

IEA Bioenergy

Country Report Germany

Update

Task 33 Thermal Gasification of Biomass

Task meeting, Nov 25th 2019, Birmingham, UK



Thomas Kolb, Mark Eberhard

KIT – The Research University in the Helmholtz Association

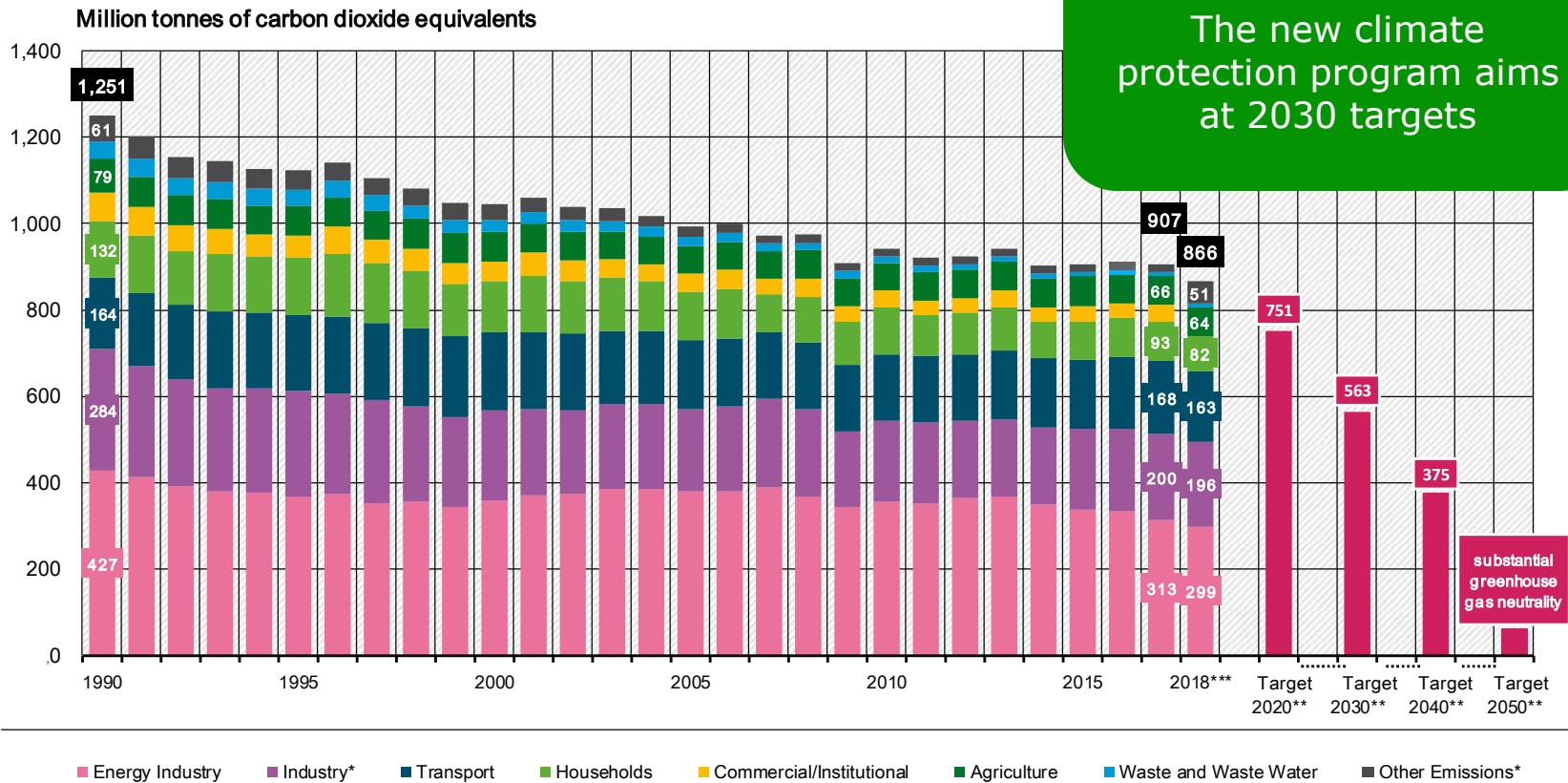
**ENGLER-BUNTE-INSTITUT Fuel Technology, EBI ceb
Institute for TECHNICAL CHEMISTRY, Gasification Technology, ITC vgt**



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Emission of greenhouse gases covered by the UN Framework Convention on

The target for 2020 will not be reached. The new climate protection program aims at 2030 targets



Emissions by UN reporting category, without land use, land use change and forestry

* Industry: Energy and process-related emissions from industry (1.A.2 & 2);

Other Emissions: Other combustion (rest of CRF 1.A.4, 1.A.5 military) & fugitive emissions from fuels (1.B)

