Karlsruher Institut für Technologie

Country Report GERMANY

Engler-Bunte-Institute, Fuel Technology
Institute for Technical Chemistry, Gasification Technology

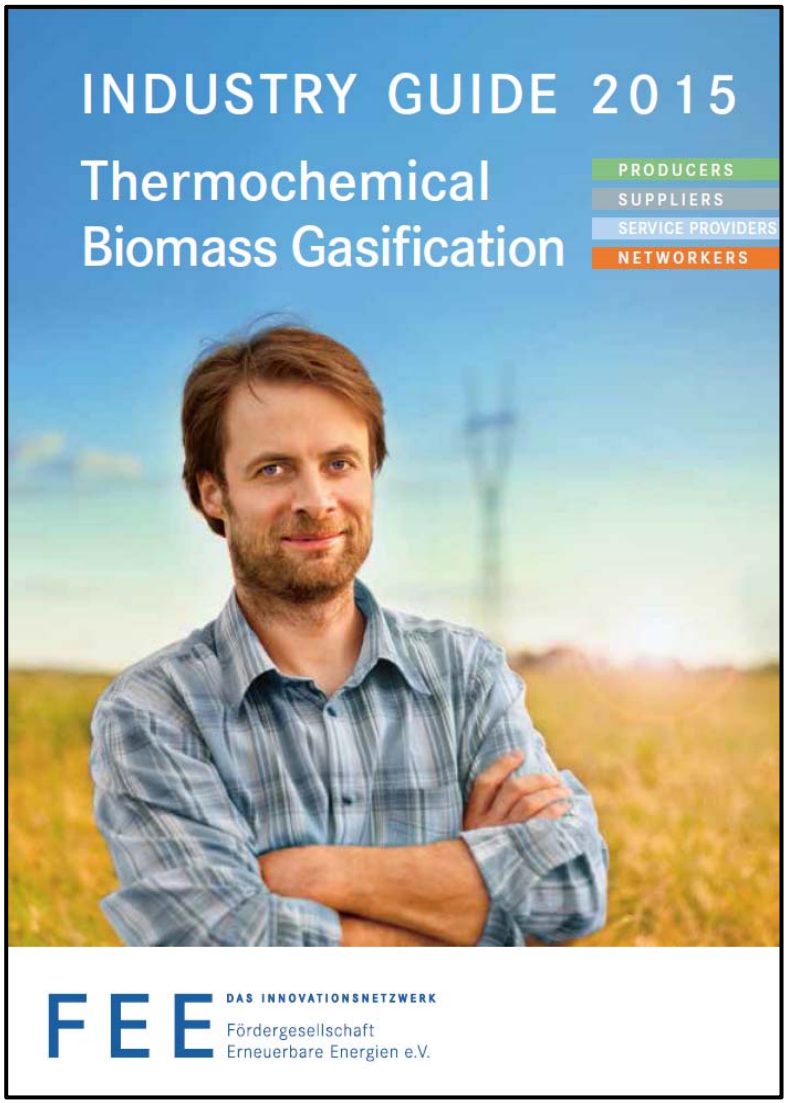
Mark Eberhard / Thomas Kolb

IEA Bioenergy: Task 33 Thermal Gasification of Biomass

Task meeting, Oct 25th 2016, Lucerne, Switzerland

Industry Guide Thermochemical Biomass Gasification 2015

- **> 400 plants in Germany, total installed capacity: 42 Mw_{el}**
- **Total efficiency up to 85 % (combined heat and power generation)**
- **Capacity range: small scale plants of 15 kW_{el} up to large scale plants of up to 5 Mw_{el}**
- **Source: Fördergesellschaft Erneuerbare Energien e.V. (FEE), Industry Guide Thermochemical Biomass Gasification, Berlin, Germany, July 2015**
- **Web: http://www.fee-ev.de/**



Mark Eberhard | Thomas Kolb

Engler-Bunte-Institut, EBI ceb
Institut für Technische Chemie, ITC vgt

Konversion von Biomassen und Kohlen
DGMK-Fachbereichstagung 9. – 11. Mai 2016 in Rotenburg a.d. Fulda

Positionsbestimmung für Anlagen zur thermochemischen Vergasung von Biomasse im sich wandelnden Energiesystem

L. Rochlitz, C. Helmes, I. Rickert
Fördergesellschaft Erneuerbare Energien e.V., Berlin

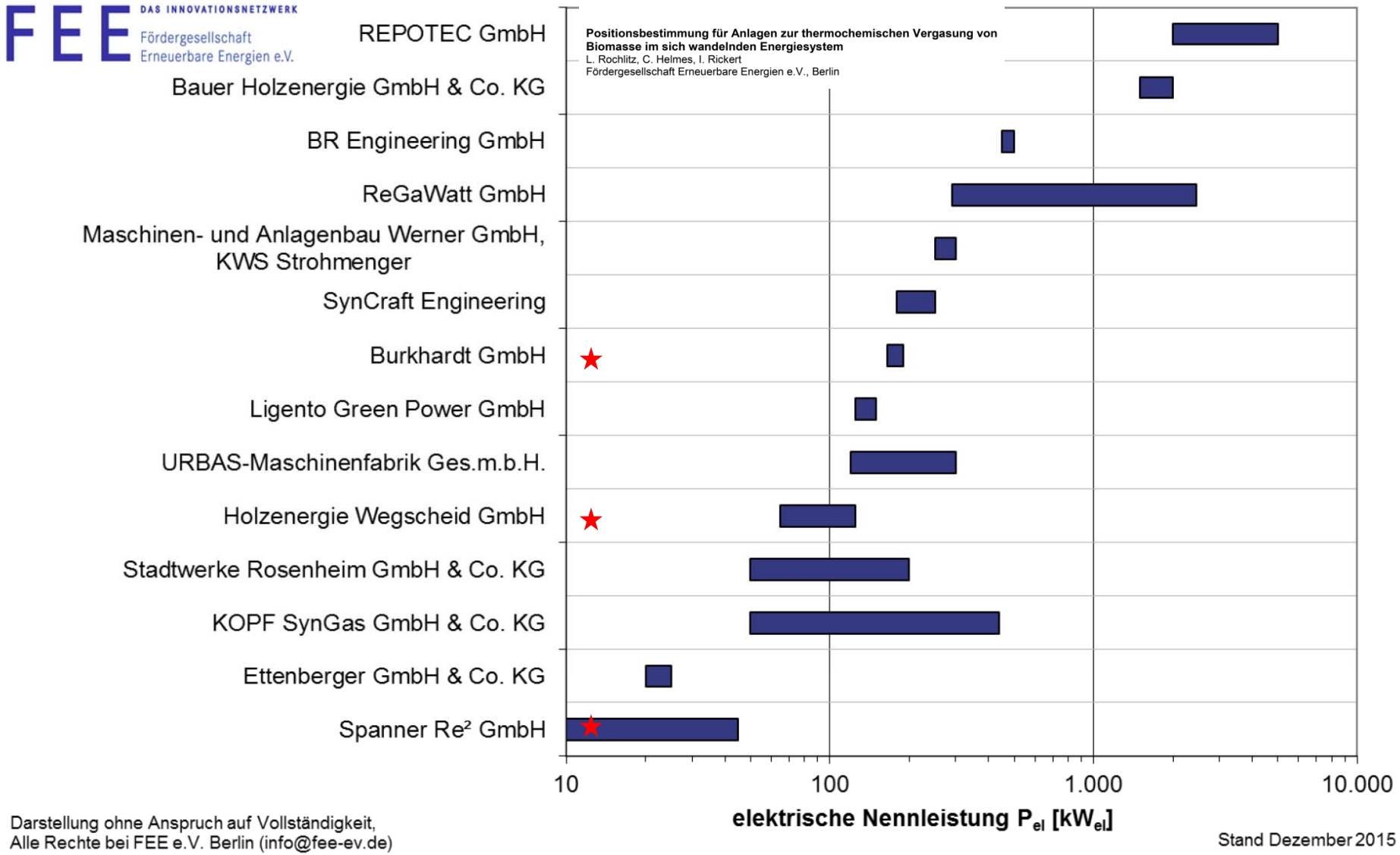


Abb. 1: Übersicht des Leistungsspektrums der Anlagen in Deutschland, Österreich und der Schweiz, die zu dieser aktuellen Befragung Rückmeldung gaben

