Karlsruher Institut für Technologie

bioliq
Biomass to Liquid Karlsruhe

Status and Outlook for bioliq-Project –

Syngas Platform for High Performance Fuels

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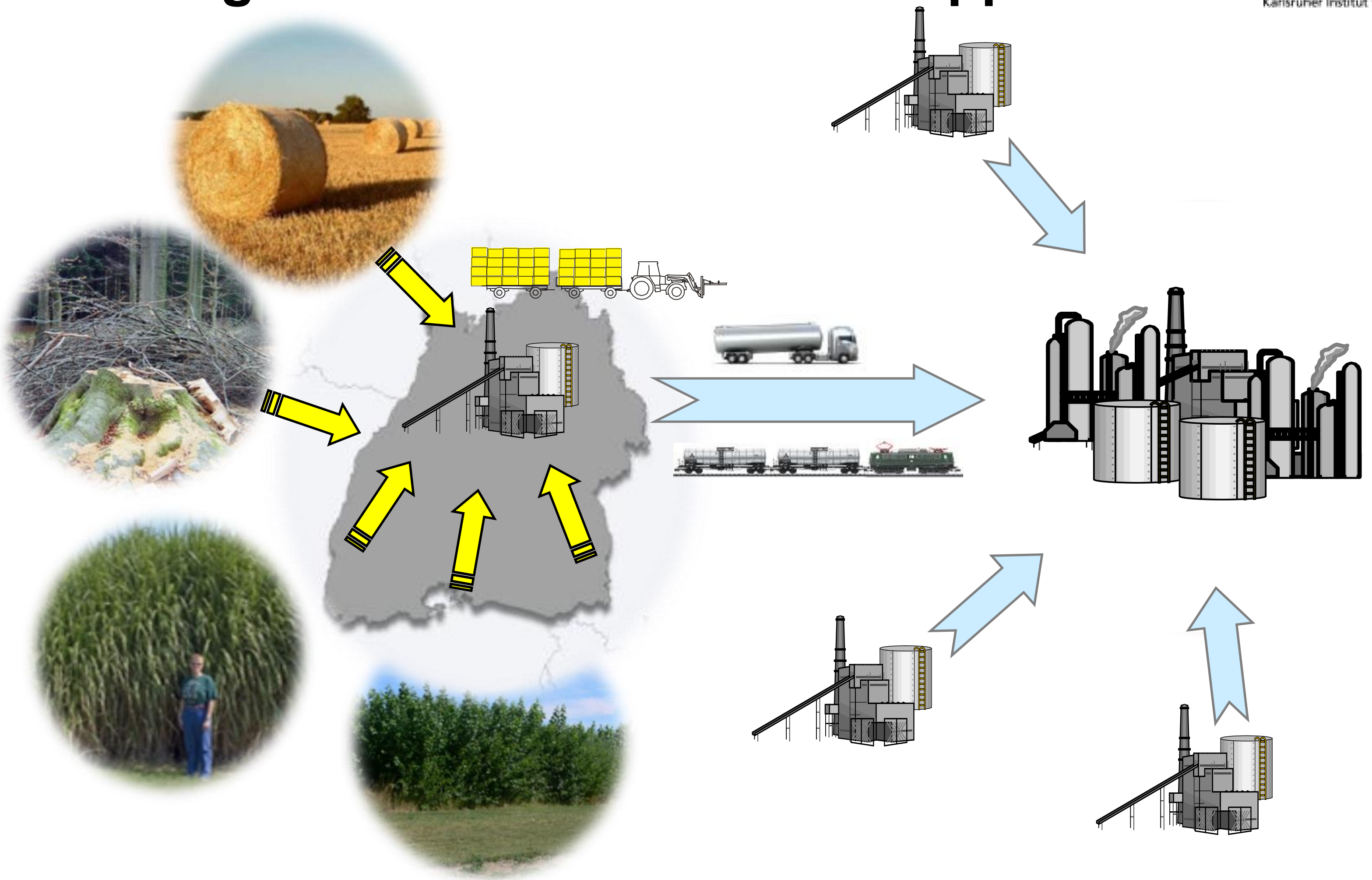
EBTP 7th stakeholder Meeting, Brussels, June 21, 2016

