

Country Activities GERMANY

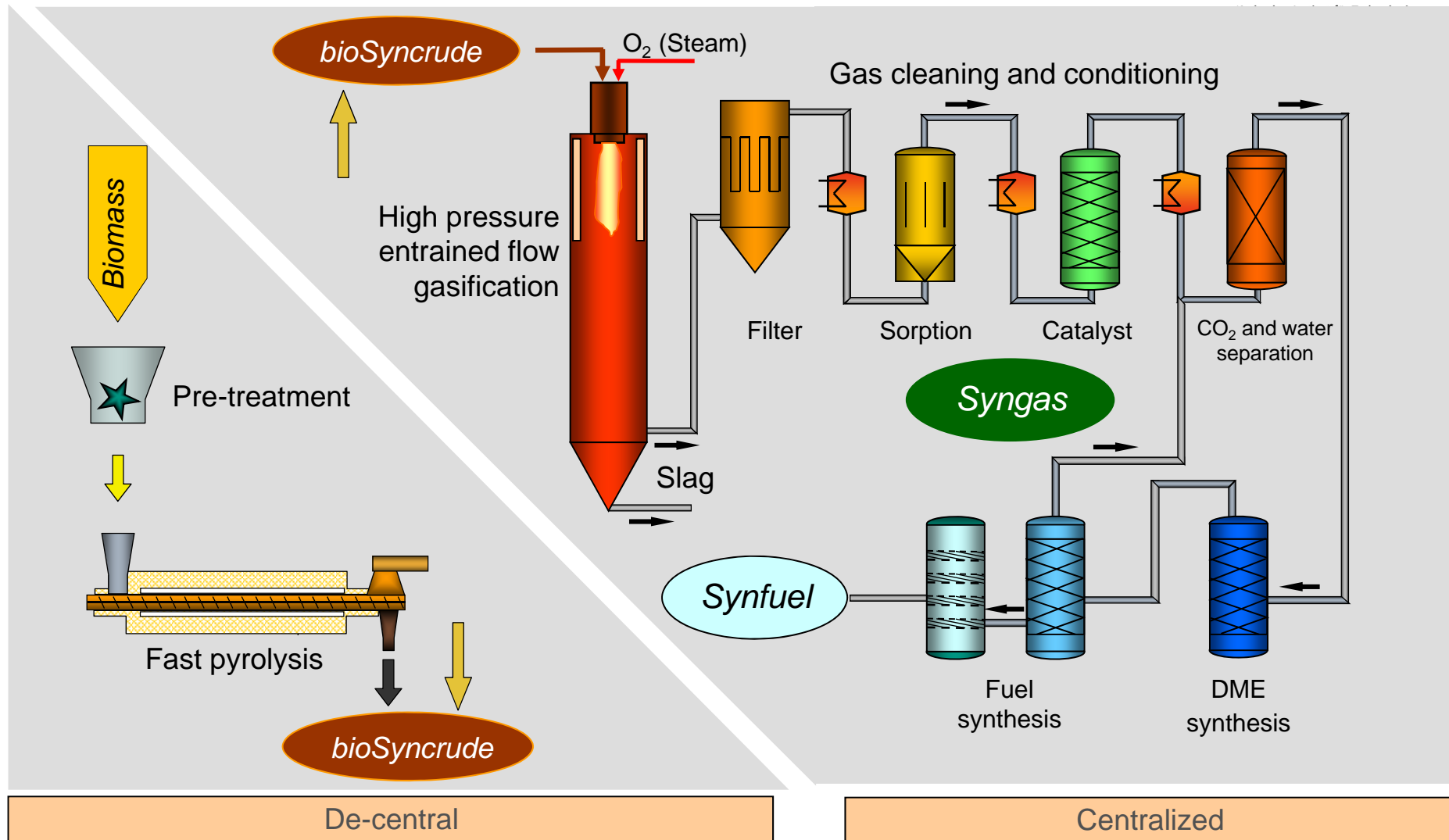
Engler-Bunte-Institute, Fuel Technology
Institute for Technical Chemistry, Gasification Technology
DVGW Research Station, Gas Technology

Thomas Kolb

IEA Bioenergy: Task 33 Thermal Gasification of Biomass

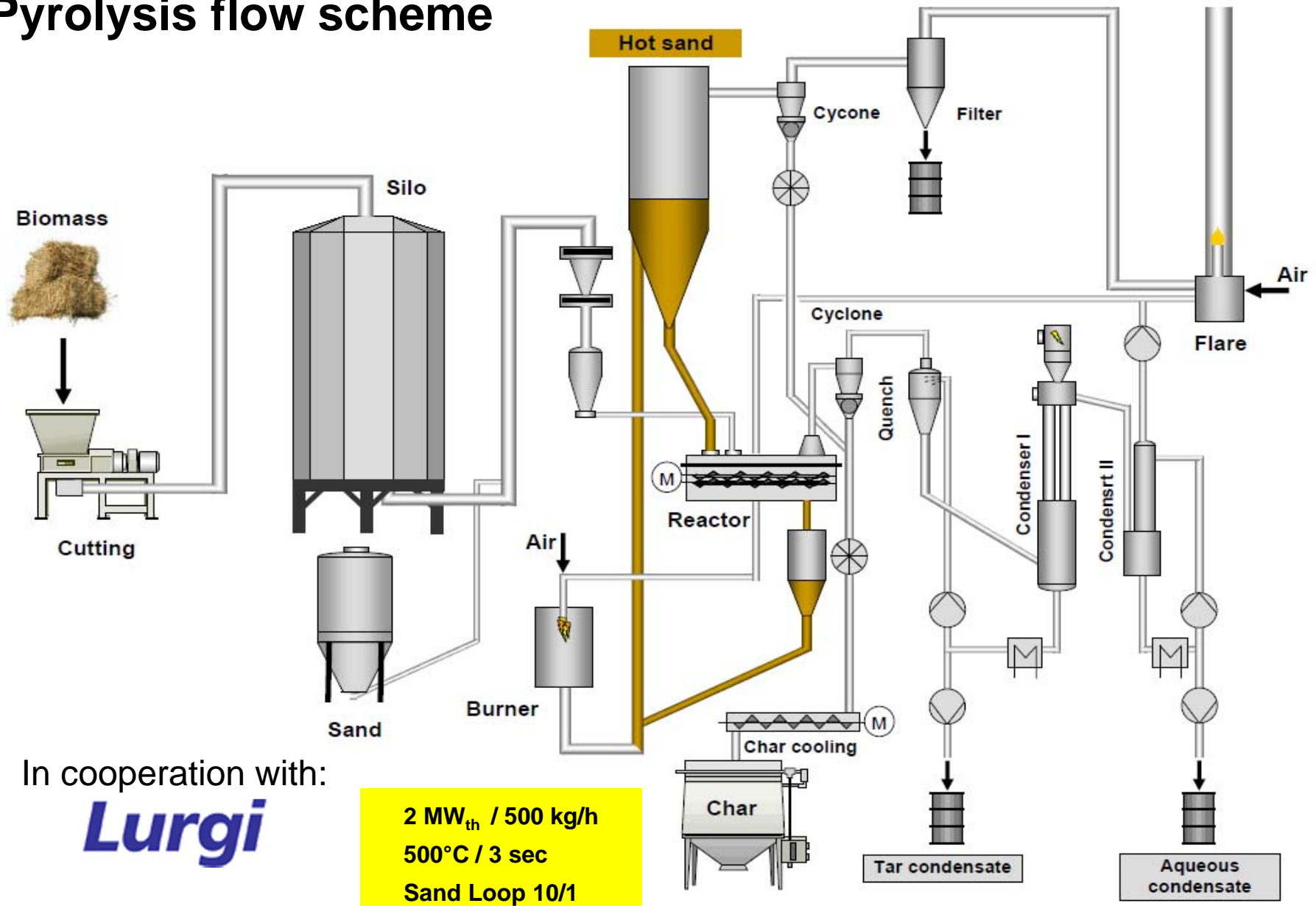
Task meeting, November 21th, 2013, Gothenburg