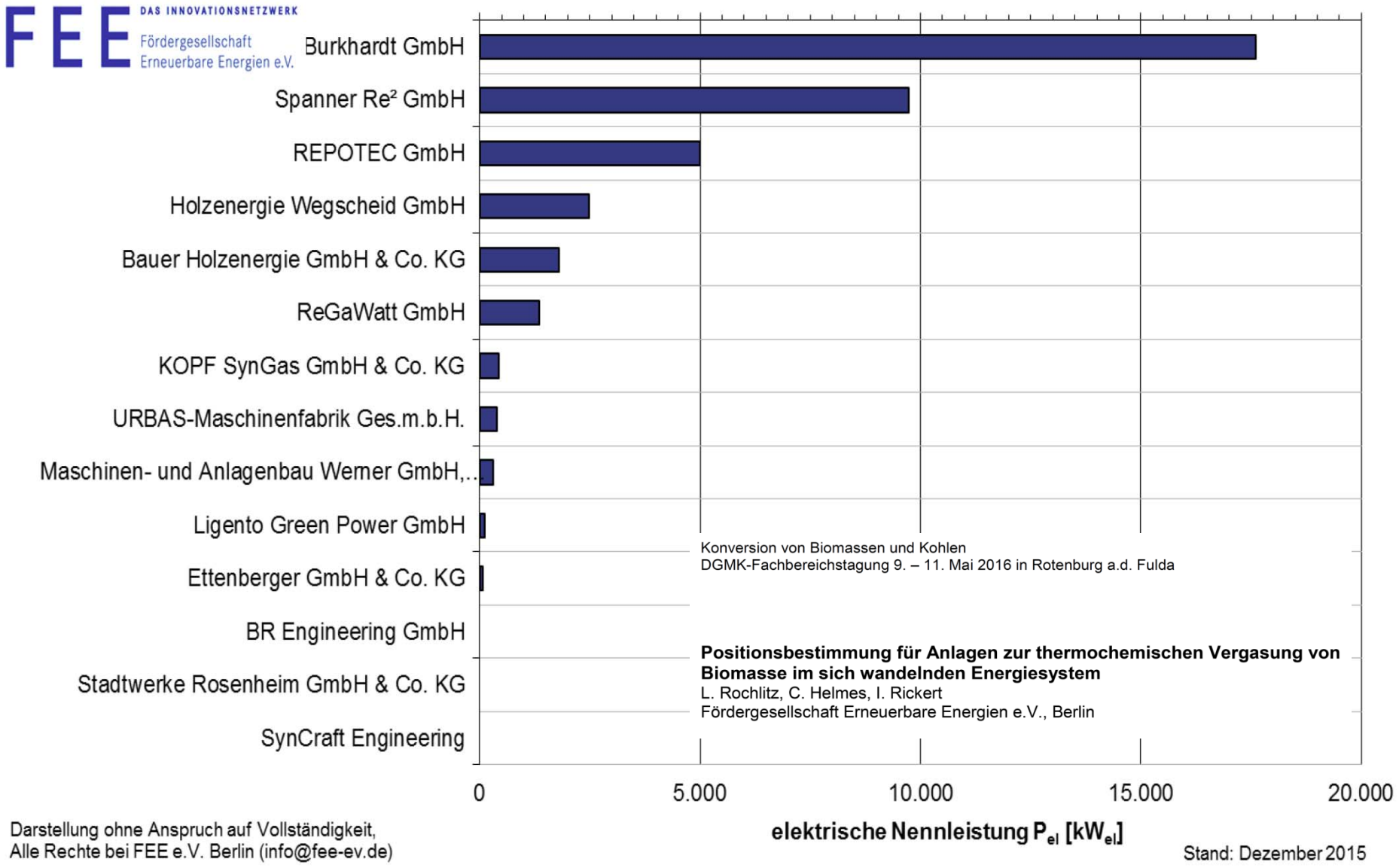


Abb. 7: Installierte elektrische Gesamtleistung kommerzieller Anlagen in Deutschland.
Die drei untersten Hersteller betreiben ihre kommerziellen Anlagen außerhalb Deutschlands.