Institut für Katalyseforschung und –technologie IKFT
Institut für Technische Chemie, Vergasungstechnologie, ITC vgt
Engler-Bunte-Institut, Chemische Energieträger – Brennstofftechnologie, EBI ceb

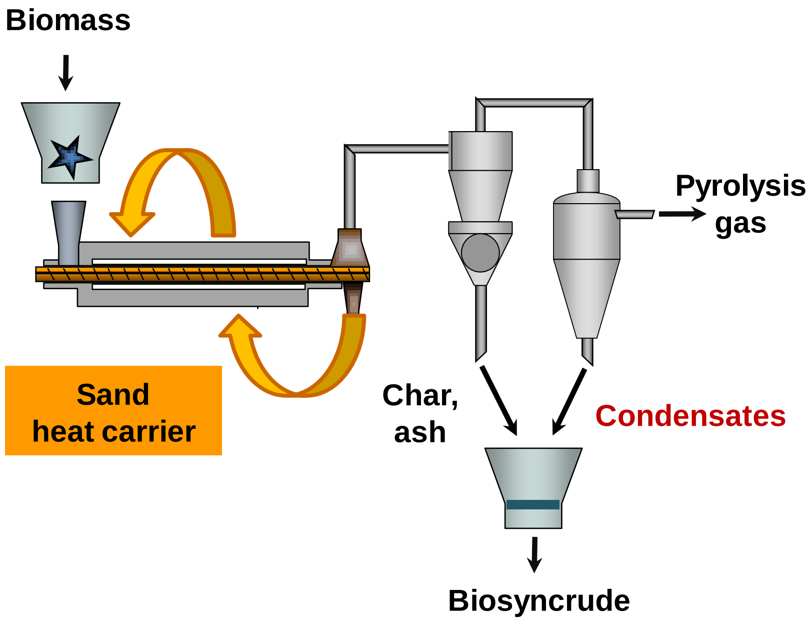
The challenge… …..and solution approach

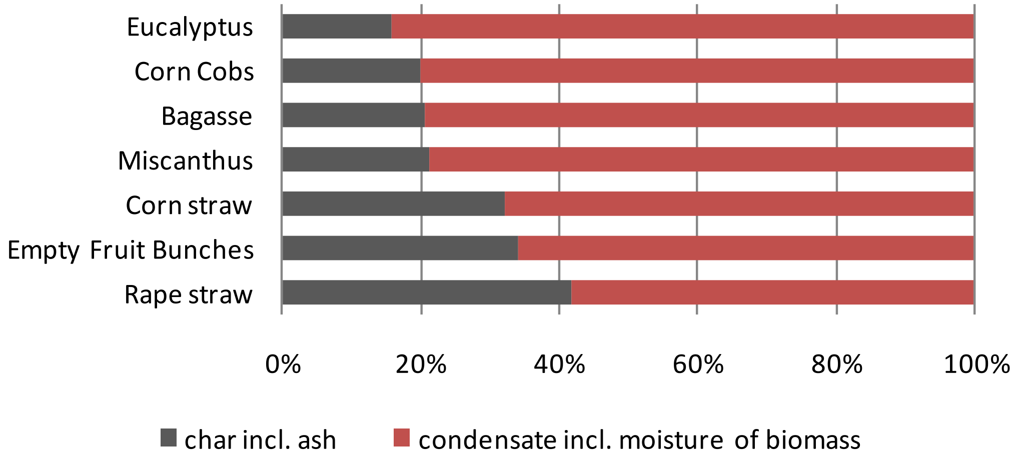


Biomass production and sourcing	Regional energy densification	Trans-port	Large scale, central further conversion

bioliq® fast pyrolysis

- Tasks in the bioliq process:
  - Produce an intermediate bioenergy carrier to maintain as much of the biomass energy as possible
  - Provide a fuel suitable for pressure loaded gasification
  - Make use of a multitude of ash rich, residual types of biomass
- Fast pyrolysis char and condensate(s) are mixed to form a biosyncrude, conserving up to 85 % of the biomass energy