bioliq[®] process scheme



Source: Presentation of Dr. Dahmen, IKFT

Pyrolysis flow scheme

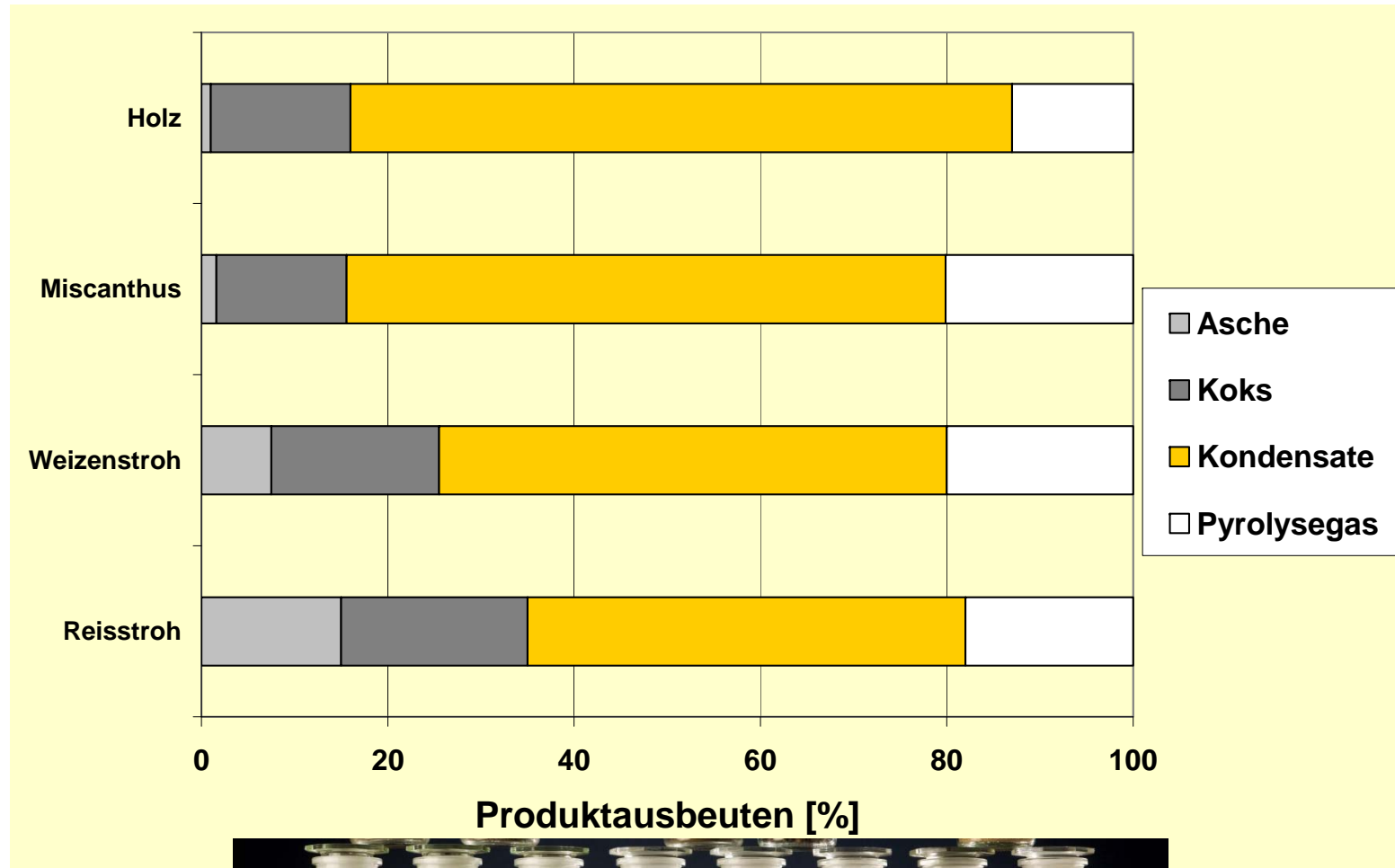


In cooperation with:

Lurgi

2 MW_{th} / 500 kg/h
 500°C / 3 sec
 Sand Loop 10/1

Fast Pyrolysis of different Feed Stock /Lab Scale



From lab scale experiment



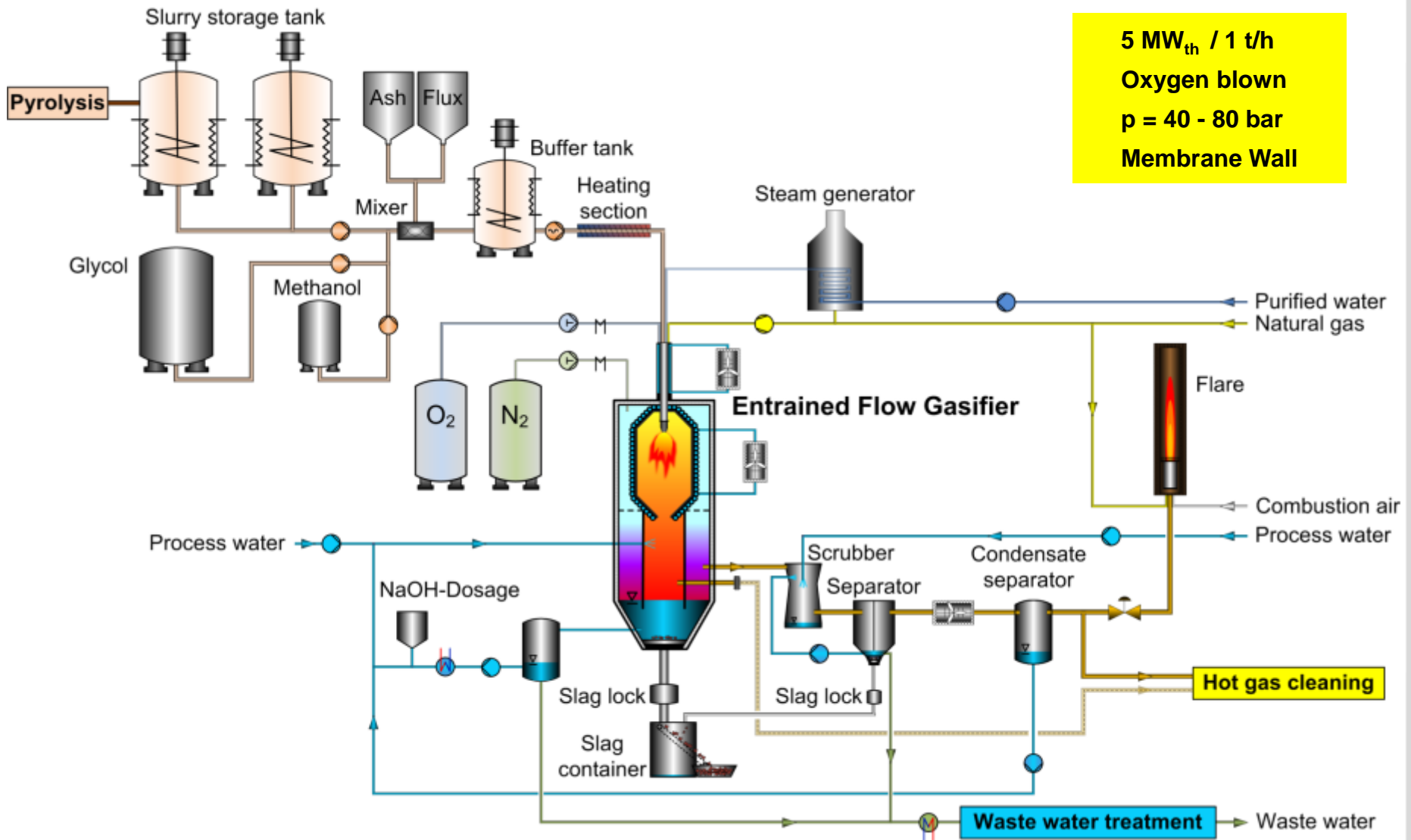
bioliq[®] Entrained Flow Gasifier

- Confirmation of Funding FNR / Sept. 2008
- Contract signed KIT-Lurgi / Dec. 2008
- Mechanical Completion / Oct. 2011
- Completion of Commissioning / July 2012
- First Flame / Aug. 2012
- Stable Operation with Liquid Fuel 80 bar / Dec. 2012
- Performance Test with Model Slurry / Jan 2013
- First Test Run July 2013

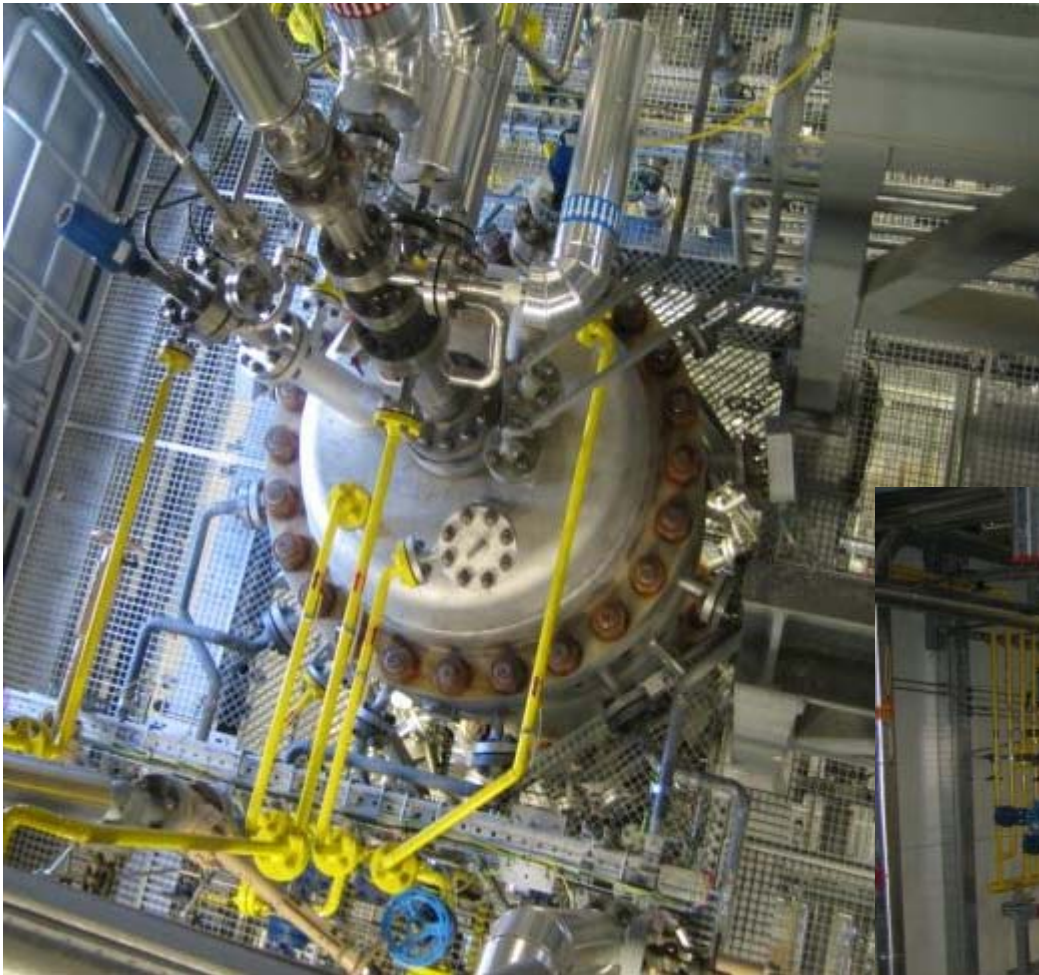


bioliq[®] Entrained Flow Gasifier

5 MW_{th} / 1 t/h
 Oxygen blown
 p = 40 - 80 bar
 Membrane Wall



bioliq® EFG



Gasifier Top
40bar configuration

Quench upper
section



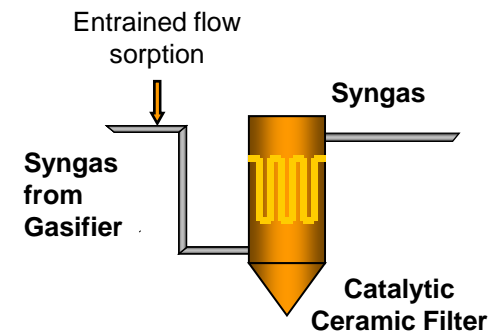
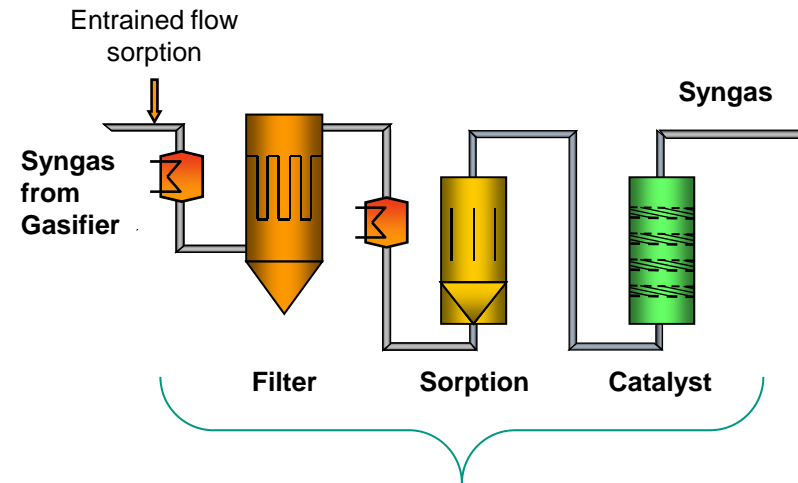
High Temperature - High Pressure (HTHP) Syngas Cleaning

