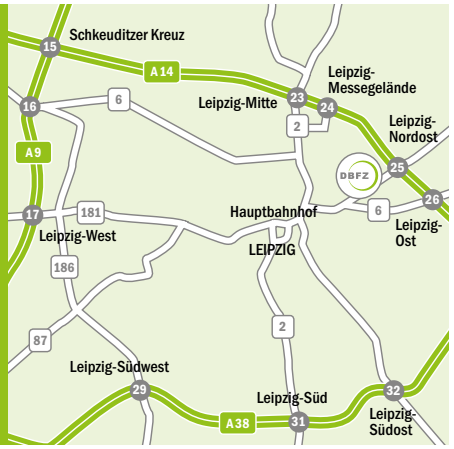
Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ






ANNUAL REPORT 2019



DIRECTIONS

By train: to Leipzig main station. Take tram line 3/3E (towards Taucha/Sommerfeld) as far as the Bautzner Strasse stop. Cross over the road, passing the car park on the right, and turn right through gate number 116, after approximately 100 metres turn left, the DBFZ entrance is 60 metres further along on the left-hand side.

By car: on the A14 motorway. Exit at Leipzig Nord-Ost; follow signs for Taucha; then follow signs for Leipzig; then follow signs for Zentrum, Innenstadt. Turn off left after the "bft" filling station (see "By train" for further directions).

By tram: line 3/3E towards Taucha/Sommerfeld; Bautzner Strasse stop (see "By train" for further directions).

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1 PREFACE BY THE MANAGEMENT

Dear Reader,

In the field of environmental, climate and resource protection, Germany has at times been at the forefront of international comparison and has set new standards. Against the background of the current climate protection debate, the aim is now once again to achieve environmentally compatible development. The establishment of a renewable energy system and a functioning bioeconomy are central elements in this process. As a research institute for the energetic and integrated material use of biomass, it is our declared goal to support the path towards a climate-neutral society with the necessary scientific contributions. Against this background, we are pleased to be a member of the European Energy Research Alliance (EERA) since 2019. One of the aims of the European research alliance is to support joint technology development. In addition to expertise in the field of bioenergy, our membership also complements the EERA portfolio with the “Smart Bioenergy” concept we have developed.

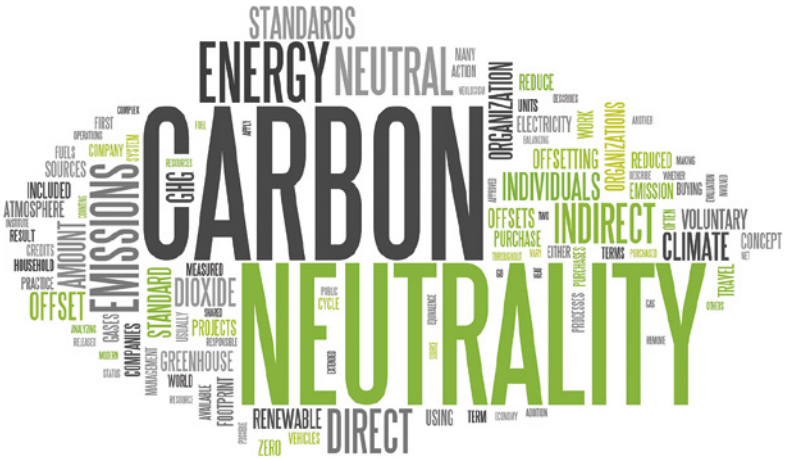
A large number of activities have shaped the past year. One highlight was once again our new building. After moving into the office building, the new technical centre is also scheduled to follow in 2020. We would like to thank the Federal Ministry of Food and Agriculture, which financed the new building with around 67 million euros (including initial equipment). In this context, we had the pleasure of welcoming Minister President Michael Kretschmer and Federal Minister Julia Klöckner at the DBFZ in June. Both showed great interest and enthusiasm for the development of the building and its contents.

In addition to our shareholder, we would also like to thank the Supervisory Board, the Research Advisory Council, the project management agencies and all our project partners. We highly appreciate your intensive cooperation and your valuable input and hope for a good cooperation in 2020!

Prof. Dr. mont. Michael Nelles
Scientific Managing Director

Daniel Mayer
Administrative Managing Director

2
OUR MISSION STATEMENT



Our research is a key to a climate-neutral society by 2050 at the latest, when closed carbon cycles in the bioeconomy will have replaced the fossil economy.

MISSION

- We conduct applied research and development.
- We research and evaluate technologies for the energetic and integrated material use of biogenic resources.
- Our results enable innovations for sustainably established products and services on the market to ensure a rapid transformation into a climate-neutral society.
- Our findings contribute to rural development, which is the starting point for the bioeconomy.
- We are guided by the Sustainable Development Goals (SDG)[1] of the United Nations.
- Our research addresses actors from science, politics, economy and society with regard to bioenergy, bioeconomy and climate-neutral supply systems.
- We network with our partners at home and abroad and share our knowledge with them.

[1] www.un.org/sustainabledevelopment/sustainable-development-goals

PHILOSOPHY

- To fulfil our mission, we are constantly developing our dedicated employees, our interdisciplinary expertise and our outstanding research infrastructure.
- As an independent federal research institution, we provide scientifically sound bases for decision-making and initiate and design research strategies.
- We support young scientists by supervising bachelor, master and doctoral theses.
- Our employees benefit from a broad continuing education programme.
- We support our employees in spin-offs and start-ups.
- We attach great importance to the compatibility of career and family.
- With the aim of continuous improvement, we regularly consult an international research advisory council and a cross-departmental supervisory board from federal and state ministries.
- We constantly optimise our processes with the quality management system ISO 9001 and along the guidelines for ensuring good scientific practice.
- We aim to achieve climate-neutral operations by 2030 at the latest.