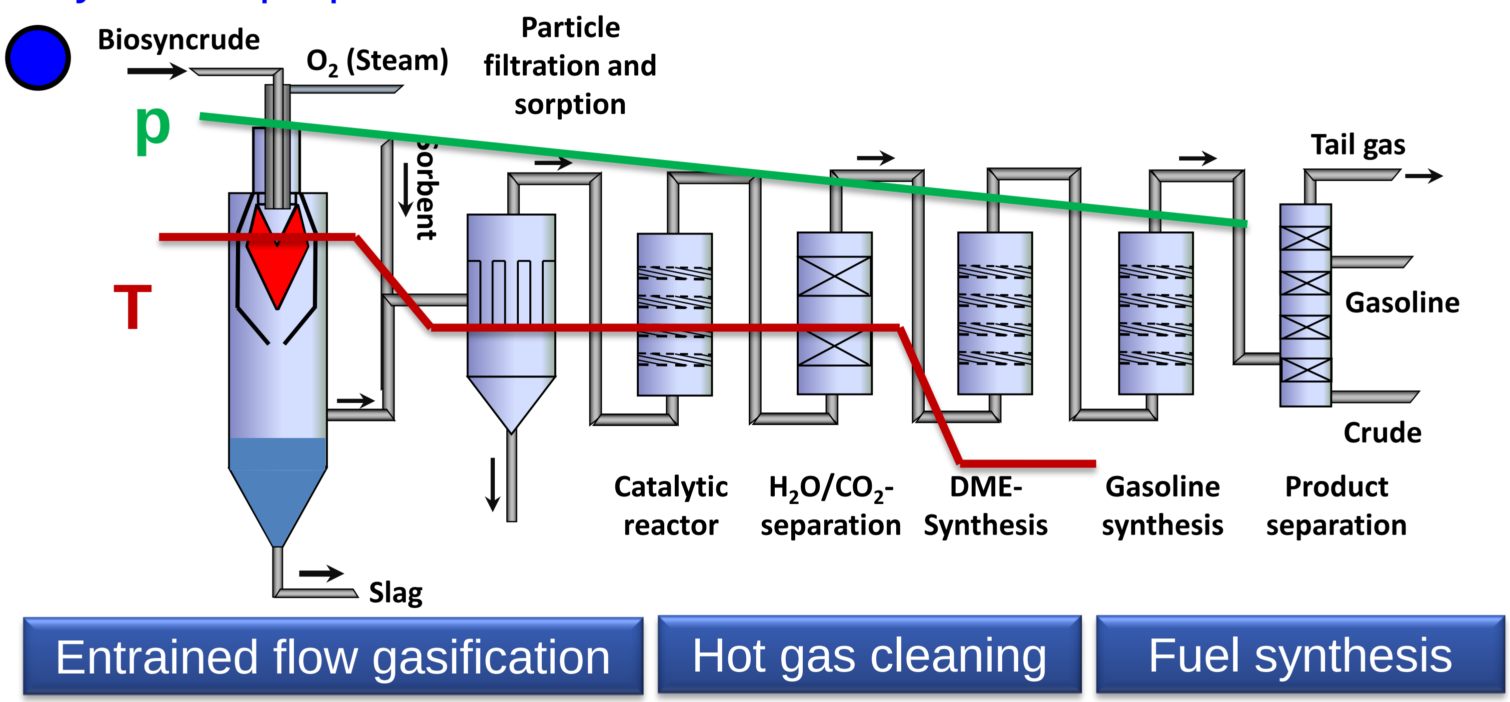




bioliq® central plant

- High pressure gasification – high temperature gas cleaning – methanol/dimethyl ether and gasoline synthesis (MtG)
- Technical innovations: Biosyncrude preparation and conditioning, high pressure gasification, and hot gas cleaning