- Compact horizontal ceramic filter for particle removal with CPP recleaning
- Dry sorption of sour gases (HCl, H₂S) and alkalies
- Catalytic conversion of organics and N-species (HCN, NH₃)
- CO₂ separation (optional)
- 700 m³/h STP synthesis gas (40 m³/h at 80 bar, 800 °C)

⇒ **Energy Savings ca. 10%**
compared to state-of-the-art gas cleaning

⇒ **Process Integration**

⇒ **Chemical Quench**



bioliq[®] HTHP Syngas Cleaning



Nov 2013: End of commissioning phase

MUT ADVANCED HEATING

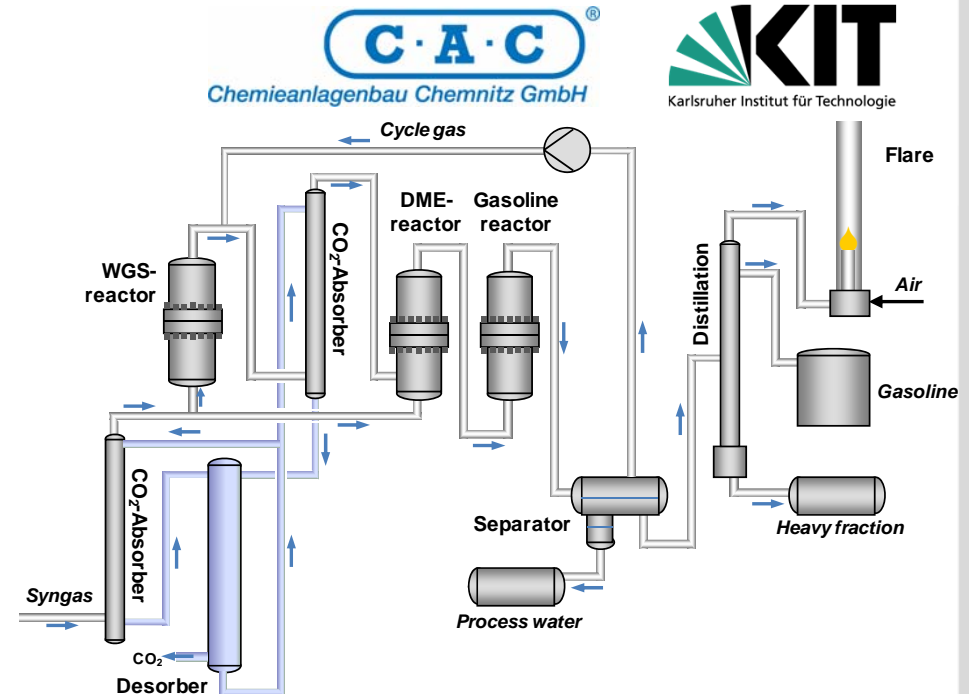
DME and Fuel Synthesis

DME-synthesis

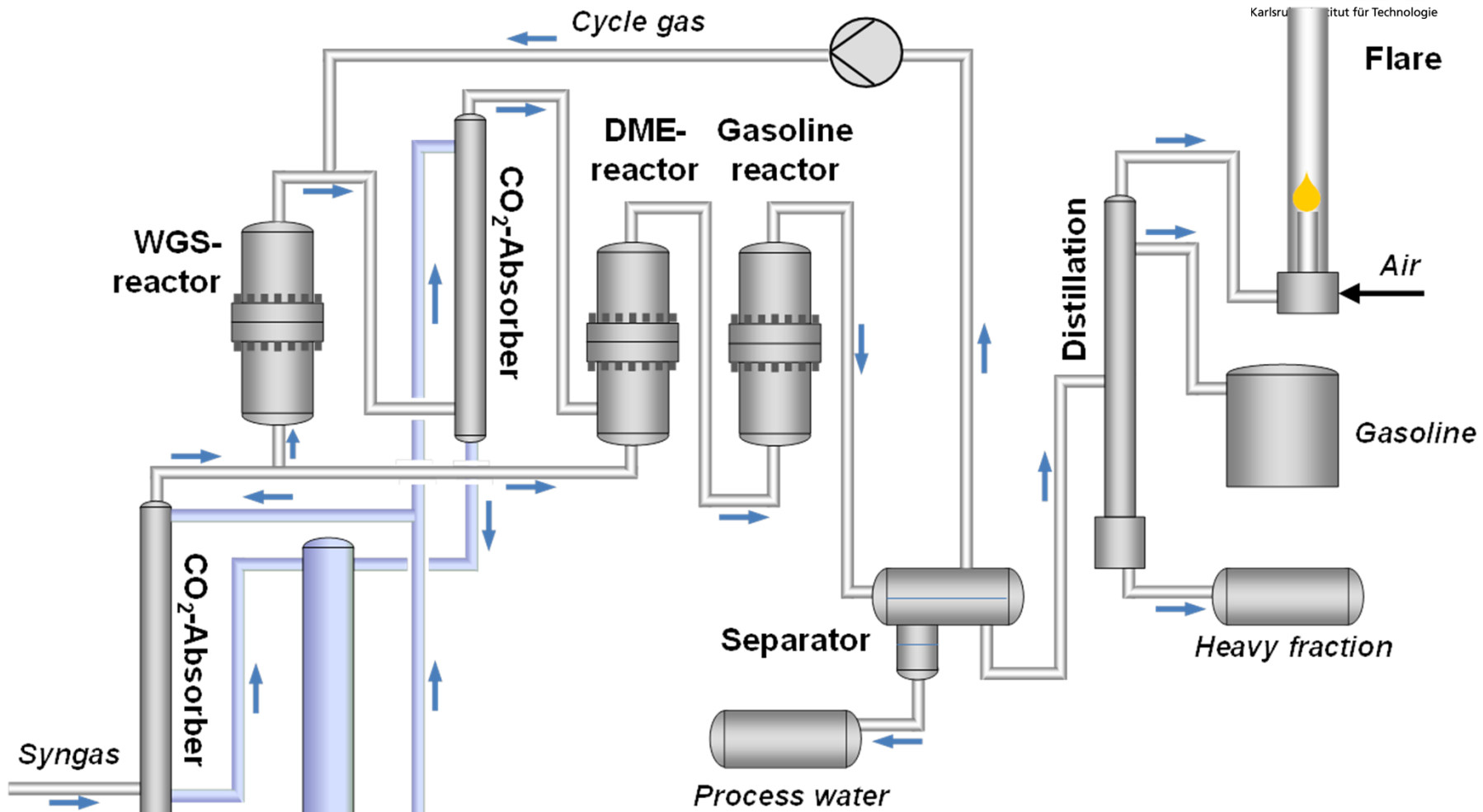
- One step DME synthesis
 - Innovative isothermal reactor
 - Temp. of 250 °C, pressure 60 bar
- ⇒ Lower investment costs
- ⇒ Direct use of CO-rich syngas