** Targets 2020 to 2050: Energy Concept of the German Federal Government (2010)

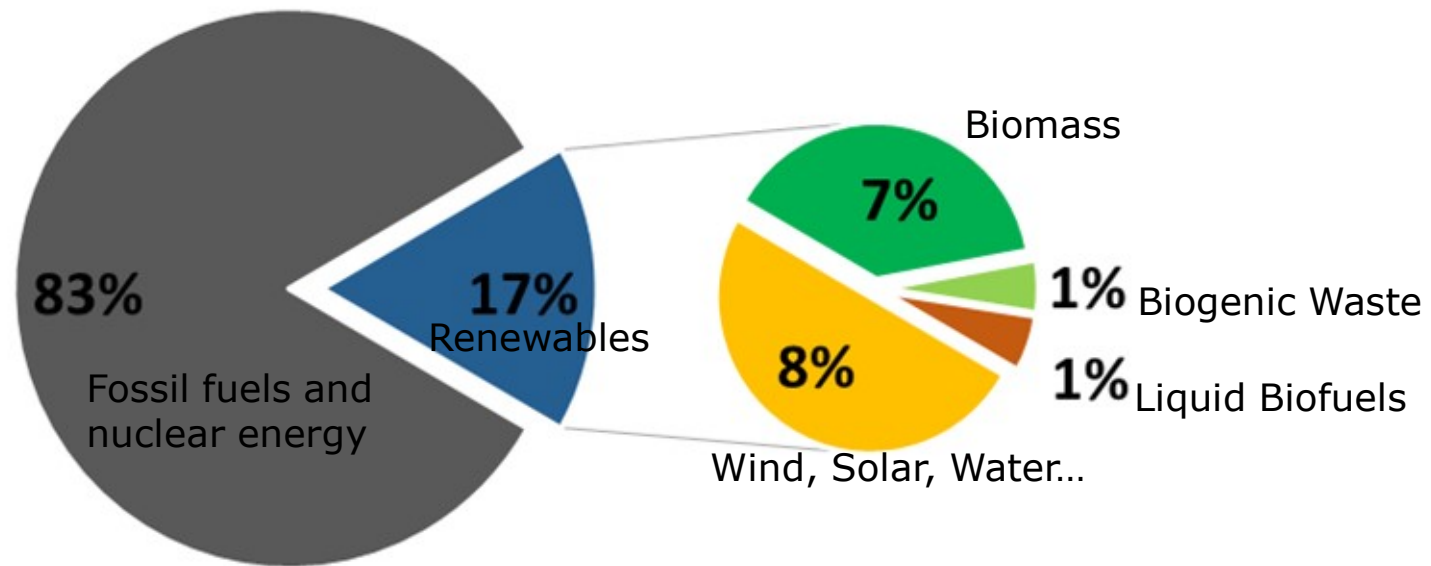
*** Short-term forecast for 2018, emissions from commerce, trade & services contained in Other Emissions

Source: German Environment Agency, National Inventory Reports for the German Greenhouse Gas Inventory 1990 to 2017 (as of 01/2019) and estimate for 2018 from UBA Press Release 09/2019 (corrected)

Source: <https://www.umweltbundesamt.de/en/indicator-greenhouse-gas-emissions>

Bioenergy in Germany

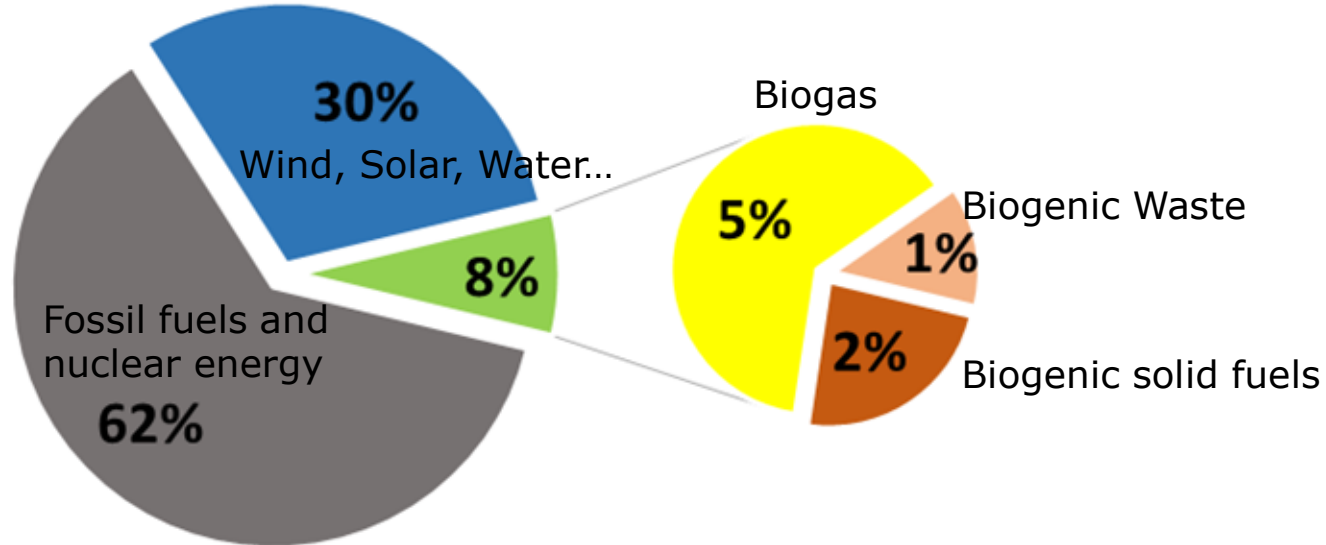
Bioenergy in primary energy consumption
in 2018 (in total 13.106 PJ)



Source: AGEB-AG Energiebilanzen
e.V.: Auswertungstabellen zur
Energiebilanz Deutschland Daten
für die Jahre von 1990 bis 2018

Bioenergy in Germany

Bioenergy power generation
in 2018 (in total 602 TWh)



Source: AGEEstat: Zeitreihen zur Entwicklung der
erneuerbaren Energien in Deutschland, August 2019

Climate Protection Program 2030 of the federal government to implement the Climate Protection Plan 2050

3.4.1.2 Expansion of RE to 65 percent share of gross electricity consumption until 2030

EE technology	power generation 2030 in TWh *	Installed capacity 2030 in GW *
Wind on land	140-145	67-71
Photovoltaic	90	98
Wind at sea	79-84	20
Biomass	42	8.4
Hydropower and other	21	6

Same values for
biomass as in 2018
No progress
planned

(*) Exact electricity mix and installed services are i.a. depending on market-driven expansion and technical progress

Climate Protection Program 2030 of the federal government to implement the Climate Protection Plan 2050

3.4.3.5 Support for advanced biofuels (Alternative fuels policy area)

- close research and development gaps,
- promote production facilities,
- Implementation of the Renewable Energy Directive (RED) II to advanced biofuels.