Biosyncrude preparation



Gasoline
Diesel
Kerosene
Ethylene
Propylene
Methane
Hydrogen
Advanced biofuels!?

bioliq® pilot plant at KIT

Fast pyrolysis Biosyncrude production	Syngas production	Gas leaning and fuel synthesis

Full commissioning: 2014

Technical demonstration & **Research platform**

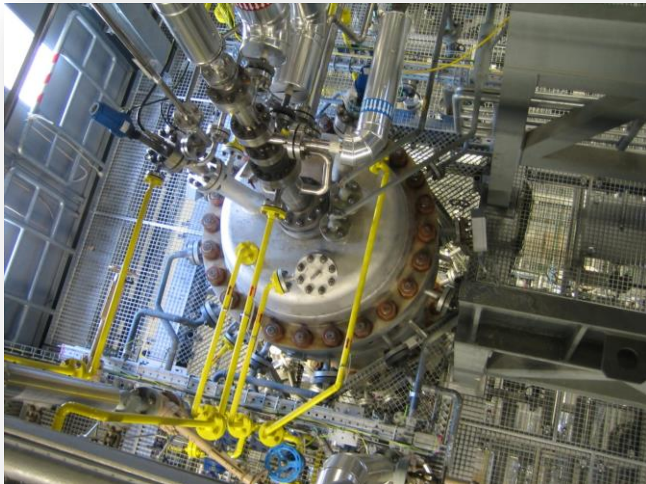
Technical demonstration:

- Mass and energy balances
- Scale-up, practicability
- Production costs

Research platform:

- Further development and optimization
- Diagnostics, modeling, simulation
- New applications