(As per March 2020)

3
THE YEAR 2019 IN FIGURES

Approx. **234,000 €**

AVERAGE PROJECT VOLUME
of the projects started in 2019

248

EMPLOYEES
(as per 31 December 2019)

50

FINISHED PROJECTS

37

NEW STARTED PROJECTS
market and third party funding projects

29

EVENTS
(trade fairs, conferences, public events)

131

WORKED PROJECTS

37

VISITORS AT THE DBFZ
(thereof 16 international)

53

PEER REVIEWED PUBLICATIONS
(thereof 26 open access)

4
MODERN HEATING SYSTEMS IN THE CONCERT OF RENEWABLES

The energy transition essentially depends on the success of the heat transition. Today, just under 90% of renewable heat comes from biomass, which covers around 11% of Germany's total heat requirements. Although biomass can be stored, it is a scarce and much sought-after commodity. Against this background, the almost complete energy supply by renewable energies that the EU and Germany are aiming for by 2050 will primarily use ambient heat, waste heat, solar thermal energy and heat from surplus electricity. In addition, efficiency measures will significantly reduce heat requirements (50–60%) and link electricity, heat and mobility more closely. The "SmartBiomassHeat" research focus area focuses on the renewable heat supply in individual buildings, small groups of buildings up to village communities or districts and industrial heating processes, including all renewable energy sources and networking intelligent heating technologies based on biomass, which primarily comes from residual materials, by-products and waste. The overall objective is to develop the supply of all renewable heat sources in a technologically and economically optimal way and to network them with the electricity sector by means of a flexible and demand-oriented use of heat technologies based on biomass.

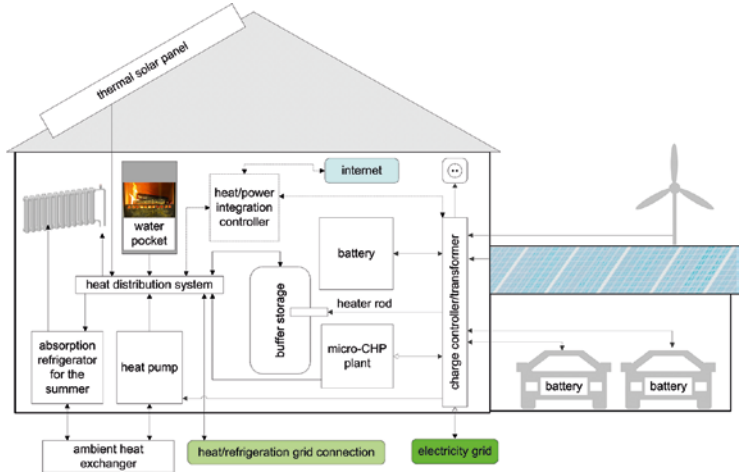


Fig. 1 Example of an integrated solution from different renewable energies

INTERVIEW WITH DR. VOLKER LENZ

Dear Dr. Lenz: Your research focus area at the DBFZ is “SmartBiomassHeat”. What exactly are you working on?

Volker Lenz: In my research focus area we are dealing with the question of how stoves, boilers and small combined heat and power plants for solid biomass such as wood can be optimised and intelligently, i. e. “smartly” integrated into a heat supply based on renewable energies. Due to the increasing coupling of heat and electricity supply, this does not only concern individual devices, but supply networks in interaction with solar energy and wind power. Our aim is to develop a resource-efficient, flexible, regionally adapted, grid-compatible and low-emission bioenergy heat supply, coupled with a grid-compatible electricity supply. Renewable heat requires intelligently used bioenergy to ensure a high level of supply security at low costs, also for the future, which for us means “SmartBiomassHeat”.

What different heat supply systems are you investigating in your work?

Volker Lenz: The devices and concepts for heat supply that we are researching can be roughly divided into three categories. At the first level are simple individual room firing systems, i. e. the classic wood-burning stove, which is usually only operated temporarily, and room heating devices with heat exchangers for heat extraction for room heating or domestic hot water heating. The second category are central heating boilers which are not located in the living space but in a separate boiler room and which are to be increasingly replaced in the future by small and micro-gasification combined heat and power plants. In addition, solutions

Fig. 2 The stoves of the future should be demand-oriented, flexible and networked, i. e. “smart”

for industrial high-temperature heating applications are becoming a third field of application. Each of these systems has its justification, but also very different requirements and specifications.

Against this background, aren’t simple wood-burning stoves rather regressive?

Volker Lenz: Single-room firing systems are still very widespread in Germany, with around 10 million appliances, and are therefore still highly relevant for us and for the research focus area “Catalytic Emission Control”. From an environmental point of view, however, the primary task and challenge is that the appliances must be operated with low emissions and overheating in the rooms, where they are installed, must be avoided.

What distinguishes “smart” small combustion systems from conventional wood-burning stoves?

Volker Lenz: In addition to minimum emissions, two aspects are particularly important to us: in the future, the appliances must also be able to handle increasingly poorer fuels (e. g. in terms of lumpiness and bark content) and must be integrated as optimally as possible into the overall system of heat supply. So the important question is how a furnace can be controlled flexibly and in line with demand, e. g. by connecting a heat compound controller and, where this is not possible, by the option of giving the user feedback on optimum heating times via an app. This requires a multitude of technical developments, which we are researching. (Editor’s note: practical examples of this can be found from page 49 onwards).