The use of biofuels in the fuel mix reduces the share of fossil fuel in the fuel and thus also the amount of the CO₂ price of the fuel. The development of liquid and gaseous regenerative fuels from biomass and their large-scale production in biogas and synthesis plants are supported in order to be able to use them in the medium and long term in certain segments of the transport sector.

First-generation biofuels based on food and feed crops are not supported.

In the future, the generation of bioenergy should be **based more on waste and residual materials**. That is why it is important to actually capture all waste and residues. An expansion of the acreage for bioenergy is not to be expected and is not considered due to land restrictions. The sustainability criteria of the RED II also apply to imports (from the internal market and from third countries).

In addition, as part of the national implementation of the RED II, a **subquota for advanced biofuels** will be introduced taking into account the ecological and economic aspects and the technical feasibility.

Taking into account all aspects, the maximum biomass available for bioenergy in Germany is currently around 1,000 to 1,200 PJ / a (domestic potential).

Existing research and development gaps in innovative advanced biofuels (eg straw fuels) will be closed by projects and demonstration projects in order to be able to realize large-scale production in the medium term.

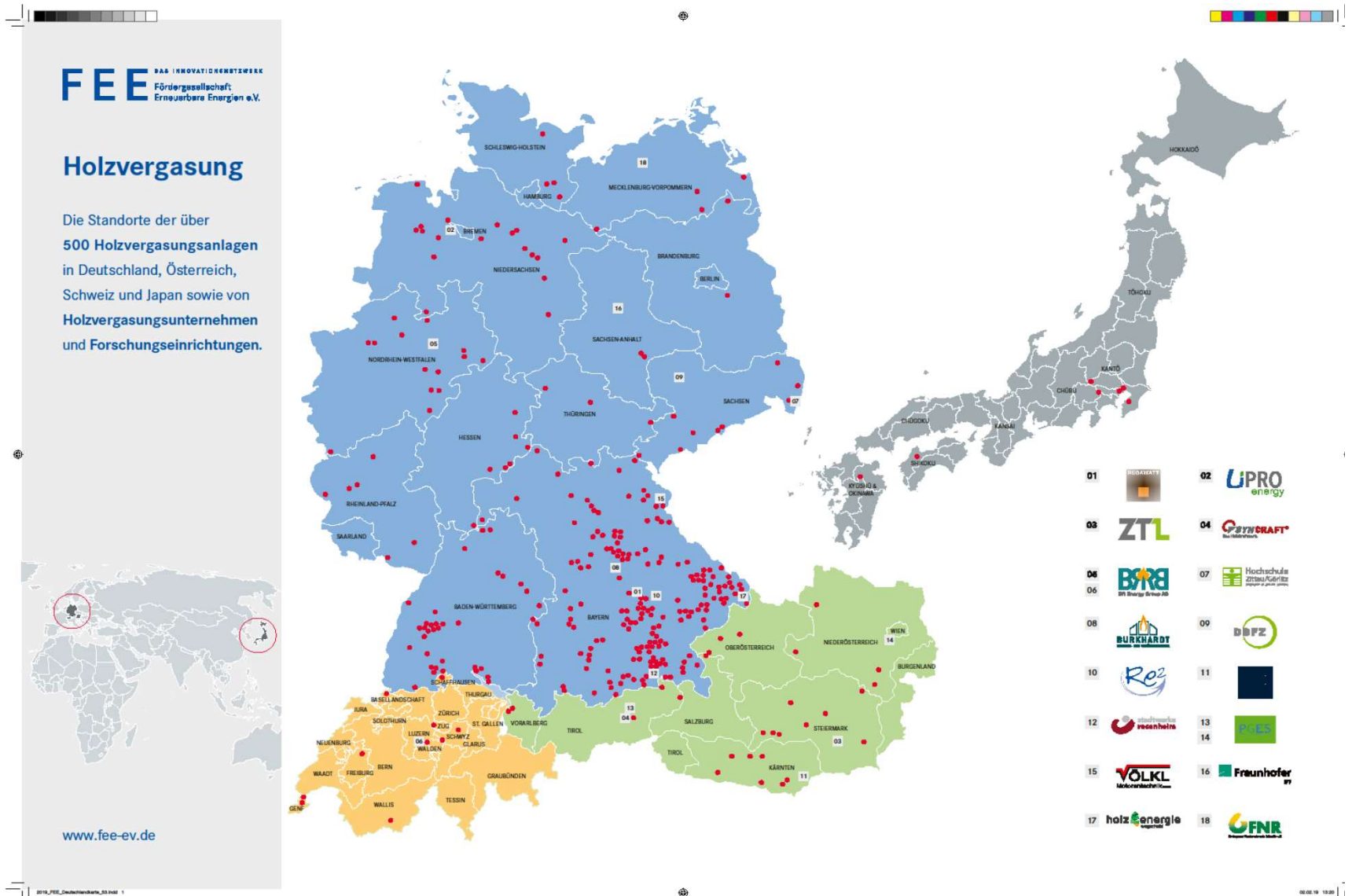
Climate Protection Program 2030 of the federal government to implement the Climate Protection Plan 2050