Einordnung in den sich wandelnden deutschen und europäischen Energiemarkt

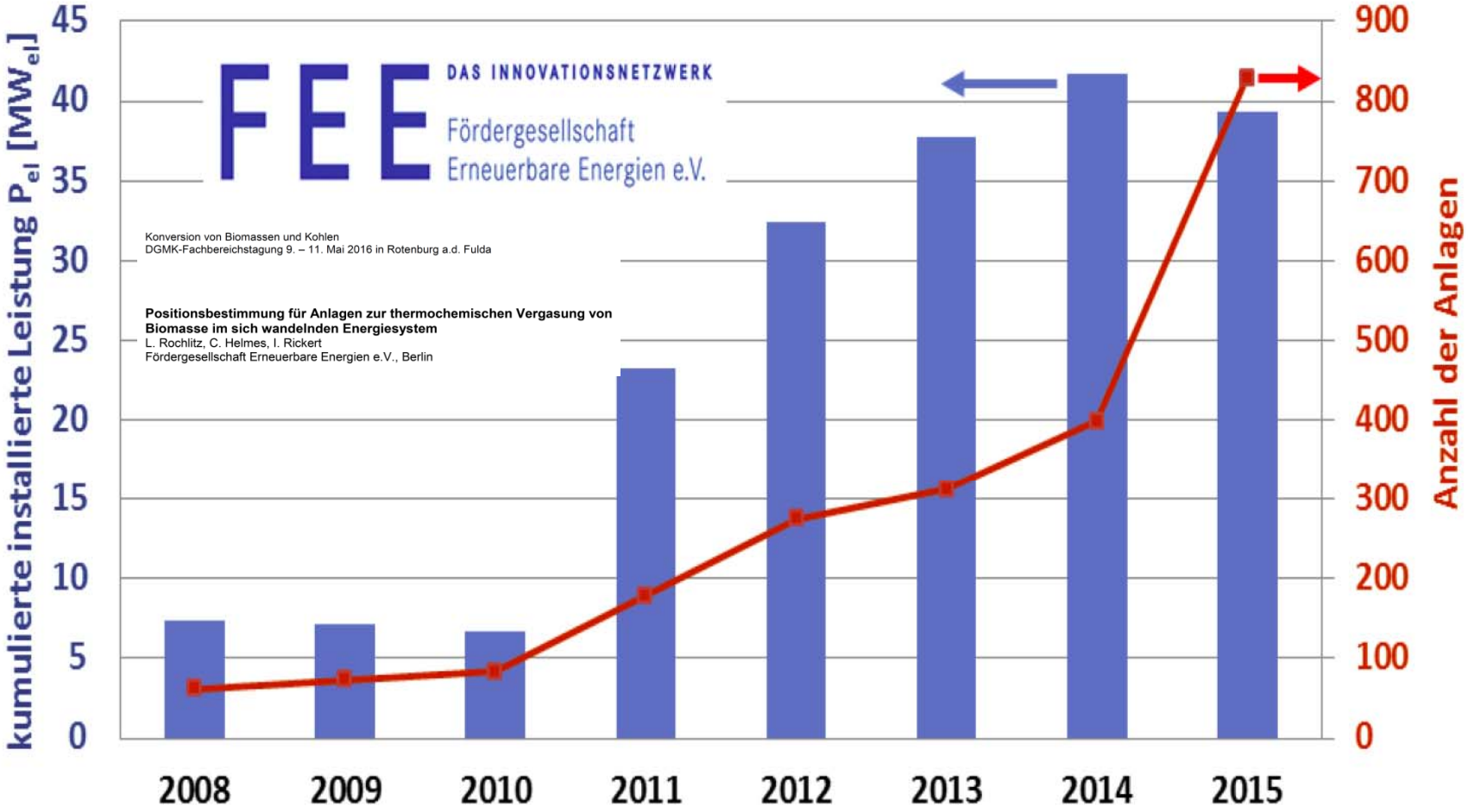
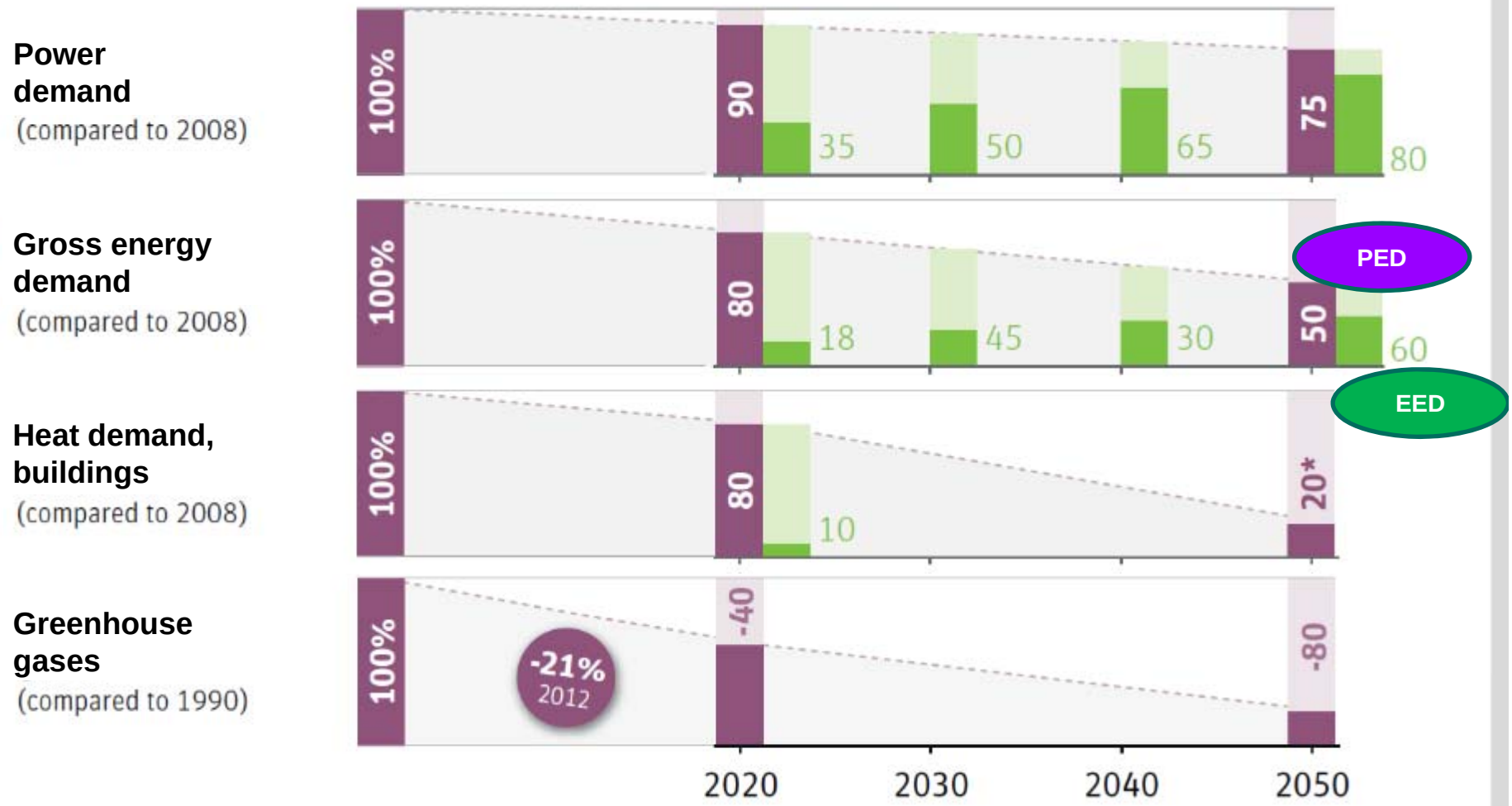


Abb. 6 Kumulierte installierte elektrische Leistung in Deutschland (Balken) und Gesamtzahl verkaufter Anlagen derselben Akteure wie in Abbildung 1.