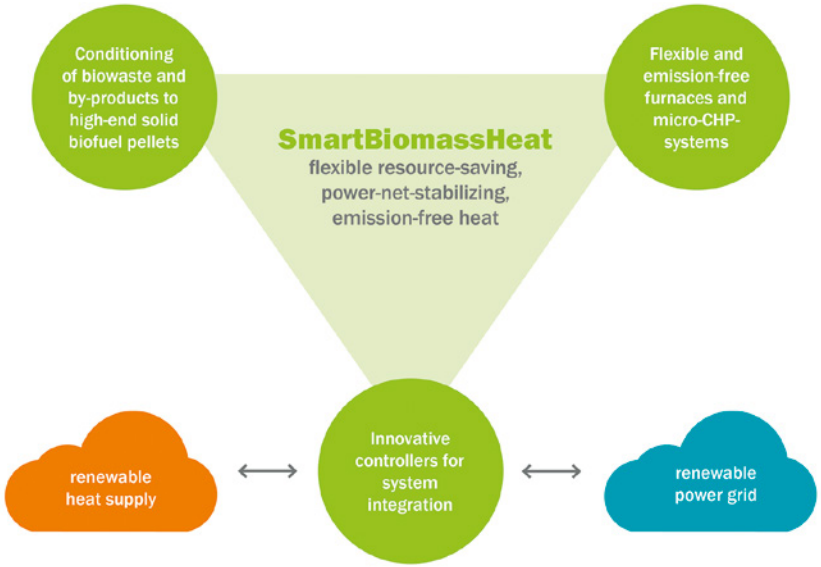


Fig. 3 The SmartBiomassHeat concept of the DBFZ

What does flexibility mean in terms of the heat supply of the future?

Volker Lenz: With the successful implementation of the energy transition, we expect that very soon the largest part of the energy supply will come from the almost unlimited renewable resources wind and solar. However, this means high fluctuations in the energy supply, both in the electricity and the heating sector. Due to a further increasing number of electrically driven heat pumps, the heat supply will be strongly coupled with the electricity sector. For us, this means that heat technologies based on biomass must be operated flexibly and in line with demand in order to be able to close supply gaps in the electricity and heating sectors. This requires, for example, a technological leap in biomass boilers towards highly flexible and grid-compatible combined heat and power plants, even in the small and smallest output range for biogenic solid fuels.

What is the significance of system integration in the heating sector?

Volker Lenz: In the past, we in Germany have designed biomass heating systems purely according to economic aspects and thus with the highest possible number of hours of use. In contrast to that we will have to use the limited biomass, which is in ever-increasing demand, much more intelligently and effectively for the overall system in the future. Energy from wind and photovoltaics will become unbeatably cheap, weather permitting. At other times, however, the question arises: how can the energy supply be secured? In the short term, accumulators (batteries) offer good options here. However, in winter we have the highest heat demand and electrically operated air-to-water heat pumps have the worst working conditions and the highest electricity demand. So, when it comes to storing the solar electricity of the summer for the winter, accumulators are in our opinion rather not well suited. We see solid biomass, as easily storable stored solar energy, as an ideal option here.

To what extent are modern heating systems dependent on an extended digital infrastructure?

Volker Lenz: For successful system integration, we need extensive digitalisation of all components in the energy system. All the different components, such as heat-

ing systems, pumps, energy consumers, energy storage systems, etc., must be recorded using data technology and must be able to communicate with each other as easily as possible. In addition, we need intelligent compound controllers that continuously optimise the operation of all components and adapt them to user requirements. These must also take the overall system into account, so that each individual system can contribute to the stable operation of the overall system. In this context, however, there are also extremely critical challenges in terms of educating users and, above all, heating installers, who are deterred by the increasing complexity. Only digitised expert systems can help here, which collect and process experience and offer it to the decisive players in simple step-by-step advice.

Biogenic residual and waste materials are the focus of bioenergy research: what role do innovative fuels play in the SmartBiomassHeat concept?

Volker Lenz: This is a very important point. The growing world population is reducing the bioenergy potential from energy crops (depending on research and eating habits). Bioenergy should and will then primarily come from residual and waste materials as well as by-products. In concrete terms, this means for us: to an increasing extent, we want to include solid biomasses such as straw, residual forest wood or biochar from hydrothermal carbonisation in the heat supply. We have also already tested the residues from Jordan's olive oil production for energy use. All of these biomasses are, so to speak, constantly available and do not need to be cultivated separately, which is a great advantage. They do, however, in some cases have very different energetic benefits and a different emission and operational risk during combustion, and this must be researched accordingly.

What special treatment processes are required for this type of biomass?