Period of implementation: from 2020
Involved: BMVI, BMWi, BMU, economy, science

Impact Assessment: Information on employment effects for the climate protection program can be expected from the forthcoming results of Working Group 4 ("Securing the Mobility and Production Location, Battery Cell Production, Raw Materials and Recycling, Education and Qualification") of the **National Future Mobility Platform**, which will launch in autumn 2019 first report. Further information will be provided by the ongoing work under the Concerted Action Mobility.

Interactions: Biomass is also needed in other sectors (for example in the heating sector). In addition, the principle of the waste hierarchy must be observed, i.e. the energetic use comes last. Higher-value uses prevail. The potential available in DEU could be smaller than the need in all sectors, so import options would need to be considered. Here it must be examined which options can be tapped under economic, ecological and technical aspects. Negative effects, eg. such as indirect land-use change, should be avoided in any case as they can lead to significant additional emissions

Biomass gasification map



CHP Biomass gasification plants

Manufacturer	Technology	Feedstock	Grid feeding plants	Note
Biotech Energietechnik GmbH	Fixed-bed process, co-current	wood chips	3	
BR Engineering GmbH (CH)	Fixed-bed process (optional: moving bed) in combination of co-current and countercurrent flow	Unadulterated wood, wood chips, other biomasses (among others hogged fuel)	2	<ul style="list-style-type: none"> • Since 1997 • Cold gas efficiency: up to 90% • Production of biochar • USP: proven for demolition wood/ ash free of char
Burkhardt GmbH (D)	Fluidized bed process in co-current flow	Pellets	240	<ul style="list-style-type: none"> • Since 2011 • wood gas cogeneration plants • wood gasifier with downstream CHP • Electric efficiency of more than 30 %
Glock Ökoenergie GmbH (A)	Fixed-bed process, co-current	wood chips	13	<ul style="list-style-type: none"> • Since 2010 • Distributing countries: D, A, CH
Holzenergie Wegscheid GmbH (D)	Fixed-bed process in co-current flow	Unadulterated wood, briquettes & maxi-sized pellets, wood chips	120	<ul style="list-style-type: none"> • Distributing countries: EU, JP, CA, ID, CH
ReGaWatt GmbH	Fixed-bed in counter-current flow	Wood chips from various sources up to 30 % bark and landscape management chips	6	<ul style="list-style-type: none"> • Since 2010 • Distributing countries: EU

Source: Fördergesellschaft Erneuerbare Energien e.V. (FEE), Industry Guide Thermochemical Biomass Gasification, Berlin, Germany, July 2015 ; [Update 2019](#)

CHP Biomass gasification plants

Manufacturer	Technology	Feedstock	Grid feeding plants	Note
LiPRO Energy &CO KG (D)	Pyrolysis with moving bed	wood chips	9	<ul style="list-style-type: none"> Since 2016
Spanner Re ² GmbH	Fixed-bed process in co-current flow	Unadulterated wood, forest chips (at 30 kWel), wood chips	>700	<ul style="list-style-type: none"> Spanner Re² wood cogeneration plants Since 2008 Distributing countries: D, A, CH, I, CZ, SLO, LV, CDN, GB, FIN, HR, J, PL
Stadtwerke Rosenheim GmbH & Co. KG	Fluidized bed and tiered process, combination of co-current and eddy flow (Rosenheimer Process)	Unadulterated wood, wood chips	1	<ul style="list-style-type: none"> Since 2015 Distributing countries: DE, AT, I
SynCraft (A)	Tiered process in co-current flow (floating fixed-bed)	Unadulterated wood, tree and shrub cuttings, waste wood class A, wood chips	6	<ul style="list-style-type: none"> By-product bio char Fuel flexibility No additives needed Electric efficiency 30 %
Xyloenergy GmbH	Fixed-bed process in co-current flow	Unadulterated wood, wood chips	1	<ul style="list-style-type: none"> capacity via 100 % diesel/ bio-diesel as well; utilization of waste wood Distributing countries: EU

Source: Fördergesellschaft Erneuerbare Energien e.V. (FEE), Industry Guide Thermochemical Biomass Gasification, Berlin, Germany, July 2015; [Update 2019](#)

CHP Biomass gasification plants

Manufaktur	Technology	Feedstock	Grid feeding plants	Note
KOPF SynGas GmbH & Co. KG	Fluidized bed process	Sewage sludge (10 % moist. cont.)	2	• Since 2000
Wood Gasifier System Werner	Fixed-bed process in co-current flow	Unadulterated wood, wood chips	1	
Meva Energy (S)	Entrained flow in co-current flow	Unadulterated wood, wood chips, pellets, saw dust, husks, straw	1	
URBAS Maschinenfabrik GmbH (A)	Fixed-bed process in concurrent flow	Unadulterated wood, wood chips	19	• Since 2008

Source: Fördergesellschaft Erneuerbare Energien e.V. (FEE), Industry Guide Thermochemical Biomass Gasification, Berlin, Germany, July 2015; [Update 2019](#)

Build-start for BOSON ENERGY gasifier in Stadtwerke Göttingen's next-generation bio-heat centre

GÖTTINGEN, GERMANY. BOSON ENERGY's gasification system will be part of Stadtwerke Göttingen's new 9 MW 15-million-euro bio-heat centre. The centre will upgrade the capacity of SWG's existing fleet of combined heat and power capacity. It will supply green heat to customers of Stadtwerke Göttingen with a view to also supply district cooling in the future. Göttingen is one of the 'green cities' of Germany and home to HAWK University of Applied Sciences and Art and its renowned biomass competence centre.