DtG-synthesis

- Zeolithe catalyzed dehydration, oligomerization and isomerization
 - Temp. 350 - 450 °C, pressure 25 bar
 - Recycling of unconverted gas
 - Gasoline stabilization
- ⇒ high selectivity towards one product
- ⇒ methanol route useful for oxygenates



Flow sheet Synthesis



syngas feed 700 mn³/h
 fuel production max. 80 l/h
 ROZ 100-110 expected from laboratory tests

Synthesis Pilot Plant

Performance Test June 2013
Acceptance July 2013



bioliq[®] Plant – State of Construction

| | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
|-------------|---|--------------------------------|--|--------------------|
| Process | Fast pyrolysis + BioSyncrude production | HP Entrained flow gasification | Hot gas cleaning + DME-synthesis | Gasoline synthesis |
| Product | BioSyncrude | Synthesis gas | DME | Gasoline |
| Capacity | 2 MW (500 kg/h) | 5 MW (1 t/h) | 150 kg/h | 50 l/h |
| Realization | 2005 - 2008 in operation | 2008 - 2013 in operation | 2009 - 2011 performance test successful Start of operation in 2014 | |
| Partner | Lurgi MAT | Lurgi | MUT, CAC | |



Lurgi

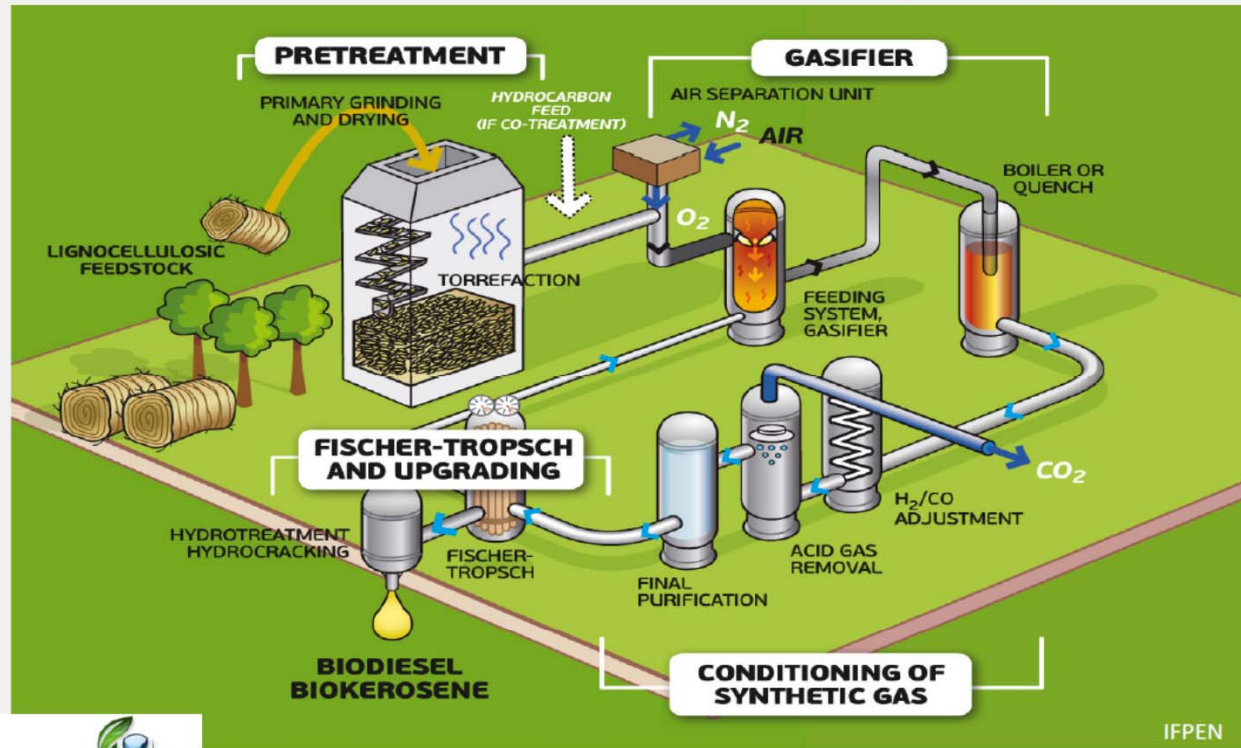


Chemieanlagenbau Chemnitz GmbH



ThyssenKrupp Uhde: BioTfuel Project

BioTfuel: 2nd Generation bio-diesel and bio-jetfuel process chain



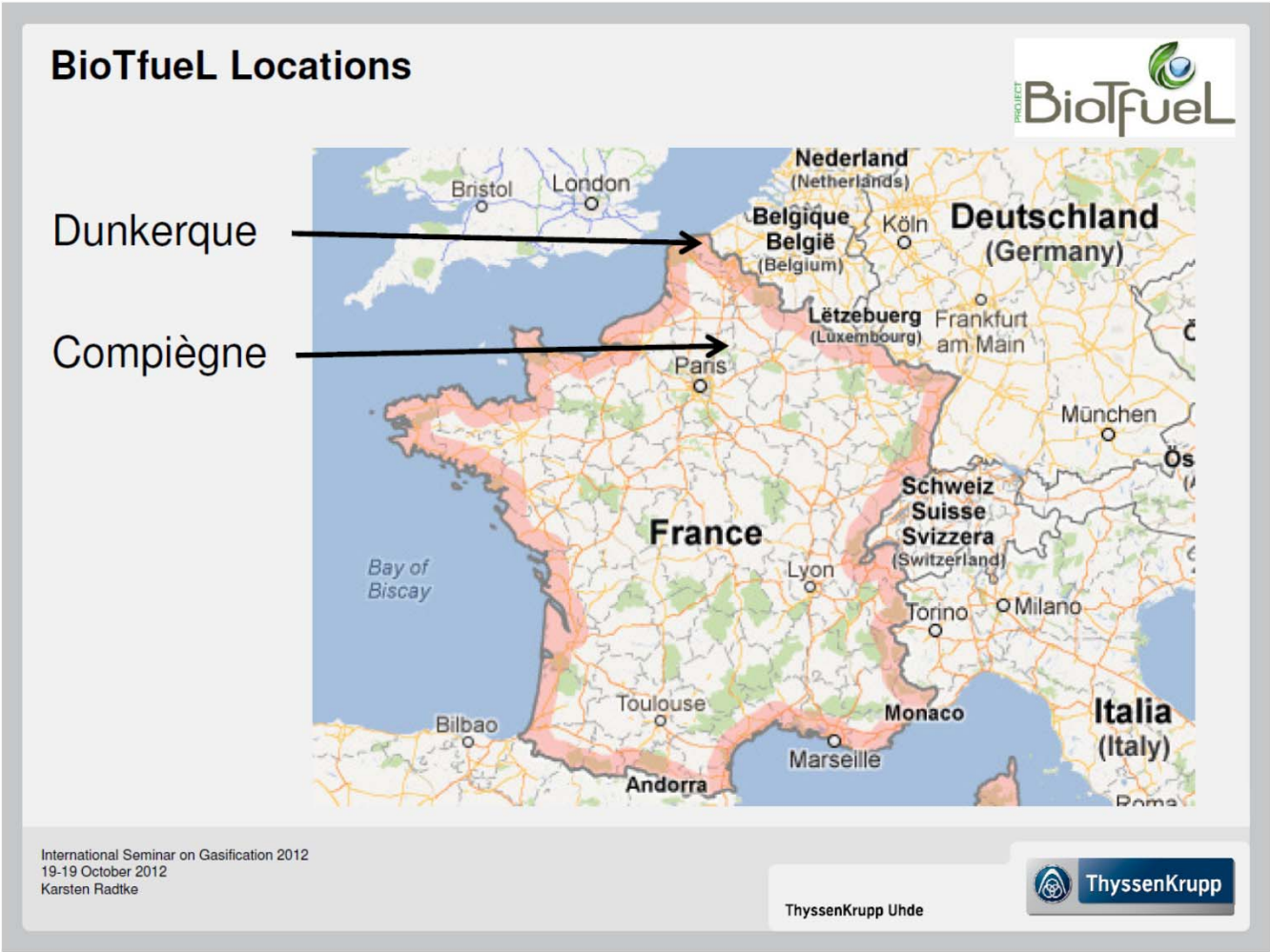
International Seminar on Gasification 2012
19-19 October 2012
Karsten Radtke

