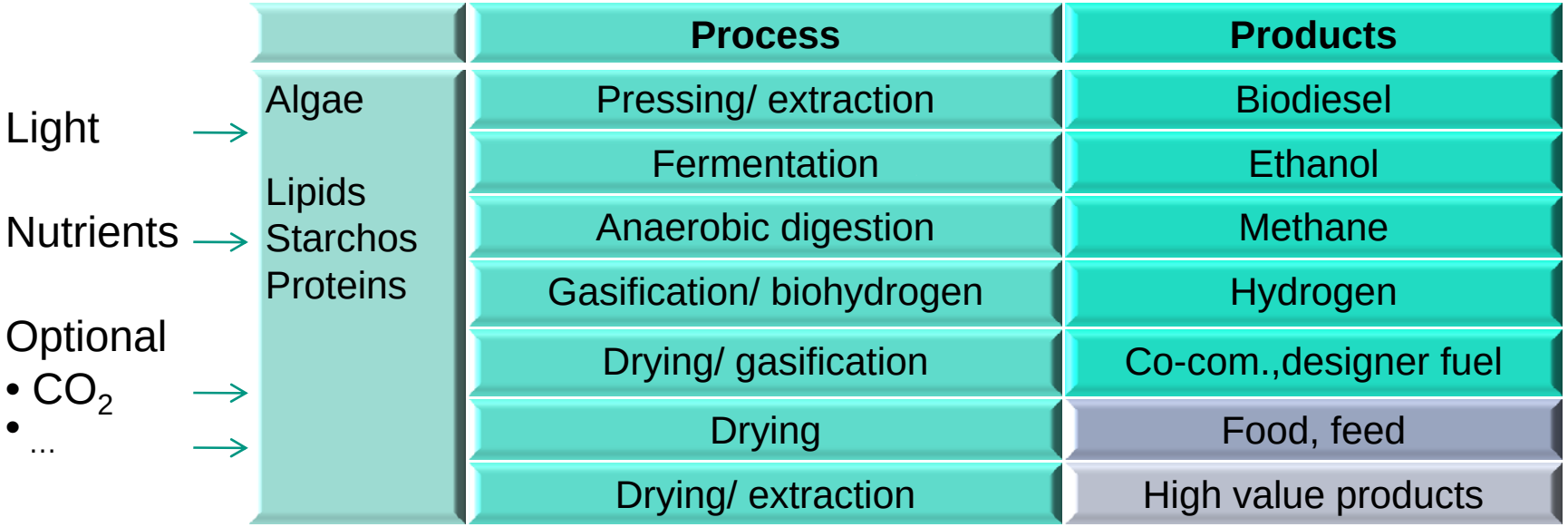
	bioliq® or comparable processes*)	References	Source/Note
Global warming potential	Residual wood: ~ -10 kg CO_2eq/ GJ	Diesel: ~ 95 kg CO_2eq/ GJ	Kercondueff 2008 Incl. credits
Costs of reducing CO_2eq	Straw: 250-350 €/ Mg CO_2eq	Ethanol (Wheat): 275-1.700 €/ Mg CO_2eq	Leible 2008; Thrän et al. 2010
Production costs	0.95 -1.10 €/l BtL-fuel		Leible 2008

*) Underlying process designs differ within the column.

Figures could vary due to underlying process design, plant size, and biomass input!

Hydrogen from microalgae

- Versatile use of microalgae



Source: Rösch et al. 2008

- CO_2 intake
- High PCE (up to 5-10(?)% - currently < 2 %) with a wide range of (potential) yields:
  - 20-100 Mg DM/ha (open raceway ponds → flat panels)
  - C3 plants and C4 plants: 8-30 Mg DM/ha