The value of BOSON ENERGY's part of the project is 6 million euro. The project aims to demonstrate commercial performance of the H3TAG biomass gasification technology developed by BOSON ENERGY in cooperation with Swedish KTH Royal Institute of Technology. The capacity of BOSON ENERGY's system will be 1MWe power and 1.5 MWth of heat. The power produced corresponds to the electricity consumption of about 2000 German households.

BOSON ENERGY's gasifier will run on regionally sourced wood chips and wood waste from local businesses. The combined output from the gasifier and boiler unit will increase Stadtwerke Göttingen's biogenic heat generation from 30% to 65%.

Jan Grimbrandt, CEO BOSON ENERGY: "Receiving a BlmSchG [environmental permit] to operate in the city centre of Göttingen proves that BOSON ENERGY's clean technology is a true 'In My Back Yard' solution. It shows the strength of our model to use local biomass and waste to produce sustainable power, heat and thermal cooling for direct local use in demanding urban environments."

Lead partners in the project are Stadtwerke Göttingen, BOSON ENERGY, and global bio-heat leader Viessmann. Other key participants include BOSON ENERGY's reactor manufacturing partner SAB Stahl- und Anlagebau in Luxembourg and HAWK University of Applied Sciences and Art in Göttingen.



Pictures in above gallery are available for download by clicking on the picture in the gallery. Rights holders retain the rights of the pictures, but are made available for use for free in any coverage of BOSON ENERGY Stadtwerke Göttingen and

Workshop

Mit Sektorenkopplung und Synergieeffekten zu energieautarken Klärwerken: Synthesegas aus Klärschlamm