Volker Lenz: In order to make the above-mentioned fuels usable in such a way that they can be used without problems, without risk and in accordance with the applicable certification standard, a large number of raw material and fuel analyses must be carried out beforehand. In addition, we use processing methods such as washing, crushing, pelletizing, torrefaction, and various combustion and gasification tests. Against the background of decreasing heating requirements,

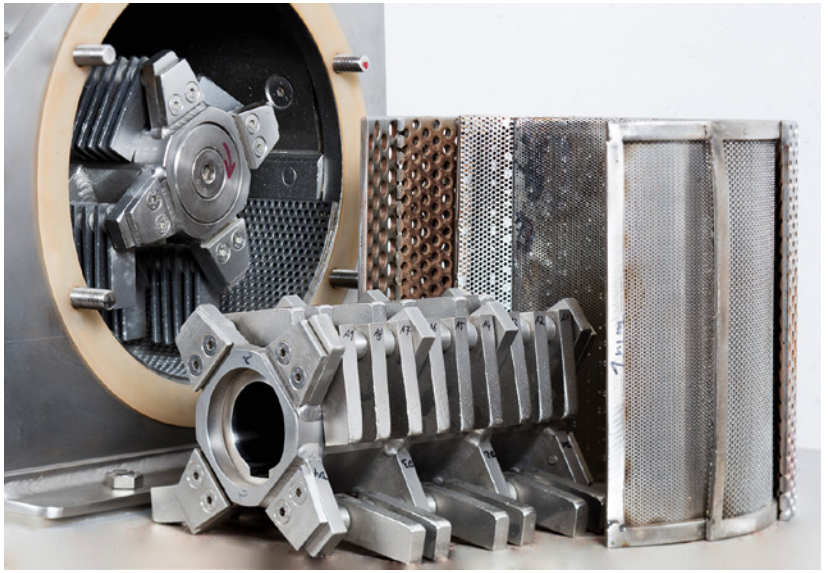


Fig. 4 Preparation technology for solid biomasses in the DBFZ's fuel conditioning lab

for example, the dimensions of the wood pellets currently available on the market with a diameter of six millimetres have to be adapted in order to be able to guarantee low-emission operation of small-scale furnaces in the future as well.

2020 is the science year of the bioeconomy: how can the residues from combustion be fed into another value chain for a biobased economy?

Volker Lenz: A fair bioeconomy means that much more biomass flows into material products, in particular into the chemical industry. In our field, it is particularly carbon-rich residues from fixed-bed gasifiers that could be suitable for activated carbon production, for use in cement production or for soil improvement. The latter point in particular could also provide a certain potential for negative emissions.

In the end, it is the users who decide on the economic success of innovations. Where do you see the greatest opportunities and risks in the market launch of smart biomass systems?

Volker Lenz: Heat supply systems from several different renewable sources connected via intelligent controllers and energy storage systems are more complex and elaborate and thus tend to be more expensive than previous renewable solutions and are still significantly more expensive than gas condensing boilers, for

example. With the exception of a few very convinced wealthy customers, there will therefore only be widespread use if the state intervenes to regulate. In this respect, initial approaches are also emerging for heating solutions with CO_2 pricing and legal requirements, e.g. for a ban on new oil boilers without additional renewable energies. However, these are still far from sufficient to make Germany climate-neutral by 2050. Social movements such as “Fridays for Future” are very important for a general understanding of these issues in order to provide incentives for politicians. In this sense, they have already achieved a surprising amount for many.

Keyword “technology transfer”: what technical or functional adaptations must be made to devices in order to be able to use them in developing and emerging countries?

Volker Lenz: What we are doing in this area primarily is to establish and maintain scientific cooperation. From our point of view, it is essential to ensure good integration into local conditions. This means that intelligent, integrative concepts must be developed in close cooperation with local actors. Only a few core components should be imported from, for example, Germany. The vast majority must be producible and maintainable in the country itself. For this reason, in addition to simplifying the concepts and finding cost-effective solutions, the question of sustainable involvement of local actors is also always important, so that plants can be operated successfully in the long term. At the moment we are trying to establish a self-sufficient water supply for agricultural enterprises in cooperation with the German-Jordanian University (GJU), including the use of agricultural residues.

Thank you for the interview.

In profile:

Dr.-Ing. Volker Lenz studied aerospace engineering at the University of the German Federal Armed Forces in Munich and graduated as Dipl.-Ing. (1994). He was an Air Force officer until 1998. He then completed postgraduate studies in energy economics at the FH Darmstadt, which he successfully completed in 2000 as a Diplom-Energiewirt (FH). After five years as project manager for wind and bioenergy at hessenENERGIE GmbH in Wiesbaden, Volker Lenz was responsible for the fields of “Combustion particles of small-scale biomass combustion plants” and “Concepts for the use of biogenic solid fuels” as project manager for bioenergy systems at the Institute for Energy and Environment (IE) Leipzig until 2008. Since the foundation of the DBFZ in 2008, Volker Lenz has been head of the research department “Thermo-Chemical Conversion” and head of the research focus area “Intelligent Biomass Heating Technologies” (SmartBiomassHeat). In 2011, he successfully completed his doctorate (Dr.-Ing.) on the topic of “Reduction of Fine Dust in the Operation of Log Wood Stoves under Consideration of Toxicological Relevance”.

Further information:
www.smartbiomassheat.com

5 HIGHLIGHTS OF THE RESEARCH FOCUS AREAS

Important research topics of energetic biomass use and integrated material use are dealt at the DBFZ in five main research focus areas. They ensure that essential questions and aspects of bioenergy can be addressed in the depth necessary for excellent research. The focus areas are oriented towards future developments and the research policy challenges and framework conditions of the Federal Government, such as the National Research Strategy BioEconomy 2030, the National Policy Strategy on Bioeconomy, the Federal Government's Mobility and Fuel Strategy or the Biorefineries Roadmap. Other important cornerstones for the scientific orientation of the research focus areas are the funding policy framework conditions, the unique selling points in the research landscape and the DBFZ's good infrastructural facilities.