bioliq® impressions

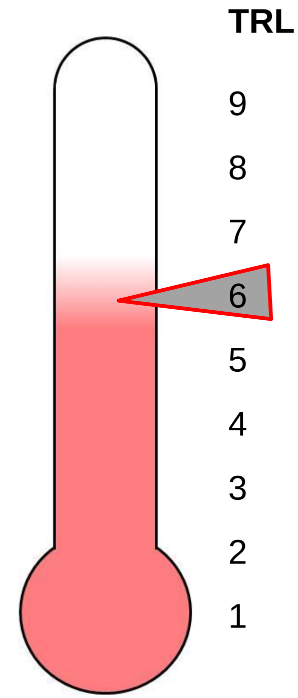


12 km pipelines, 50 km wiring,
250 motors, 1500 t steel,

1200 I/Os, 40 pumps,
100.000 engineering hours

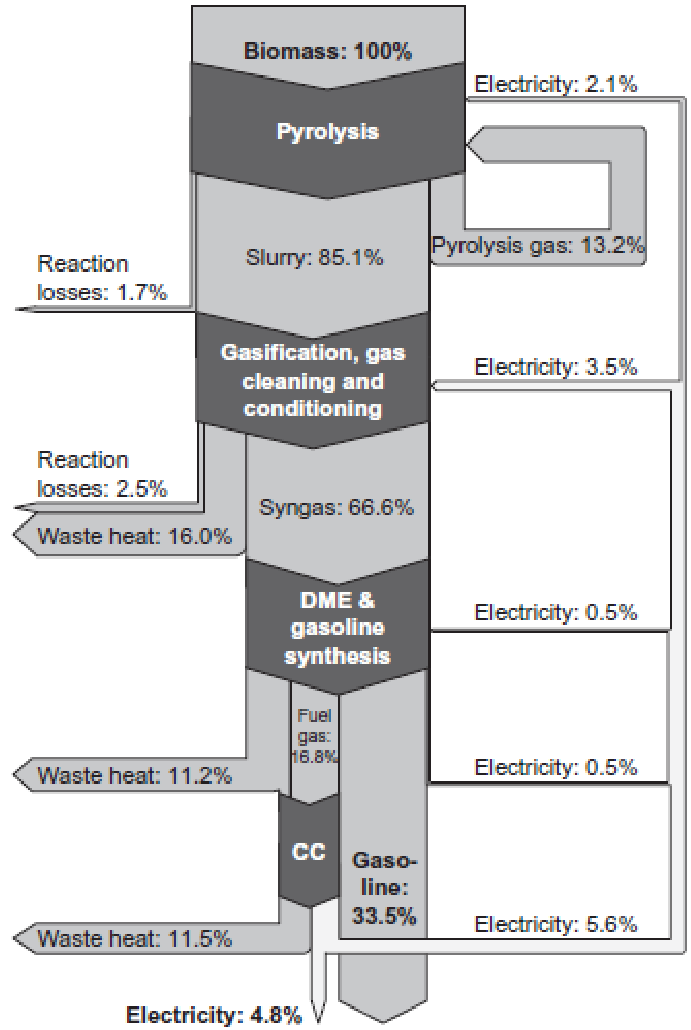
R&D implementation

- Program oriented funding of Helmholtz Association
  - Pilot plant operation and R&D themes addressed in HGF ENERGY program 2015-2020
- bioliq PhD network at KIT
  - Actually 25 students working on fundamental, bioliq technology related aspects at 5 institutes of KIT
- HVIGasTech Network of Young Scientists
  - 12 PhD students with partners for modeling gasification of solid/liquid fuel in an entrained flow reactor (www.hvigastech.org)
- Funded joint projects



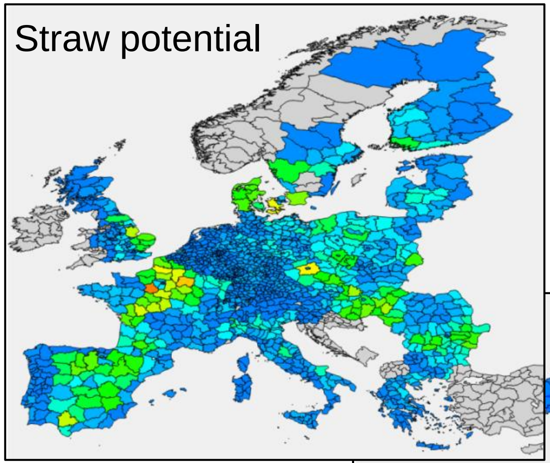
Systems analysis

- Biomass potential studies
  - Regional
  - National
  - EU 27+CH, NUTS 3 level
- Logistic models and simulation
- Life cycle assessment:
  > 82 % CO_2 reduction potential
- Techno-economic assessment
  - Different studies: 1-1.85 EUR/L
  - Target price: 1.0-1.4 EUR/L



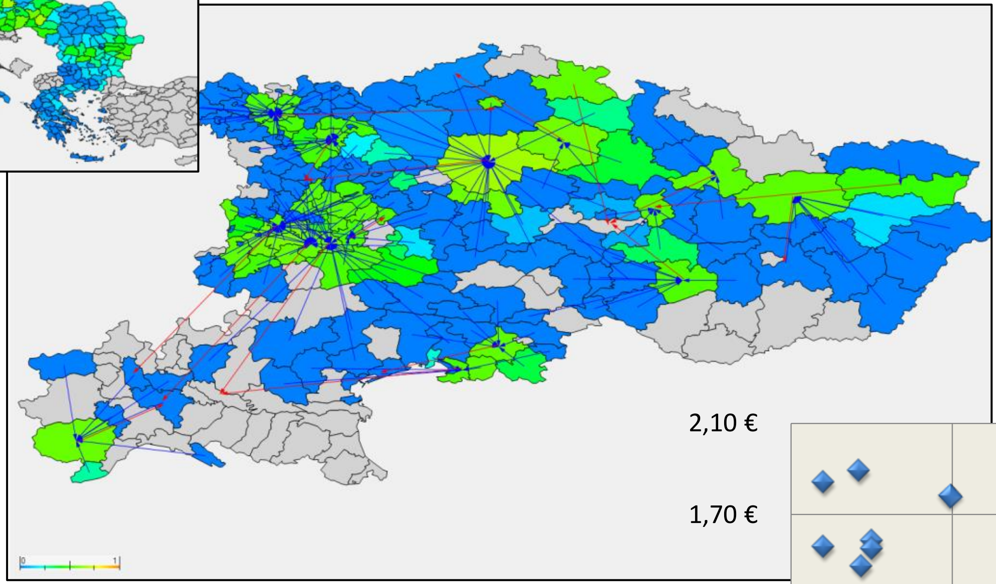
F. Trippe et al., Fuel Processing Technology 106 (2013) 577–586