Montag, 28.10.2019 | Koblenz

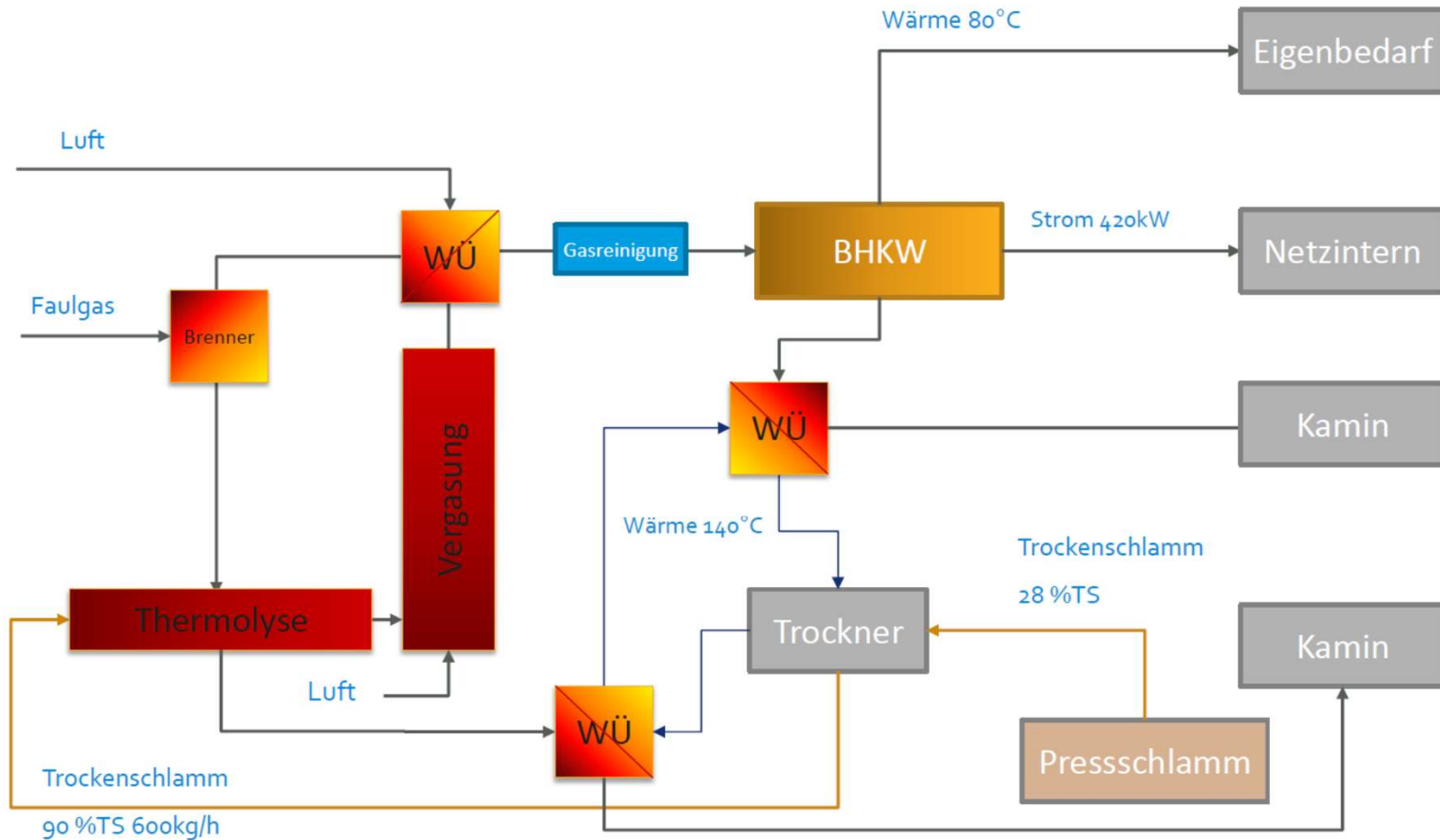
Workshop:
Syngas from
sewage sludge

13:00	Begrüßung und Vorstellung der Teilnehmer*innen Eberhard Oettel, Senior Leiter Technologietransfer und internationale Zusammenarbeit in der Fördergesellschaft Erneuerbare Energien e.V., Berlin, Verbandskoordinator des Bundesverbands Regenerative Mobilität e.V. (BRM), Erkner
13:30	Vorstellung der SEK Stadtentwässerung, Eigenbetrieb der Stadt Koblenz, und seiner Erfahrungen auf dem Weg zu Energieautarkie und Wertstoffrückgewinnung Dipl.-Volkswirt Bernhard Mohrs, Thomas Keßelheim, SEK Stadtentwässerung, Eigenbetrieb der Stadt Koblenz, Nordrhein-Westfalen
14:00	KOPF-Thermochemische Klärschlammvergasung zur Kraft-Wärme-Kopplung und Phosphorrückgewinnung Dr.-Ing. Johannes Judex, KOPF SynGas GmbH & Co. KG*, Sulz am Neckar, Baden-Württemberg
14:30	BiON®-Verfahren zur Umwandlung von Synthesegas zu multipel verwendbarem Methan M.Sc. Robert Böhm, Business Development, microEnergy GmbH Schwandorf, Bayern
15:00	Pause
15:45	Potenziale zur Effizienzsteigerung von Kläranlagen durch lokale Sauerstoffherzeugung Dr. Ralf Kriegel, Fraunhofer-Institut für Keramische Technologien und Systeme (IKTS), Institutsteil Hermsdorf*, Thüringen
16:15	Energieeffizienz von Kläranlagen - Das physikalische Optimum als neue Bewertungs- und Optimierungsmethode Dr.-Ing. Torsten Birth, Ing. B.Sc. Sebastian Jentsch, M.Sc. Marcel Scheffler Fraunhofer-Institut für Fabrikbetrieb und Fabrikautomatisierung*, Magdeburg, Sachsen-Anhalt
16:45	Zusammenfassung und Ausblick auf die nächsten Workshops Eberhard Oettel, Fördergesellschaft Erneuerbare Energien e.V (FEE), Berlin Bundesverband Regenerative Mobilität e.V. (BRM), Erkner
17:00	Besichtigung des Klärwerks sowie der Anlagen zur Klärschlamm-trocknung und -vergasung anlage Thomas Keßelheim, SEK Stadtentwässerung, Eigenbetrieb der Stadt Koblenz Dr. Johannes Judex, KOPF SynGas GmbH & Co. KG
18:00	Ende der Veranstaltung

Industry activities:

Klärschlammvergasung

Gesamtkonzept (vereinfacht)



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Industry activities: BioTfuel-Projekt

BioTfuel - Venette Torrefaction Demo Plant

The demonstration plant for biomass preparation in Venette has been built to convert the raw biomass into a suitable feed for the selected entrained-flow gasification process and includes biomass torrefaction as well as optional pelletization and all relevant storage and feeding sites.



Venette Demo Plant

- Avril industrial site
- Size 5 t/h feed
- Different kind of biomasses to be prepared



Further optimization of construction and function of the demo unit



23.05.2019 / N. Ullrich



Industry activities: BioTfuel-Projekt

BioTfuel-Dunkirk / Demoplant for Milling, Gasification, Gas Cleaning and FT

The demonstration plant in Dunkirk has been built to demonstrate the grinding and gasification of torrefied biomass and fossil feedstock in an entrained-flow reactor as well as the syngas conversion and cleaning for Fischer-Tropsch application.