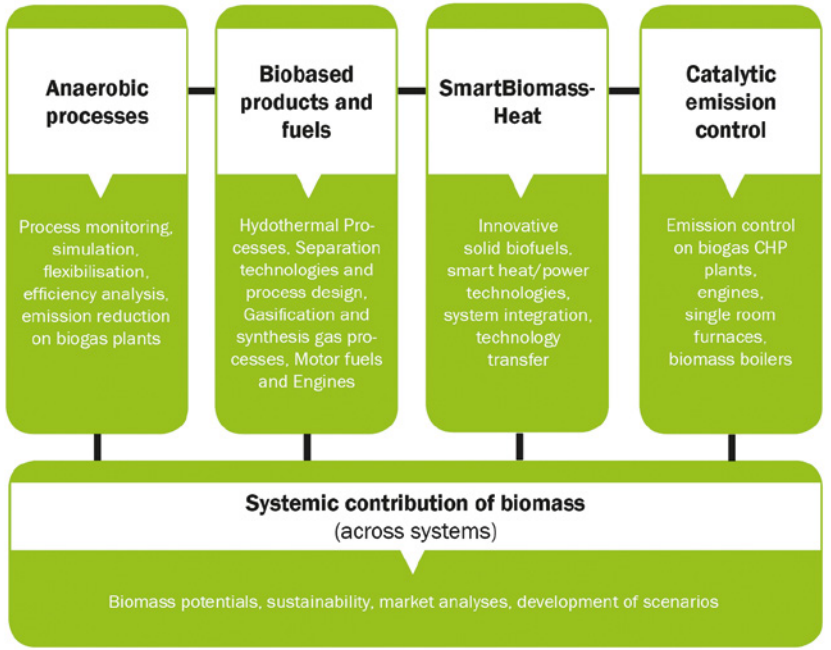


Fig. 5 The five research focus areas of the DBFZ

5.1
SYSTEMIC CONTRIBUTION OF BIOMASS

"SYMOBIO shows possibilities for evaluating the effects of the bioeconomy. In the project, we are investigating concrete tools such as sustainability certification in order to accompany the development of the bioeconomy in the coming years and make it as sustainable as possible."

Stefan Majer, Project Manager

SYMOBIO – SYSTEMIC MONITORING AND MODELLING OF THE BIOECONOMY

The SYMOBIO project is one of three sub-projects for the development of a comprehensive monitoring of the German bioeconomy. While subprojects I & II describe the material flows and quantity structures of the German bioeconomy as well as the economic indicators of the bioeconomy, SYMOBIO (Systemic Monitoring and Modelling of the Bioeconomy) works on modelling and describing the effects and impacts of the German bioeconomy. To this end, key criteria and indicators for the evaluation were first derived and an integrated modelling approach

was developed, with which life cycle assessments can be prepared and the socioeconomic performance of the bioeconomy analysed. In addition, tools to accompany sustainable development, such as the improved use of certification and life cycle analysis (LCA), are being researched. The project is divided into the following six work packages:

I. Development of a framework for systemic monitoring: Expectations of the bioeconomy by politics, business, non-governmental organisations and science are systematised. Important criteria and indicators for assessing the development of the bioeconomy will be identified.
II. Development of a modelling and evaluation system: A system for multi-scale analysis of the bioeconomy and for its evaluation from a sustainability perspective is being developed. Material flow models, input-output databases, econometric models and models for land and water use will be linked. Footprints of agricultural land use, forest, water and greenhouse gas emissions as well as the socioeconomic balance of the bioeconomy will be determined.
III. Analysis of the key drivers for the transformation of the bioeconomy: the factors determining trends will be analysed: agricultural production systems, nutritional patterns, food waste, energetic and material use of biomass, closed-loop and cascade use, and new technologies.
IV. Modelling of trends and their environmental and socioeconomic effects: Past trends and the status quo will be analysed. Counterfactual modelling will be explored to estimate the effects of the bioeconomy. Future development trends and their effects are modelled.
V. Indicators and data from certification and life cycle assessment: the possible uses and expansion options for the data and indicators collected in certification procedures and product life cycle assessment for monitoring purposes will be examined.
VI. Development of a monitoring system: A prototypical monitoring report on the bioeconomy in Germany will be prepared and an interactive website for the exploration of data and characteristics of the bioeconomy will be developed. Remote sensing methods will be tested in Germany and abroad to map land use changes and impacts on biodiversity and make them usable for monitoring and certification.

METHODS

In SYMOBIO, the DBFZ is responsible for identifying interfaces between the sustainability certification of biobased products and the monitoring of the effects of the bioeconomy. An approach was developed to combine methods from the global assessment of the effects of the bioeconomy, via the modelling of global footprints (e. g. for water consumption, land use, GHG emissions, etc.) with the actual sustainability certification of real farms. In this way, conclusions can be derived for improving certification (e. g. adjusting audit intensities due to risks).
To this end, the first step was a comprehensive review of the status quo of sustainability certification of the bioeconomy. A total of about 50 certification systems were examined in more detail regarding the sustainability criteria and indicators as well as the underlying methods. The results of this stocktaking were compared with the target figures of the bioeconomy monitoring. These target figures were defined within the framework of SYMOBIO by the project partners of the University of Kassel and the Helmholtz Centre for Environmental Research – UFZ, taking into account the priorities of various stakeholders.
The result shows a strong agreement between the selected target values and the criteria and indicators already contained in existing certification systems. This