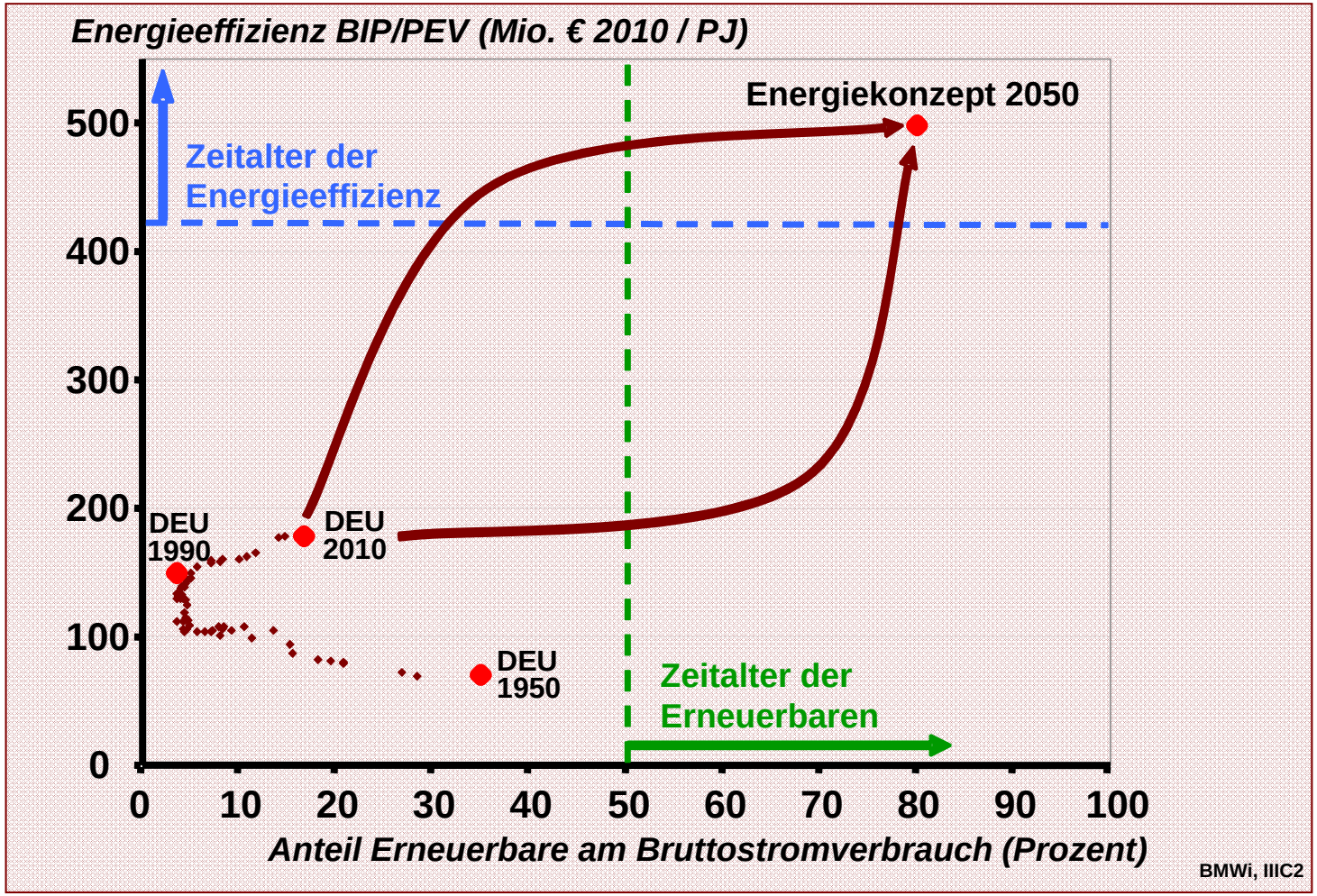
The German Energy Transition



Source: Craig Morris, Martin Pehnt (2012)

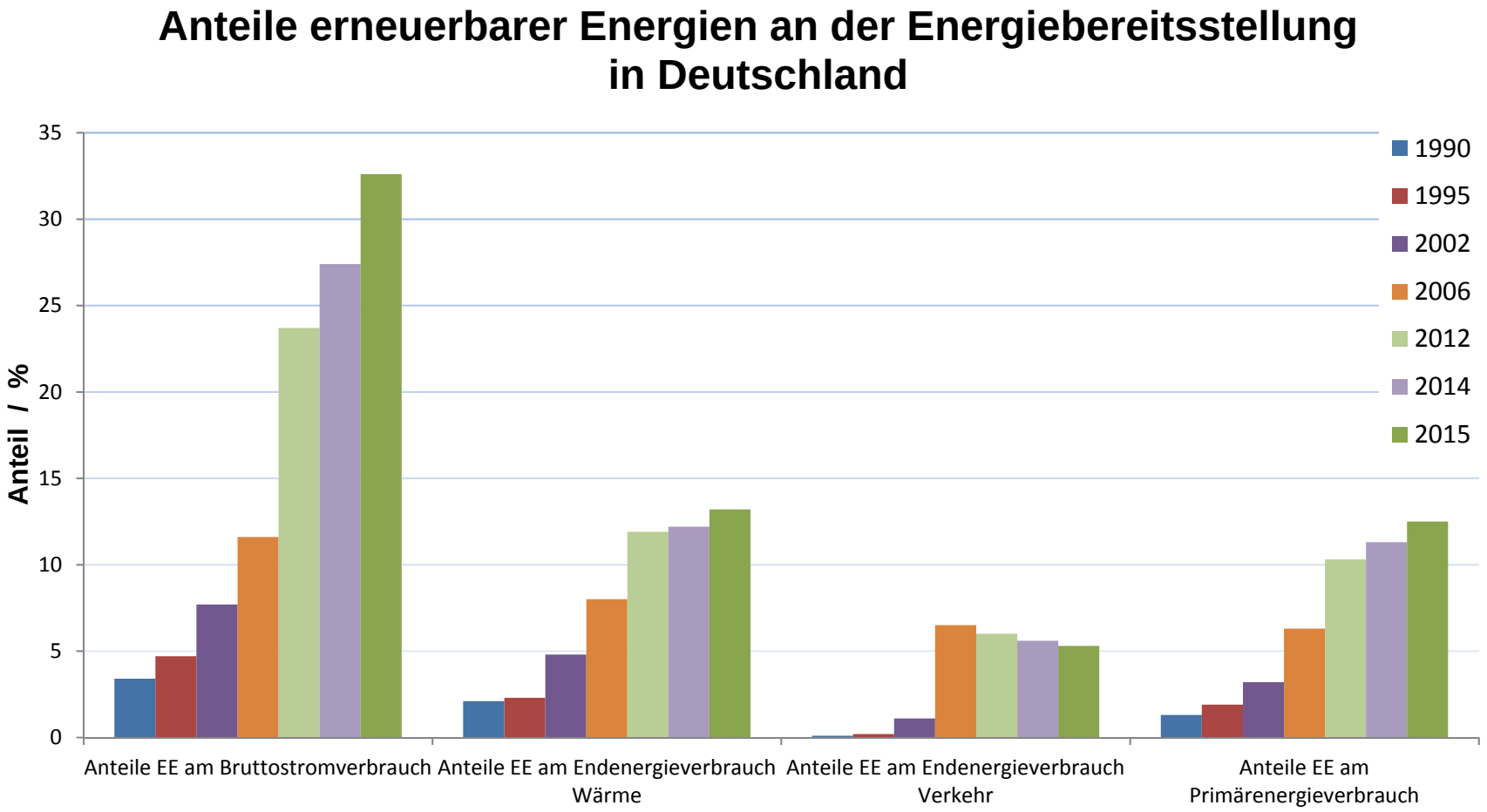
Prof. Dr.-Ing. T. Kolb, Prof. Dr.-Ing. N. Zarzalis
Engler-Bunte-Institut, EBI