ThyssenKrupp Uhde



Source: K. Radtke, SGG Gasification Seminar 2012

ThyssenKrupp Uhde: BioTfuel Project



Source: K. Radtke, SGG Gasification Seminar 2012

ThyssenKrupp Uhde: BioTfuel Project

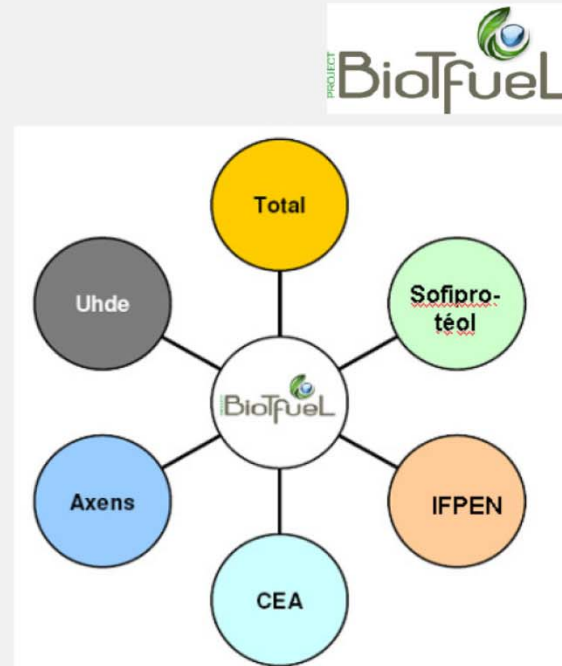
BioTfuel main figures & objectives

➤ BioTfuel project:

- 7 years programme [2010- 2016]
 - R&D = 7 years
 - EPC = 2 years
 - Test programs = 4 years
- 6 partners
- 2 sites for demo plants
 - Sofiprotéol Venette site
 - Total Dunkirk site
- Budget = **112.7 M€**

➤ Project Subsidies: 33.3 M€

- ADEME: 30.1 M€
- CRP: 3.2 M€



Update Nov. 2013 | Abraham UHDE
 Detailed Engineering UHDE: start Spring 2014
 Delay 2 – 3 years
 Involvement CEA ?

International Seminar on Gasification 2012
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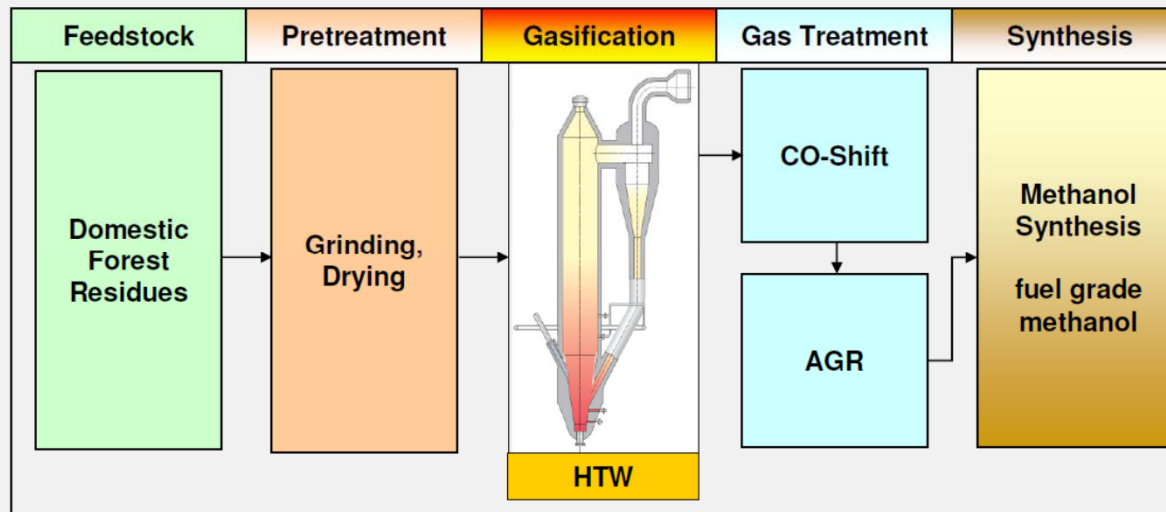


Source: K. Radtke, SGG Gasification Seminar 2012

ThyssenKrupp Uhde: VärmlandsMetanol Project

VärmlandsMetanol AB

Integrated Process Chain for the Production of Bio-Methanol



Biomass to Methanol, VärmlandsMetanol, Sweden
applying HTW Fluidised Bed Gasification