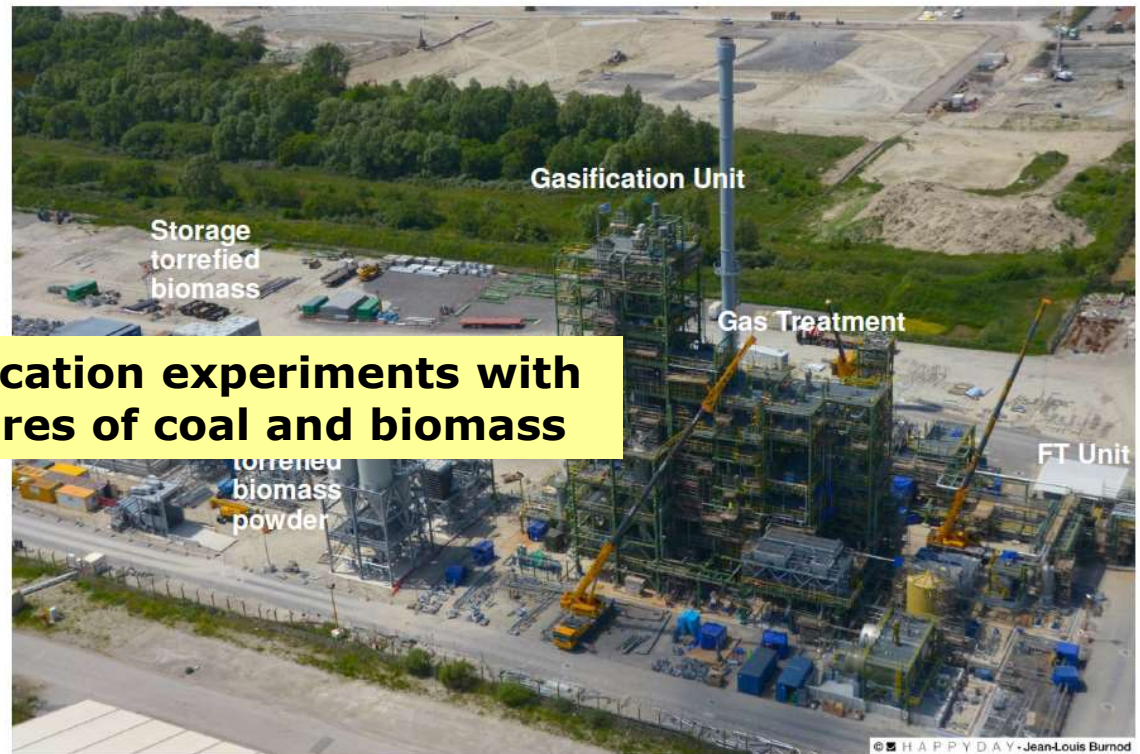


Dunkirk Demo Plant

- Total industrial site
- Multi scale for a safe scale up
- Gasification 15 MWth (3 t/h torrefied wood)
- Gasifier in operation since 2019



Gasification experiments with mixtures of coal and biomass



23.06.2019 / N. Ullrich



State of the bioliq[®]-Project

Technical details campaign March 2019

- ❑ Test run to determine the the optimum operating point for glycol based Modelslurry
- ❑ Pre tests for the investigation of the catalytic properties of sodium

Technical details campaign May 2019

- ❑ Test run to determine the the optimum operating point for glycol straw coke based Modelslurry under influence of Na-based fluxing agent
- ❑ production of 720l Petrol for reFuels

Technical details campaign Nov 2019 (ongoing)

- ❑ production of Petrol for reFuels
- ❑ Commissioning of an AGAM-System: acoustic gas temperature measurement in the reaction zone

reFuels – Think fuels new

- Provide, test and evaluate reFuels produced by KIT's syngas platform
- Find practicable solution to realize CO₂ reduction by at least 20% by 2030 with drop-in components which are available or can be introduced on short term.
- Assure compatibility to EN228 and EN590 gasoline and diesel standards to serve the whole fleet
- Evaluation of scenarios differing by resource, technology, and products and their integration into the energy system
- Development of a demonstration plant design for refinery integration

EnergyLab2.0



reFuels – fuel pathways

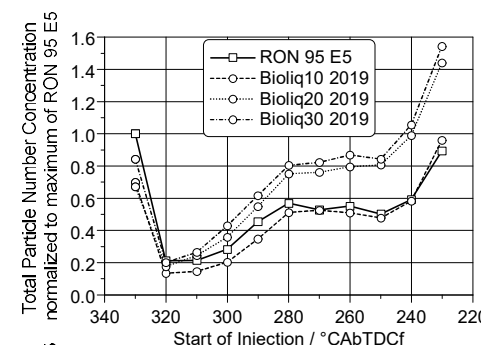


IKFT, ITC)

- Gasoline from BIOLIQ 's methanol-to-gasoline process utilizing biomass as feedstock
 - Drop in aromat-rich distillate (IKFT)
 - Upgraded heavy gasoline fraction (EBI)
- Improved Fischer-Tropsch diesel from INERATEC 's micro-structured reactors from renewable hydrogen and CO₂
- Engine and fleet test with blends
 - Fuel and combustion properties
 - Emission behaviour
 - Dynamic behaviour
 - Component approval



IMVT



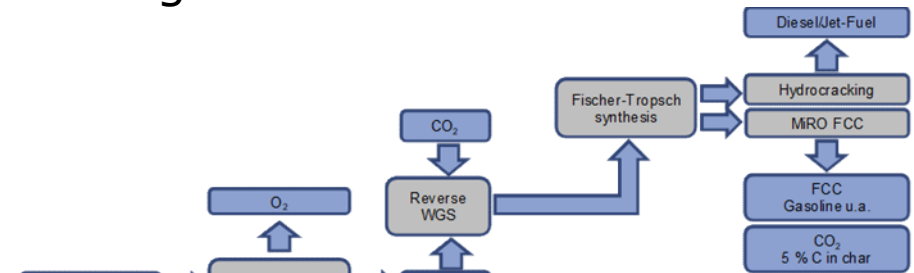
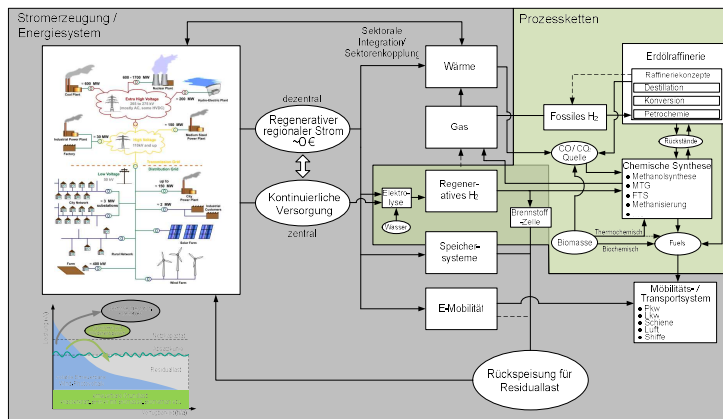
IFKM