Deutschland auf dem Weg in ein neues Energiezeitalter



Quelle: Dr. Knut Kübler, BMWi | Karlsruhe, 31. Januar 2012

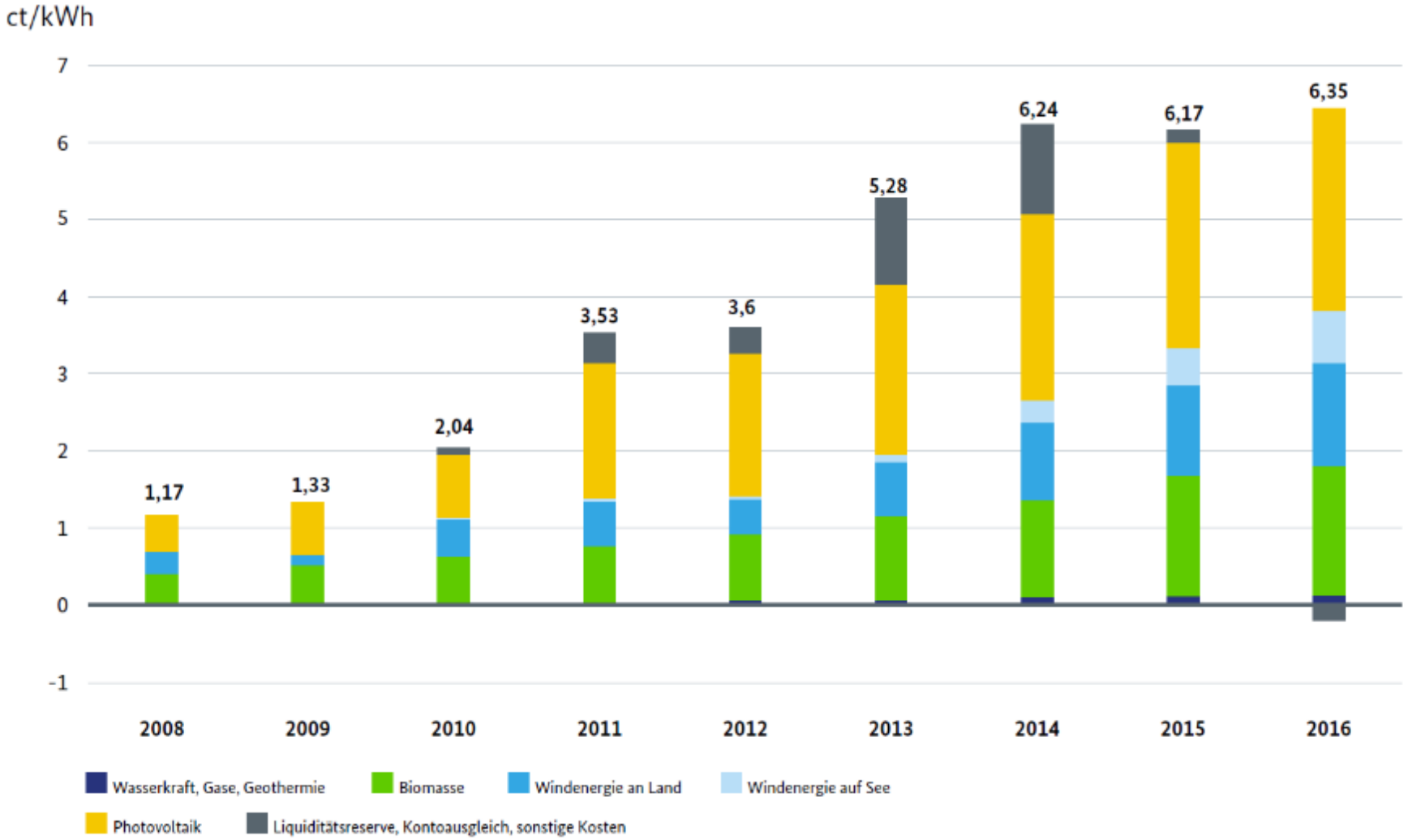
Anteil erneuerbarer Energien an der Energiebereitstellung in Deutschland



Quelle: BMWi nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat)
Stand: Februar 2016

Prof. Dr.-Ing. Thomas Kolb
Engler-Bunte-Institut, EBI ceb

EEG-Umlage nach Technologiesparten

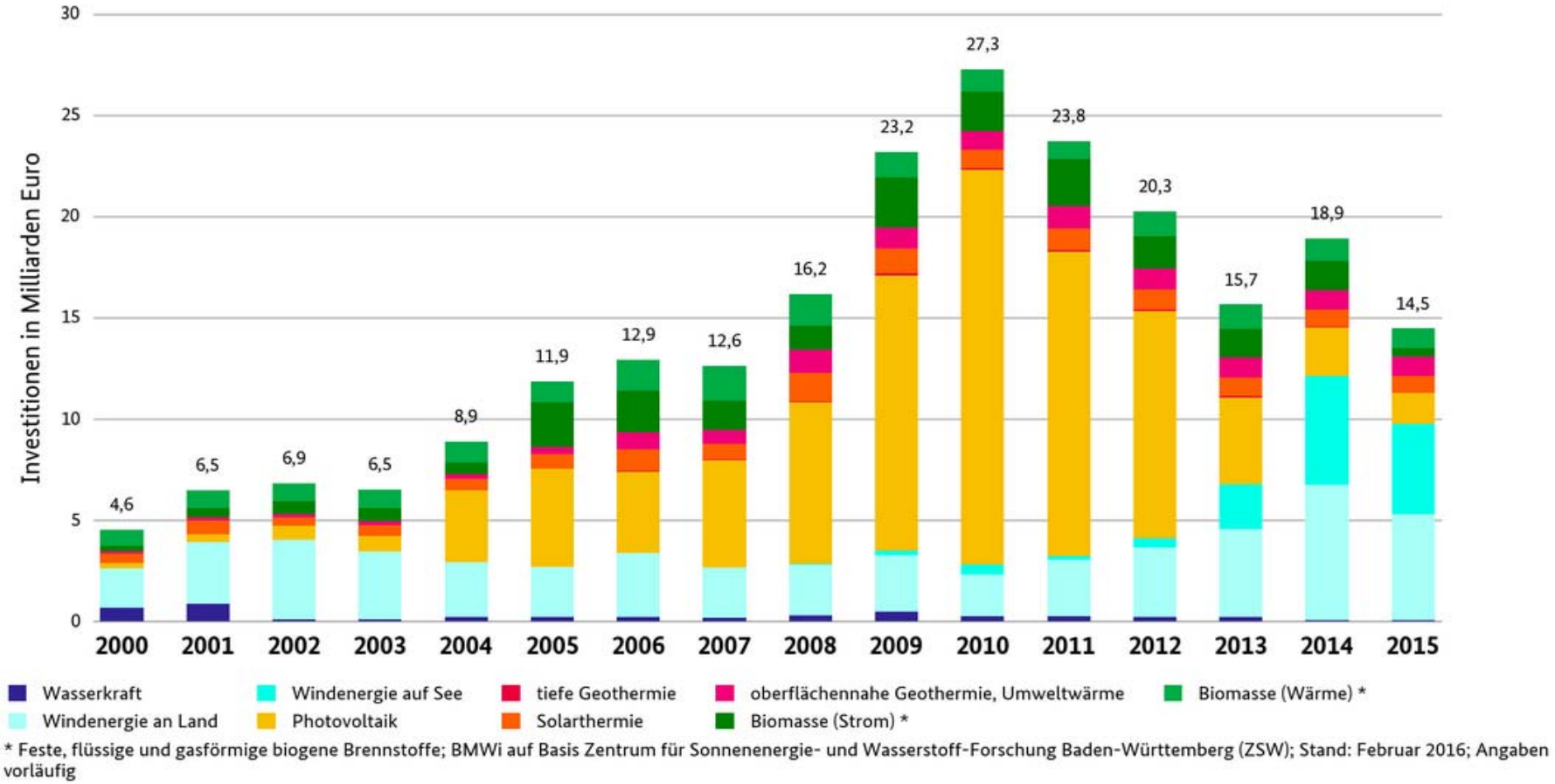


Quelle: Bundesministerium für Wirtschaft und Energie 10/2015. Im Jahr 2016 überdeckt der Kontoausgleich die Liquiditätsreserve geringfügig.