Systems analysis



Sustainable potential
of biomass residues

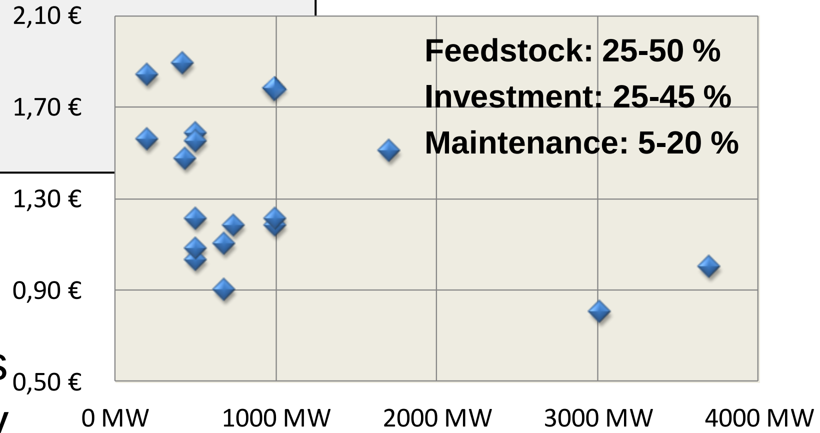
Simulation for cost optimization



[Navigator by www.bioboost.eu](http://www.bioboost.eu)

New cost model

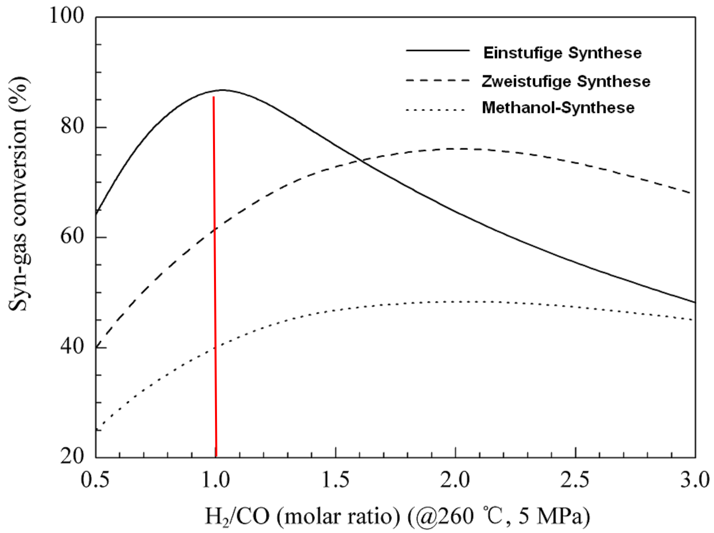
- Reference case
- Conversion costs
- Fossil co-feed
- Hydrogen feed-in



Specific production costs
by bioliq meta-study

The dimethyl ether (DME) issue

- Single step DME production by mixed/bifunctional catalysts
- DME formation is favored at CO/H_2 ratio around 1
- DME principally is an excellent fuel component, but….
- DME as intermediate for high performance fuel additives
  - Full compatible (drop-in)
  - Emission reduction