Technology scenarios and integration

Techno-economic, life cycle, acceptance analysis of de-centralized, central and other processing scenarios

- Economy of Scale vs. Economy of Numbers
De-centralized and central plant concepts (including logistics)
- Comparison of production in Germany and outside of it
- Increase of carbon efficiency for BtL-processes by additional H₂
- Large scale plant with Direct Air Capture (DAC)
- Consideration of different spatial regimes

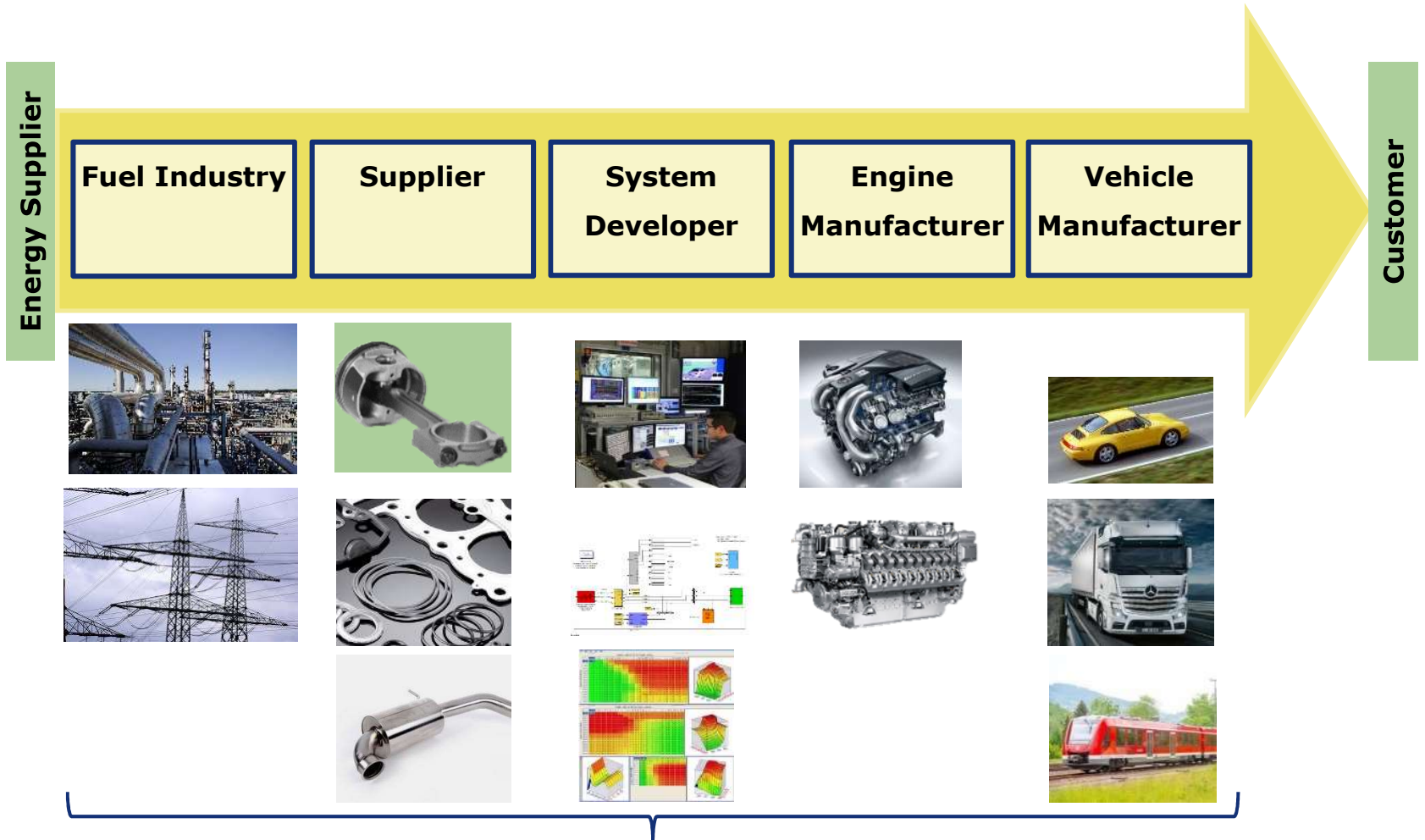
Energy system integration



Demo plant concept in Baden-Württemberg

- Production capacity around 50.000 t/a product
- Use of CO₂ from refinery FCC cracker
- PEM electrolysis for hydrogen supply

Consortium Structure



accompanying Research

IEA Bioenergy

www.ieabioenergy.com

Project Partners



AUDI AG, BorgWarner Inc. Ludwigsburg, Caterpillar Energy Solutions GmbH (MWM), Daimler AG, Eberspächer GmbH & Co. KG, Freudenberg Sealing Technologies GmbH & Co. KG, Ineratec, KS Kolbenschmidt GmbH, Mahle GmbH, Mann + Hummel GmbH, Dr. Ing. h.c. F. Porsche AG, Robert Bosch GmbH, Rolls-Royce Powersystems AG (MTU) Schaeffler, Deutsche Bahn and ENBW AG and MiRO GmbH & Co. KG with support of Mineralölwirtschaftsverband (MWW).

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The End

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