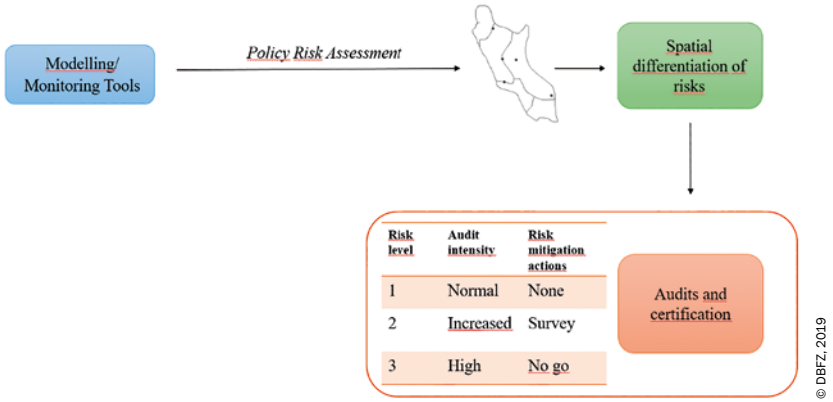


Fig. 6 Combination of global risk modelling with the sustainability certification of actual operations

means that sustainability certification seems to be a suitable instrument to accompany the development of a sustainable bioeconomy. In addition, data sets from certification processes could also support the modelling of the bioeconomy and its monitoring.
On the other hand, it was investigated how sustainable production practices could be implemented in farms through certification. One of the key questions is how to deal with the import of products from regions where unsustainable production conditions are found on a large scale. Examples could be deforestation to create agricultural land or intensive agricultural production in regions with water stress. SYMOBIO pursues the idea of identifying such regions by modelling global risks and then showing possibilities of how farms in the respective regions can enter into sustainable production conditions. This was investigated by the DBFZ using the example of the water footprint of palm oil production. In order to investigate the possibility of a greater overlap between global risk modelling and certification processes, a comprehensive catalogue of measures was drawn up to reduce the effects of biomass production in relation to various footprints (e. g. water footprint, GHG footprint, etc.). By means of a questionnaire, operators of palm oil plantations and mills were then asked about the feasibility of these practices and their effect on their production processes. The result was a set of recommendations for the implementation of sustainable practices, which can be used in future certification approaches.

PERSPECTIVES

The SYMOBIO project will be completed in spring 2020. The results, especially the developed catalogues of measures for the improvement of production practices, can be used and are to be further implemented in practice within the framework of follow-up projects. To this end, it is necessary to implement the measures developed together with risk assessment instruments in the system bases for certification systems. If possible, this should be demonstrated in a pilot project.

Further information:
www.symobio.de/en

Project summary

Duration:	01.03.2017–29.02.2020
Project partners:	University of Kassel; Helmholtz Centre for Environmental Research; Gesellschaft für wirtschaftliche Strukturforschung mgH (GWS); Öko-Institut; Information Systems for Resources (INFRO); Meo Carbon Solutions (MEO); Institute for Energy and Environment (IFEU)
Scientific contact:	Josephin Helka
Project number:	031B0281C
Funding body:	Federal Ministry of Education and Research/ Project Management Jülich

SPONSORED BY THE

Federal Ministry of Education and Research

Projektträger Jülich Forschungszentrum Jülich

THE RESEARCH FOCUS AREA "SYSTEM CONTRIBUTION OF BIOMASS"

The research focus area is intended to contribute to the development of sustainable bioenergy strategies at national and international level. For this purpose, regionally and globally available biomass potentials are determined and the various options of different biomass utilisation concepts are considered and evaluated. The overriding aim is to answer methodological and systems engineering questions on the efficiency and sustainability of biomass use from an economic, environmental and technical point of view, taking into account both the land resources used and the processing and conversion technologies specific to the energy source. The combination of these topics provides the basis for the derivation of strategies and recommendations for action for decision makers in politics and industry.

Important reference projects and publications

Project: BE20PLUS – BIO E Bioenergie: Potenziale, Langfristperspektiven und Strategien für Anlagen zur Stromerzeugung nach 2020, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.11.2017–31.10.2019 (FKZ: 22404016)

Project: BECOOL – Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels, EU/Horizon2020, 01.06.2017–31.05.2021 (GA 744821)

Project: BKSQuote – Untersuchungen zur Ausgestaltung der Biokraftstoffgesetzgebung, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.06.2016–31.03.2019 (FKZ: 22401416)

Project: HyFlexFuel – Hydrothermal liquefaction: Enhanced performance and feedstock flexibility for efficient biofuel production, EU/Horizon2020, 01.10.2017–30.09.2020 (GA 764734)

Project: POWER4BIO – emPOWERing regional stakeholders for realising the full potential of European BIOeconomy, EU/Horizon2020, 01.10.2018–31.03.2021 (GA 818351)

Publication: Brosowski, A.; Krause, T.; Mantau, U.; Mahro, B.; Noke, A.; Richter, F.; Raussen, T.; Bischof, R.; Hering, T.; Blanke, C.; Müller, P.; Thrän, D. (2019). "How to measure the impact of biogenic residues, wastes and by-products: Development of a national resource monitoring based on the example of Germany". Biomass and Bioenergy (ISSN: 0961-9534), H. 127. DOI: 10.1016/j.biombioe.2019.105275.