Ogawa et al., J. Nat. Gas Chem. 2003,12, 219-227

$$3\,CO + 3\,H_2 \leftrightarrows CH_3OCH_3 + CO_2$$

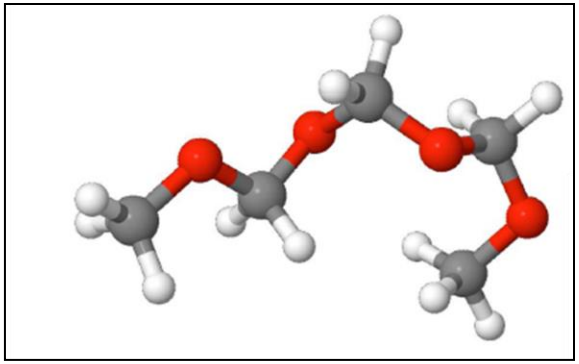
Tailor made fuel (components) via DME

- Reduction of aromatics content in DME to gasoline synthesis
- Improve gasoline quality towards advanced IC engines
- Alkylate based petrol
- Polyoxymethylene ethers (OME) as diesel additives
- …by new and improved catalysts

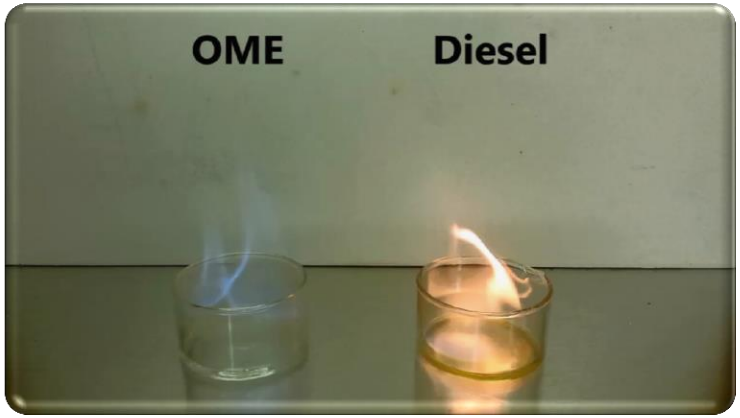
Reduction of..

… toxicity

…emissions



Polyoxymethylene ether (OME 4)



bioliq® essentials

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- Energy densification of a **multitude of lignocellulosic biomass** in regionally distributed plants by **biosyncrude production**
- Economic conversion in large scale to syngas and further **refining into synthetic fuels & chemicals**
  - **Network scalability**: combination of local pre-treatment of biomass with centralized synthesis at high feedstock flexibility
- Syngas offers a broad application range for fuels and chemical
  - **High product quality**: Targeted production of drop-in capable fuels with high energy density and improved emission behavior
- bioliq® pilot plant for **process demonstration and research platform** for optimization, further development, and scale-up
  - Critical mass and expertise along the full process chain with aligned R&D program and appropriated partners

Lessons learned

- Trivial: Things take longer than expected
- Biofuels development is a long term task, stable frame conditions for R&D required
- Consider co-utilization of fossil fuels to improve specific production costs
- If applicable, use additional H_2 to increase carbon efficiency and product yield
- Make use of the oxygen contained in biomass
- Care for cost determining biomass supply logistics

Next steps

- Increase pilot plant availability (1000 h/a)
- Perform proof of concept
- Improve and optimize process (steps)
- Establish R&D platform for the development of high performance fuel components
- Establish commercialization platform to prepare business model(s) & market implementation

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FNR Fachagentur Nachwachsende Rohstoffe e.V.

AIR LIQUIDE GLOBAL E&C SOLUTIONS

C·A·C Chemieanlagenbau Chemnitz GmbH

MUT ADVANCED HEATING

MAT Mischanlagentechnik GmbH

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