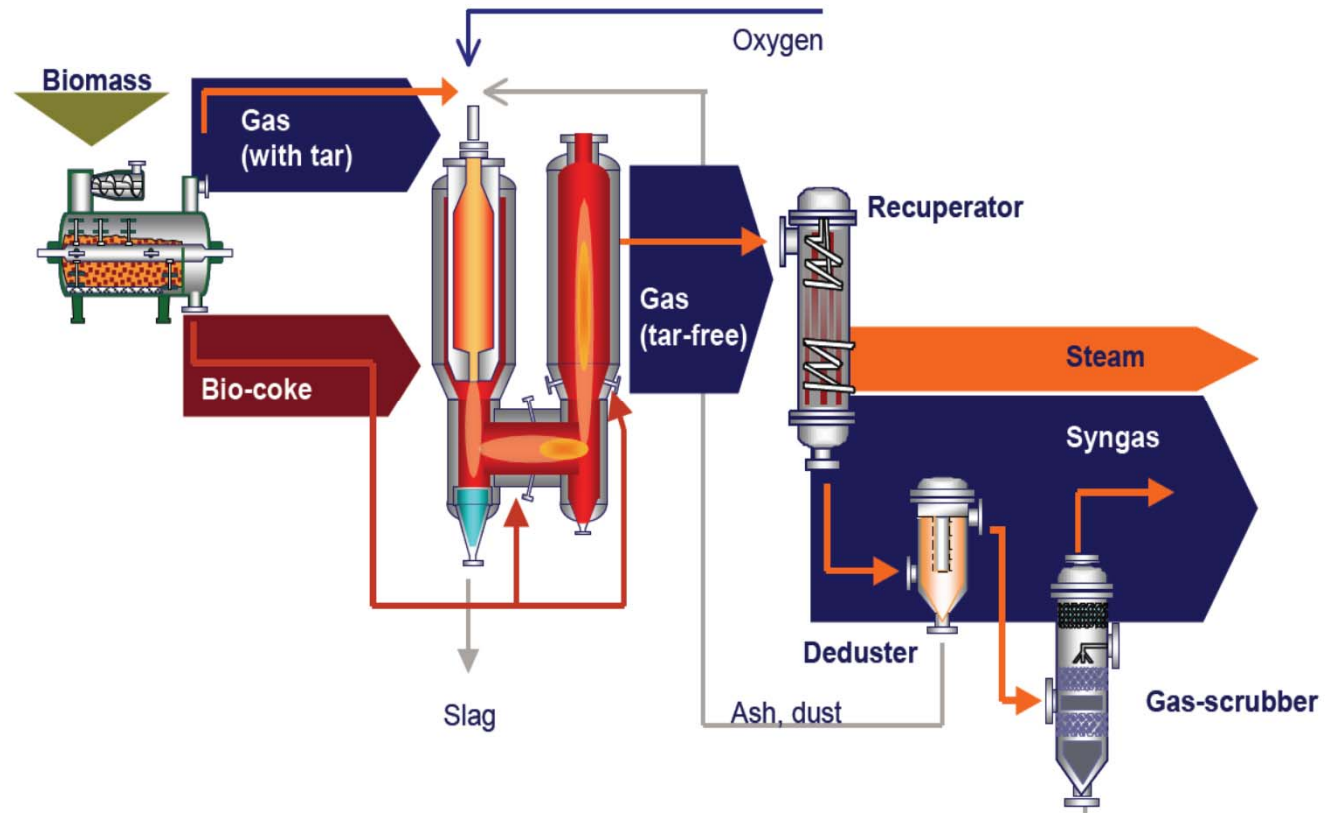
Update Nov. 2013 | Abraham UHDE
Fuel accepted as biofuel
To be continued

ThyssenKrupp Uhde



Source: K. Radtke, SGG Gasification Seminar 2012

Carbo-V (LINDE former CHOREN)



| | |
|------------------|---|
| Februar 2012 | Linde Engineering Dresden GmbH bought Carbo-V® IP |
| Januar 2013 | Linde and Forest BtL (Finnland) sign agreement Carbo-V for Biodiesel and Naphta Kemi, Finnland |
| Update Nov 2013: | Linde no longer in contract with ForestBtL |

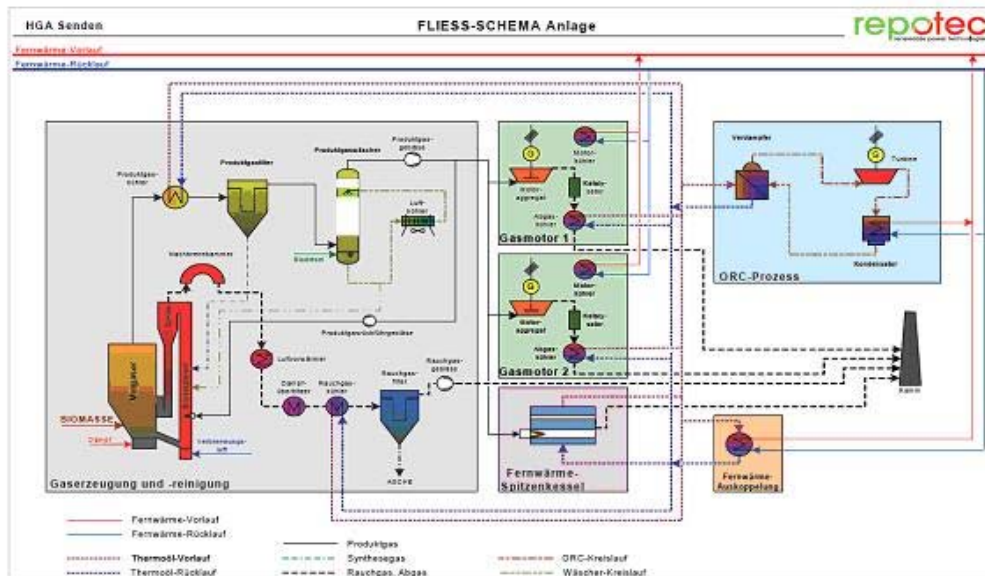
SWU Stadtwerke Ulm CHP demo plant

wood chips

thermal load 15.1 MW_{th} (4.55 MW_{el})

technology based on the FICFB Güssing (repotec)

HolzgasHeizKraftwerk Senden Änderungen gegenüber Güssing



HolzgasHeizKraftwerk Senden Anlagendaten

- 2 BHKW Motoren (je ca. 2 MW_{el})
- 1 ORC (ca. 0,6 MW_{el})
- 1 Thermoölkessel (ca. 11 MW_{th})
- FWL Vergaser 15,1 MW
- Elektrische Leistung Anlage 4,55 MW_{el}
- Fernwärmeabgabe 6,4 MW_{th}
- η_{el} 33%
- η_{ges} 80%
- Betriebsstundenziel: 7000 – 7200 Bh/a