Publication: Klepper, G.; Thrän, D.; Cramon-Taubadel, S. v.; Dahmen, M.; Erb, K.; Geden, O.; Haberl, H.; Hirschl, B.; Heinbach, K.; Krautkremer, B.; Liebscher, A.; Sauer, J.; Schulze, E.-D.; Schweizer-Ries, P.; Rau, I.; Strefler, J.; Baur, F.; Erlach, B.; Hennig, C.; Schünemann, F. (2019). Biomasse im Spannungsfeld zwischen Energie-und Klimapolitik: Strategien für eine nachhaltige Bioenergienutzung. Stellungnahme. (Publication series "Energiesysteme der Zukunft"). München et al.: Acatech et al. 105 S. ISBN: 978-3-8047-3917-8.

Publication: Klepper, G.; Thrän, D. (Ed.) (2019). Klepper, G.; Thrän, D.; Cramon-Taubadel, S. von; Dahmen, N.; Erb, K.; Geden, O.; Haberl, H.; Hirschl, B.; Heinbach; Katharina; Krautkremer, B.; Liebscher; Axel; Sauer, J.; Schulze, E.-D.; Schweizer-Ries, P.; Rau, I.; Hildebrandt, J.; Strefler, J.; Baur, F.; Nelles, M.; Erlach, B.; Hennig, C.; Schünemann, F. Biomasse im Spannungsfeld zwischen Energie- und Klimapolitik: Potenziale – Technologien – Zielkonflikte. Analyse. (Publication series "Energiesysteme der Zukunft"). München et al.: Acatech et al. 112 S. ISBN: 978-3-9820053-0-0.

Publication: Majer, S.; Thrän, D.; Brosowski, A. (2019). Removal of Agricultural Residues from Conventional Cropping Systems. In: Schröter, M.; Bonn, A.; Klotz, S.; Seppelt, R.; Baessler, Cornelia (Ed.) Atlas of ecosystem services: Drivers, risks, and societal responses. Cham (Schweiz): Springer. ISBN: 978-3-319-96228-3. S. 263–269. DOI: 10.1007/978-3-319-96229-0_41.

Publication: Szarka, N.; Lenz, V.; Thrän, D. (2019). "The crucial role of biomass-based heat in a climate-friendly Germany–A scenario analysis". Energy (ISSN: 0360-5442), Vol. 186. DOI: 10.1016/j.energy.2019.115859.

5

Head of the research focus area

Prof. Dr.-Ing. Daniela Thrän
Phone: +49 (0)341 2434-435
E-Mail: daniela.thraen@dbfz.de

5.2
ANAEROBIC PROCESSES

"EvEmBi makes an important contribution to the estimation and recording of emissions in the biogas sector in Germany, Austria, Switzerland, Sweden and Denmark. The different types of biogas plants, e. g. agricultural plants or waste plants, are assessed in the individual countries with regard to their methane emissions. In a second step, concrete solutions for the reduction of methane emissions from biogas plants will be developed and implemented."

Dr. rer. nat. Tina Clauß, Project Manager

EVEMBI – EVALUATION AND REDUCTION OF METHANE EMISSIONS FROM DIFFERENT EUROPEAN BIOGAS PLANT CONCEPTS

The use of biogas as an energy source makes an important contribution to replacing fossil fuels and thus saving greenhouse gas emissions. However, these positive effects are also largely dependent on how much methane a biogas plant emits. In order to contribute to climate protection, methane emissions during operation of a biogas plant must be kept as low as possible, as methane is a very effective greenhouse gas (greenhouse gas potential over 100 years compared to CO_2 is 28 according to IPCC [1]).

In the United Nations Framework Convention on Climate Change, regular emissions reporting by individual countries has been agreed upon. Up to now, standard values for biogas plants have been assumed here. A more precise quantification

Fig. 7 Emission measurements at a biogas plant using the remote measurement method (l.) and on-site method (r.)

of emissions from this sector could therefore also be of great interest here in order to assess the emissions of the total stock.
In addition, it is important to estimate the total methane emissions from the biogas sector and the individual technologies in order to get an overview of the contribution biogas can make to climate protection and where it can be used to implement climate-friendly energy concepts. A recording of the total emissions can also help to develop and establish measures to reduce emissions.
On the one hand, it is therefore important to identify low-emission plant concepts in order to establish them as technical standards in the future. On the other hand, emissions at existing plants should be minimised as far as possible, which can be achieved by appropriate emission reduction measures. There are both technical (e. g. covering open storage facilities) and organisational measures, i. e. changes in operating procedures, such as regular leak detection, which can lead to success. Secondary measures, such as appropriate knowledge transfer, can also achieve a sustainable reduction of methane emissions in the biogas plant sector.
The EvEmBi research project therefore aims to record the emissions of various plant components and use this data to develop a model that can be used to estimate the emissions of the various plant concepts or the entire plant stock. For this purpose, both survey and measurement data will be collected in the project and incorporated into the model. EvEmBi should also contribute to reduce actual

methane emissions from biogas plants and to develop concrete measures that lead to a reduction of methane emissions in the biogas sector. This includes the implementation of mitigation measures at selected biogas plants, an assessment of the costs and benefits of different mitigation measures, the publication of national and European position papers, the organisation of training courses and workshops on this topic and the development of voluntary operator initiatives in the partner countries.