PCE = Photo-conversion efficiency

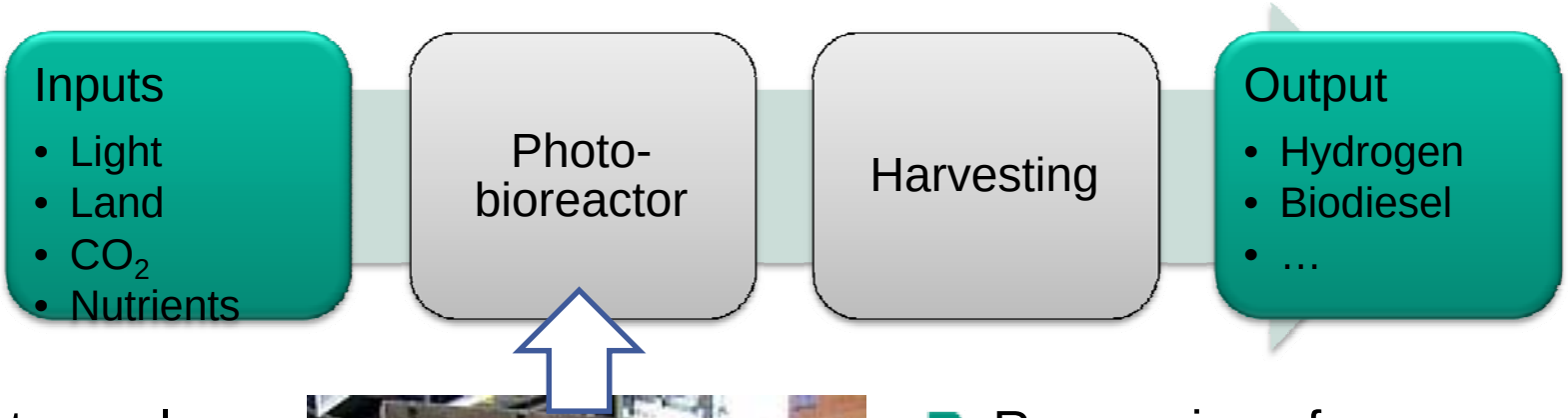
Hydrogen from Microalgae – HydroMicPro

- *The HydroMicPro project is focused on the development of an affordable, highly efficient production process with optimized biology and process technology in order to create the prerequisites for the production of large amounts of hydrogen* (C. Posten, KIT)

- Partners: KIT (Institut für Bio- und Lebensmitteltechnik, Engler-Bunte-Institut), Ehrfeld Mikrotechnik BTS GmbH Wendelsheim, Institut für Getreideverarbeitung GmbH Nuthetal, Max-Planck-Institut für molekulare Pflanzenphysiologie Potsdam, OHB-System AG Bremen, Universität Bielefeld
- Client: BMBF
- Project term: 01.10.2009 - 30.09.2012

Microalgae – HydroMicPro

- Concept



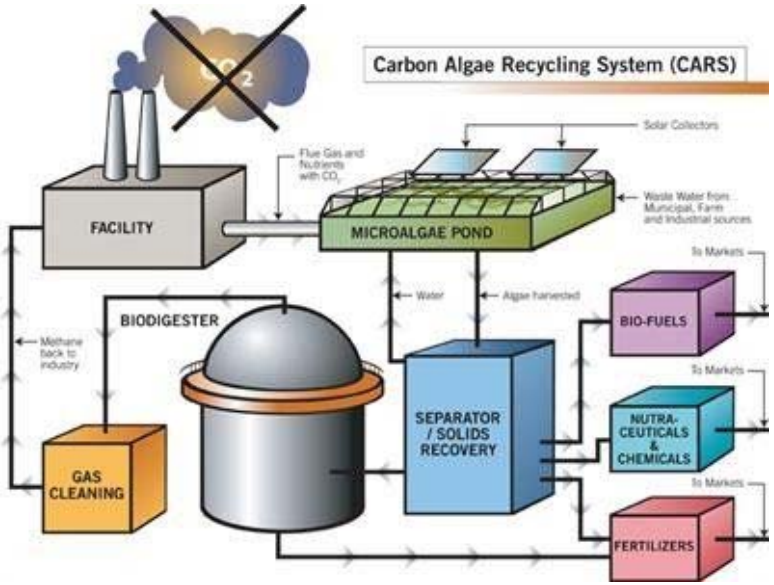
- Flat-panel closed bioreactor
- Engineered microalgae

Source: ATZonline (2009)

- Recovering of exhaust air, which contains inter alia hydrogen

Microalgae – Opportunities & Challenges

- Capturing and recycling of CO_2 – soundness under review



Source: news.net.com (2008)

Carbon Algae Recycling System (CARS)

- Conversion of algal biomass into energy
  – still not energy efficient:
  - 2.5 MJ energy input per 1 MJ energy output o/w 1.5 MJ operating of photobioreactor (Weiss 2010)

- Development of an hydrogen economy

Concluding remarks

- Environment – Greenhouse gas emissions
  - bioliq®
    - Noteworthy reduction of carbon dioxide emissions
    - Carbon reduction costs are not inacceptable high – compared to other biofuels
  - Microalgae
    - Still energy inefficient
    - Soundness of carbon capturing concepts are under review

- Considered market implementation
  - bioliq®: 2015
  - Microalgae:
    - Hydrogen: > 2020
    - Biodiesel: < 2020(?)

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