Quelle: Bundesministerium für Wirtschaft & Energie, Die Energie der Zukunft – Vierter Monitoring-Bericht zur Energiewende, Berlin, November 2015

Bundesministerium
für Wirtschaft
und Energie

Investment for new instalation of renewable energy plants in Germany



* Feste, flüssige und gasförmige biogene Brennstoffe; BMWi auf Basis Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW); Stand: Februar 2016; Angaben vorläufig

Engler-Bunte-Institut, EBI ceb
Institut für Technische Chemie, ITC vgt

Status of the bioliq®-process at KIT

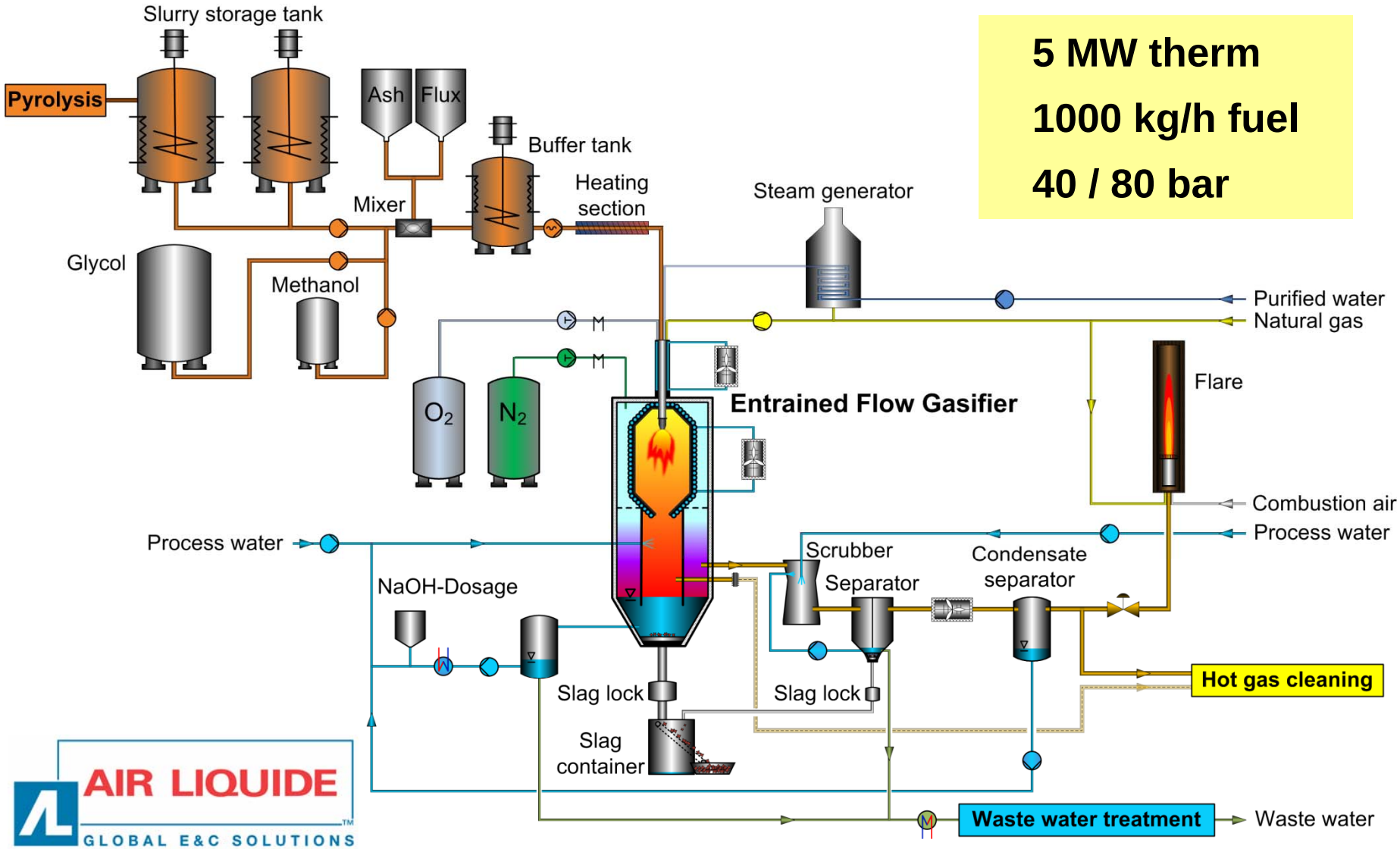
Bernd Zimmerlin, Thomas Kolb, Mark Eberhard, Nicolaus Dahmen

International Seminar on Gasification, Malmö, Sweden, October 19-20, 2016

bioliq biomass to liquid

Engler-Bunte-Institute, Division 1, Fuel Chemistry and -technology, EBI ceb
Institute for Catalysis Research and Technologie, IKFT
Institute for Technical Chemistry, ITC

bioliq® - High Pressure Entrained Flow Gasifier



5 MW therm

1000 kg/h fuel

40 / 80 bar

AIR LIQUIDE GLOBAL E&C SOLUTIONS

bioliq® gasifier - Main Features

- Operation Pressure
  - 40 bar(a) or 80 bar(a)
- Load range
  - 700 kg/h – 1000 kg/h Slurry (3.5 – 5 MW_{th})
  - Auxiliary NG feeding of up to 1MW
- Feedstock – Slurry
  - LHV 13 – 25 MJ/kg
  - max. 40 wt% solids with max. particle size of 1 mm
  - Viscosity of up to 1 Pas at 70 °C
- Especially equipped/prepared for research
  - Two reactor sizes (cooling screens) and two burners
  - Two possible quench configurations (dip tube or open quench)
  - Optical access to reaction chamber
  - Extensively equipped with instrumentation (p, T, V, composition, etc.),
  - Sampling possibilities

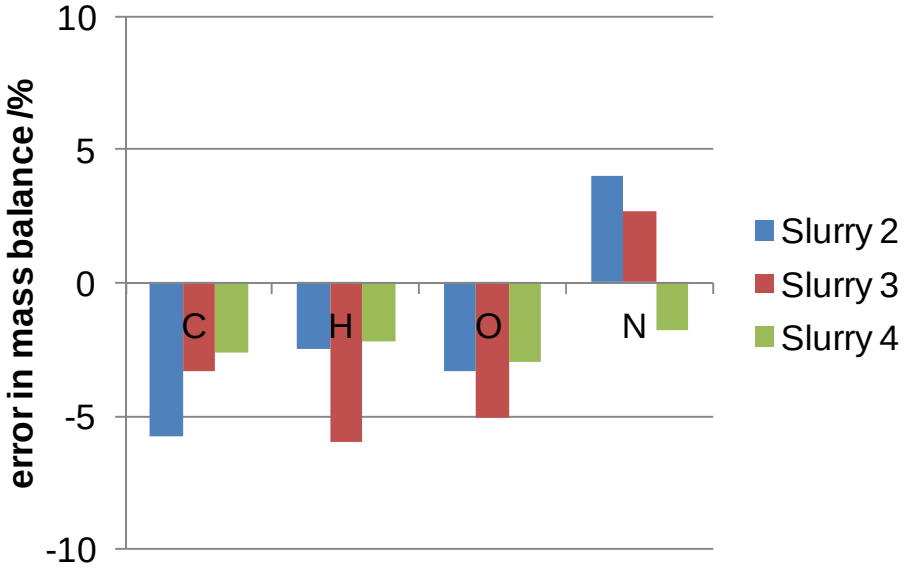
Mass Balance by Main Elements

- Typical syngas composition (dry in vol%)