SWU Stadtwerke Ulm CHP Demo Plant

Biomass gasification plant Senden/Ulm, DE



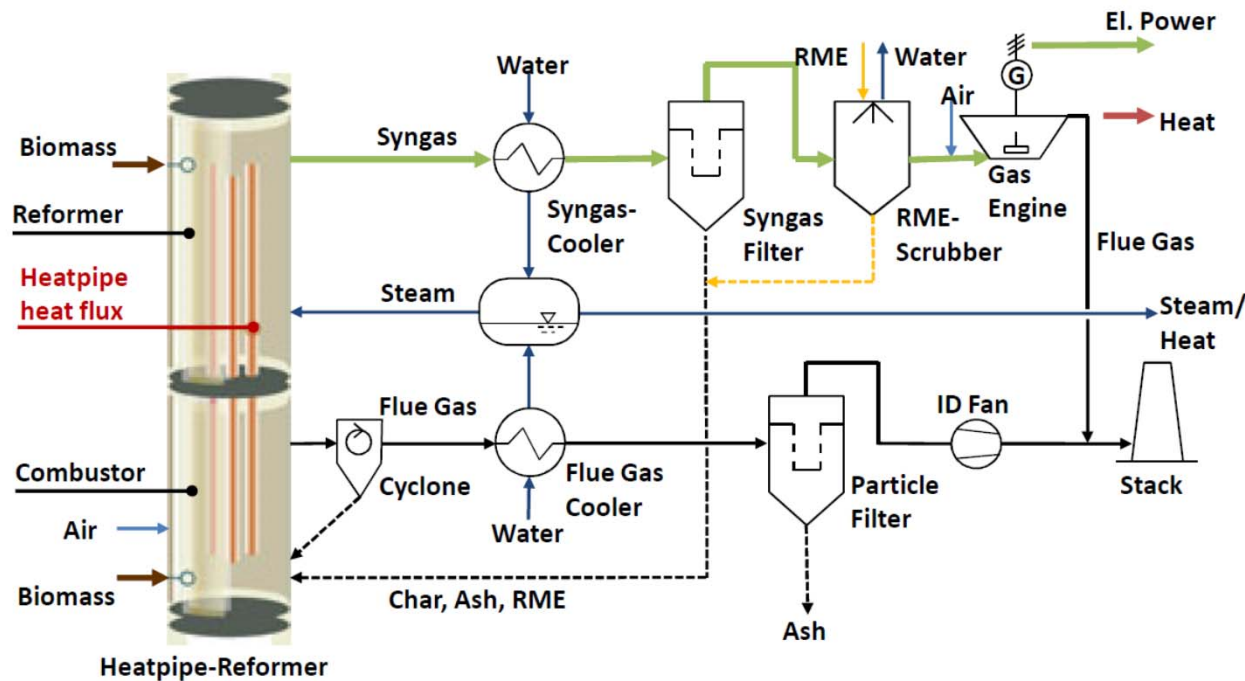
| | | |
|---------------------------|---------------|--------------------|
| Start of the construction | 12/2009 | |
| Actual status | commissioning | |
| Fuel | Wood chips | |
| Input | 14,3 | MW _{fuel} |
| Output | 5,0 | MW _{el} |
| | 6,2 | MW _{th} |
| Total efficiency | 78 | % |
| Overall investment | 33 | Mio. € |

Up date Nov. 2013
 Still in commissioning
 Plant Constructor AGO canceled cooperation with SWU
latest info from R Rauch

Source: R. Rauch, SGG Gasification Seminar 2012

agnion Heatpipe Reformer

Flow Chart of Heatpipe-Reformer Technology with CHP Application



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Source: T. Kienberger, SGG Gasification Seminar 2012

agnion Heatpipe Reformer

Pilot Plant Pfaffenhofen

agnion 

- > 10.000h operation experience
- 500 kW_{th} Input (Pellets)
- 100-140 kW_{el} Output
- Research facility for CHP application and SNG synthesis



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Not in operation due to insolvency of host site

Source: T. Kienberger, SGG Gasification Seminar 2012

agnion Heatpipe Reformer

Commercial Demonstration Plant Grassau



- Location: Grassau (Germany)
- Partner: Biomassehof Achenal
- Subsidies: BMU
- $1.3 \text{ MW}_{\text{therm}}$ $400 \text{ kW}_{\text{el}}$ $600 \text{ kW}_{\text{Heat}}$
- Fuel: Start-up with pellets then change to wood-chips
- Official inauguration: May 2012

- Hours of operation reformer: approx. 1200h
- Hours of operation gas-engine: approx. 1000h



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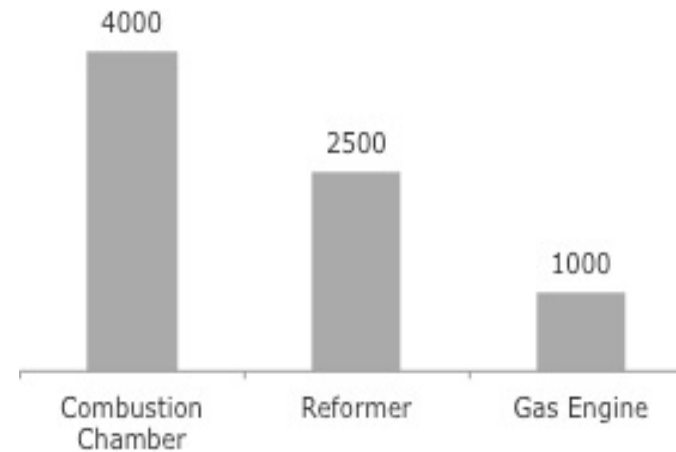
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Source: T. Kienberger, SGG Gasification Seminar 2012

Commercial Plant Grassau



Operating hours - Achental



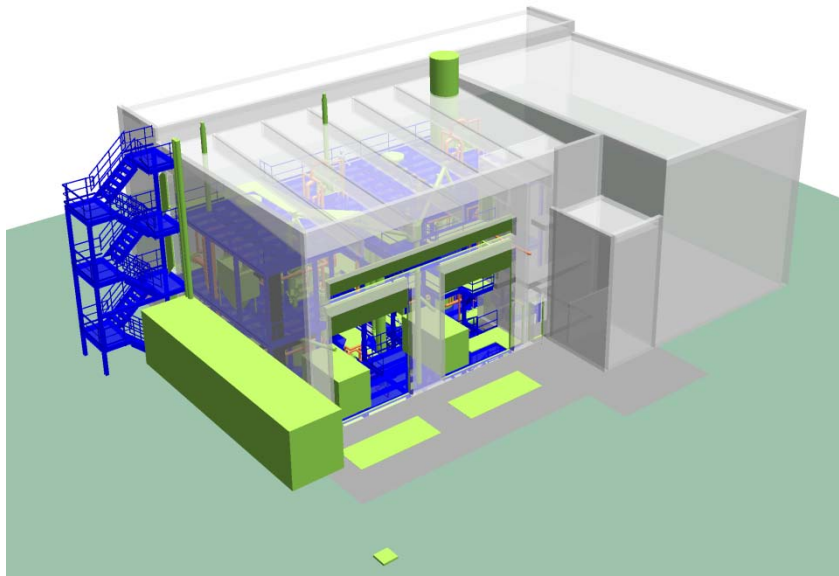
Status 2013:

- Shut down Feb 2013 due to agnion’s insolvency
- Revival Dec 2013 and exchange RME-gas cleaning to Catalytical dry cleaning process
- Feb 2014, full production mode, providing 400 kWel and 630kWTh 90/70°C



van Ritter, AGNION | Stand Nov 2013

Commercial plant Auer/Bozen



Status 2013:

- Double Modularly build unit (Südtirol/Italy)
- Commissioned Dec 2012, and secured Italian FIT (€0,28ct/kWhel)
- 800 kWel +50 kWel ORC
- Integrated within an existing industrial building
- Shut down Feb 2013 due to agnion's insolvency
- Revival Dec 2013 and exchange RME-gas cleaning for Catalytic dry cleaning process
- Jan 2014, full production mode.

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New partner for AGNION: ENTRADE

van Ritter, AGNION | Stand Nov 2013

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