H_2	CO	CO_2	N_2	CH_4
28-33	28-37	18-27	12-18	<0,1-0,3

  - rel. high N_2 concentration due to purging several accesses to pilot reactor

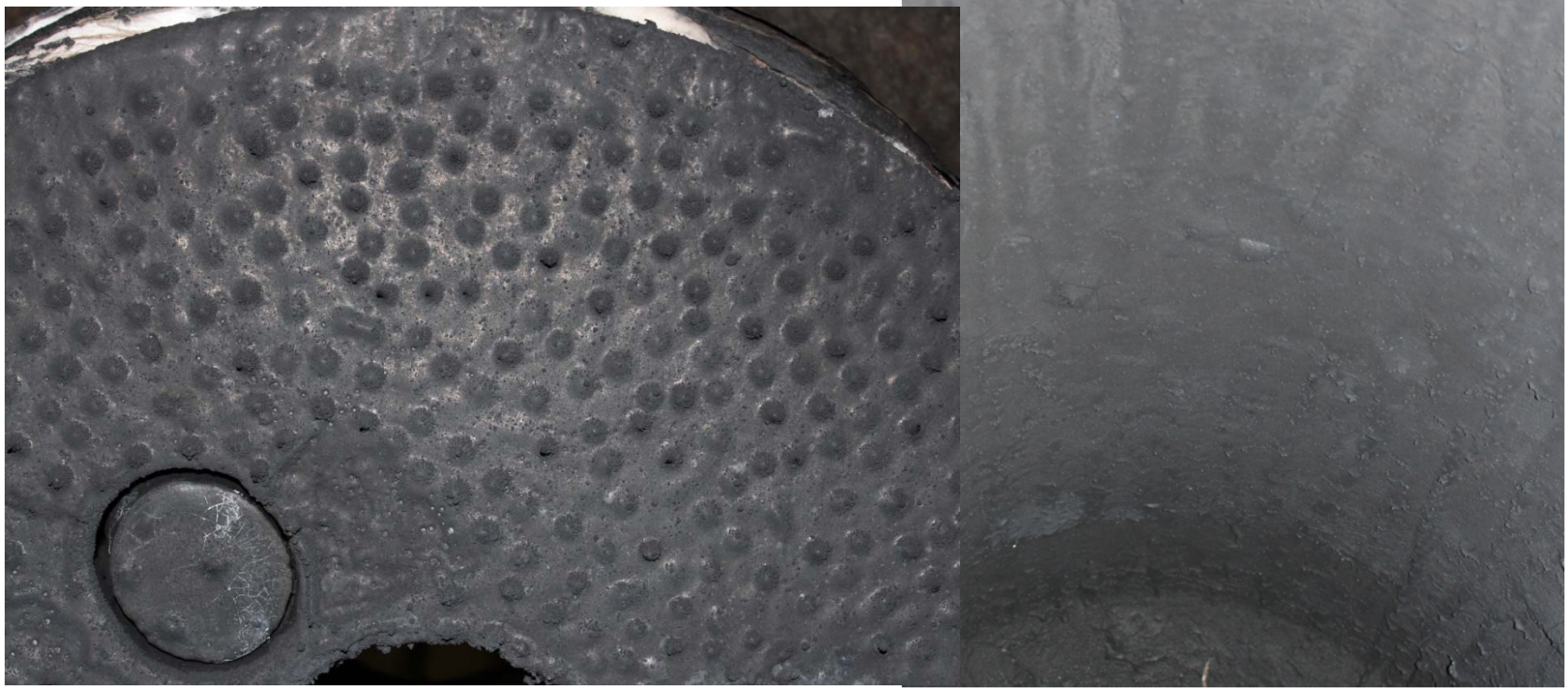
- Mass balance performed for main elements
  - July and Dec. 2015 campaigns
  - averaged values for three different slurries
  - indicating good overall balance



Source: M. Müller-Hagedorn et al, 8th International Freiberg Conference June, 13th, 2016

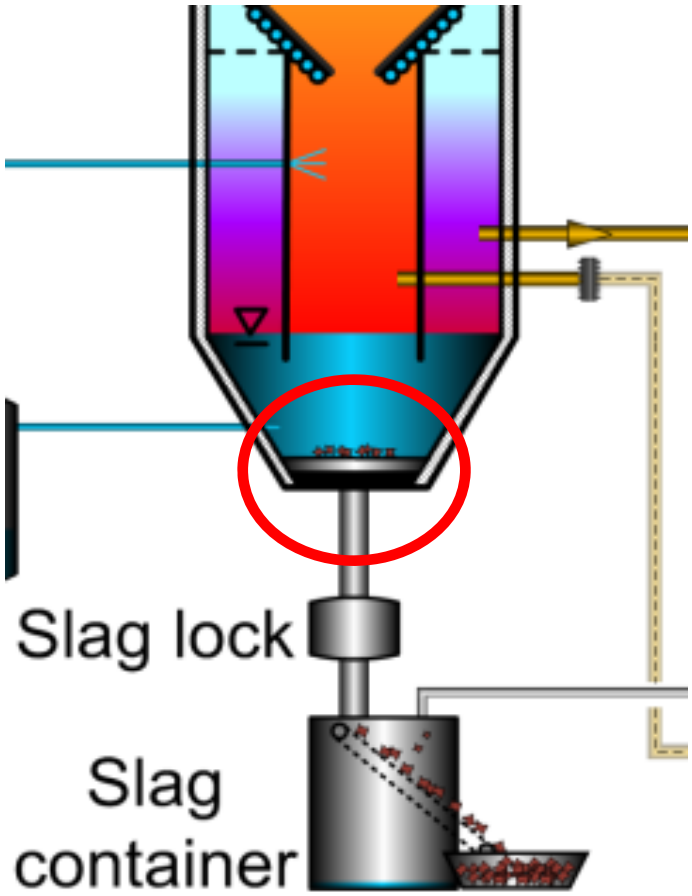
Slag distribution inside the reactor

- Validation of design of reactor and burner
  - all walls have to be covered completely with slag
  - reactor walls
  - reactor top



Source: M. Müller-Hagedorn et al, 8th International Freiberg Conference June, 13th, 2016

Slag Discharge

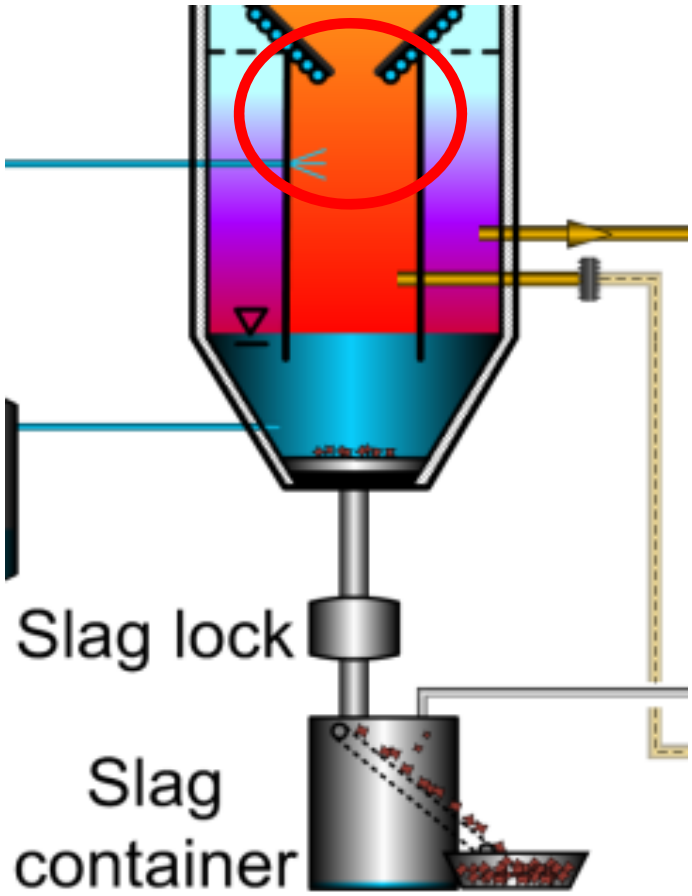


Challenge:

frequently clogging at quench cone

by slag lumps

Slag Discharge



Slag Lumps

Influence of slag viscosity and
flow temperature by variation of:

- additives (flux)
- reactor temperature (syngas temperature)

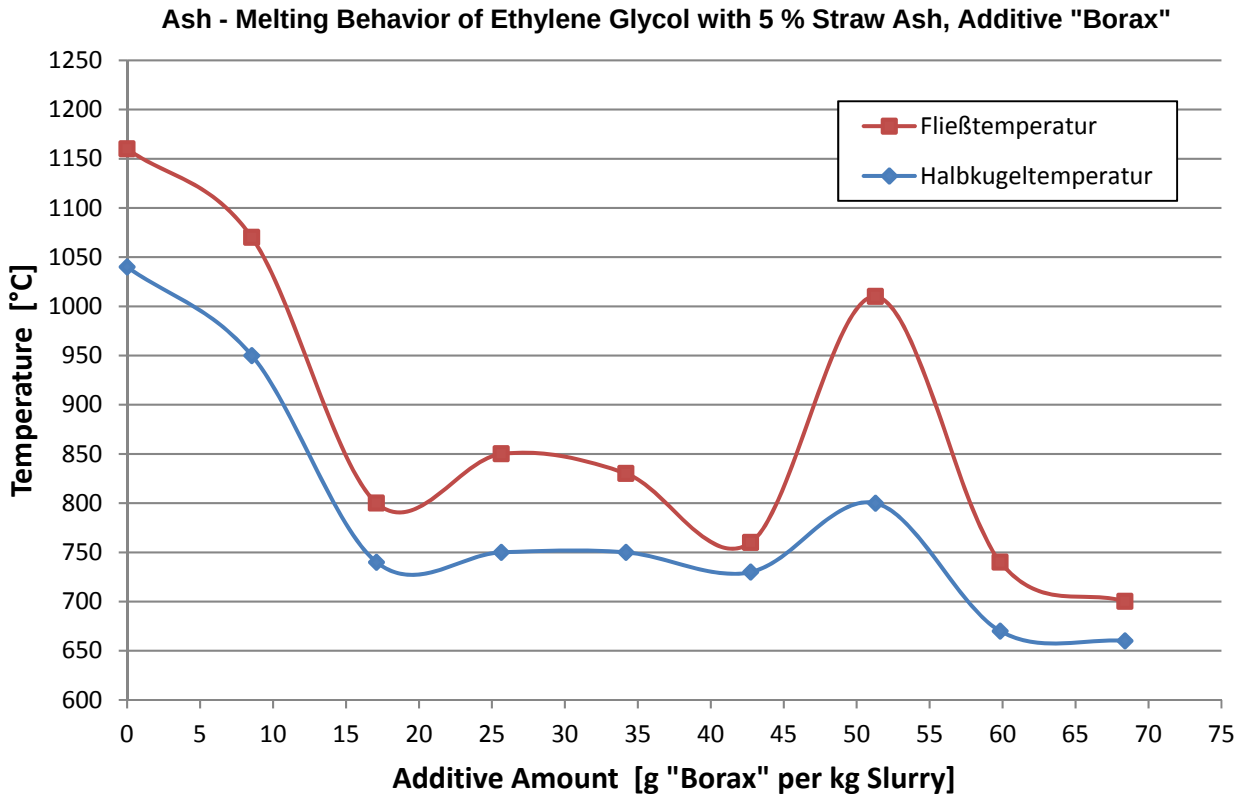
Influence of thermal conditions at
reactor bottom /outlet by variation of:

- slag amount
- syngas-flow / -temperature
- quench cooling

bioliq® gasifier - Additives Dosage

Reduction of slag flow temperature by additives

- ➔ reduced reactor temperature needed
- ➔ increase of Cold Gas Efficiency



bioliq® gasifier - Additives Dosage

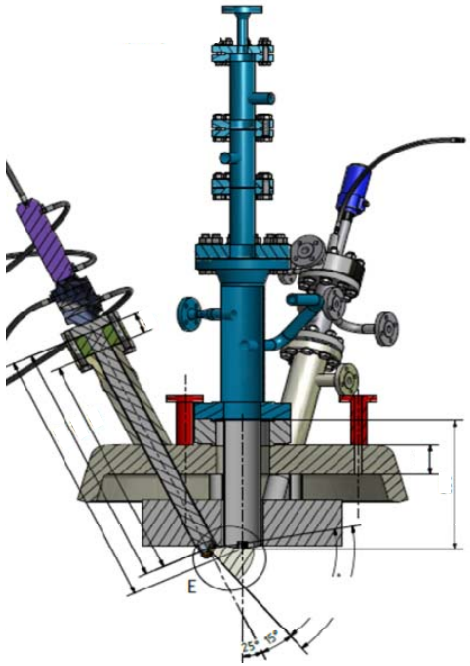
Characteristics:

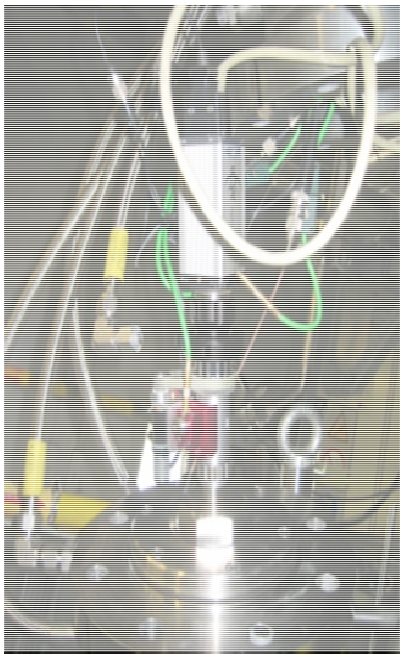
- Big Bag – station
- atmospheric, N_2 - purged
- max. 2 x 50 kg/h additives

bioliq® - High Pressure Optical Borescope

camera based systems for analysis of atomization

- High Dynamic Range Camera
- High Speed Camera





gasifier flame at 40 bar

cooperation: KIT Institute for Applied Computer Science, IAI

Thanks to…

- Funding Agencies and institutions
- partners from industry and academia
- the teams from KIT
- …and to the audience

L. Tkotz

www.bioliq.de

contact:
Dr.-Ing. Bernd Zimmerlin
Karlsruher Institut für Technologie
Institute for Technical Chemistry
phone: +49 721 608 24116
mail: bernd.zimmerlin@kit.edu