METHODS/MEASURES

Within the framework of EvEmBi, methane emission measurements are carried out at different types of plants in the individual partner countries. Methane emissions at individual emission sources are determined using on-site measuring methods, and total emissions are determined using remote measuring methods at the individual plants. A detailed description of the measurement methods used can be found in [2].
The methane emissions at these installations can thus be determined and evaluated. It will also be examined whether it is possible to implement concrete reduction measures at the installations investigated. This could be, for example, the covering of an open storage facility, the repair of major leaks or a change in gas management. These measures will be implemented. Subsequently, in a second measuring phase, it is examined whether emission reductions could be achieved by these measures.
Cost-benefit considerations for the individual mitigation measures are to be derived from the experiences of the measurement phases and from the experiences of the project consortium. Furthermore, data from the measurement phases, from previous research projects, from third parties (e. g. service providers) and from operator surveys will be collected in order to feed them into an emission quantification model. The individual steps in this model have already been developed and are shown in Figure 9. The schematic diagram also shows the results obtained from the emission quantification model. On the one hand, the model is intended to quantify the emissions of the plant stock, and on the other hand, the various plant concepts are to be evaluated with regard to their emissions. Furthermore,

with the model, it is possible to evaluate concrete measured installations and to classify how their emissions compare to other installations of the same type. From this, it can be deduced whether further emission reductions can be implemented at this installation, if necessary.
A further goal is the transfer of knowledge into practice on the subject of emissions at biogas plants. This is to be achieved by means of position papers, which are published in the individual countries on the one hand, but also for Europe via the European Biogas Association (EBA). These papers should make clear how important it is to keep methane emissions from biogas plants low and which reduction measures are possible here. The knowledge will also be passed on in operator training courses, workshops and a webinar. The training courses will be carried out in the individual partner countries and in the European context via the EBA. A first European workshop on emissions from biogas plants was held in Brussels on 29 January 2020.
Within the project, additional concepts for voluntary operator initiatives will be developed and their implementation in the individual countries will be examined with the help of the associations involved in the project. Here the partners can benefit significantly from the experience of the Swedish and Danish project partners, as voluntary operator initiatives have already been implemented in these countries and have been successfully applied for several years.

Fig. 8 DBFZ Report No. 33 "Recommendations for reliable methane emission rate quantification at biogas plants"

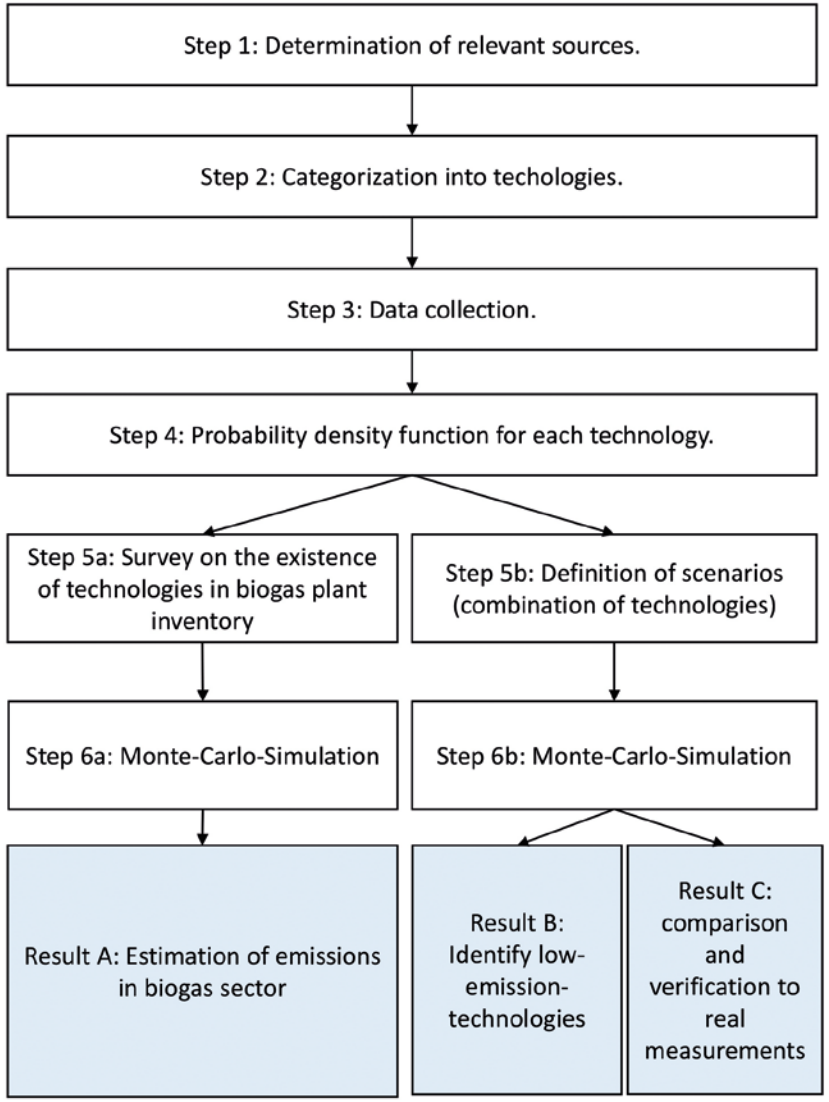


Fig. 9 Schematic representation of the emission quantification model

MILESTONES/CHALLENGES

In the project, measurements have already been carried out on different plant concepts (in Germany on twelve agricultural plants of different sizes) and the component and total methane emissions of the plants were determined. Several reduction measures have already been implemented at the plants investigated.
A challenge is to identify and implement further emission reduction strategies at the investigated plants and to prove the reduction in a second measuring phase. A cost-benefit analysis of individual reduction measures is to be developed in the project and represents a milestone in the project.
A major result of this research project is the emission quantification model, which allows to estimate the emissions of different biogas plant concepts. The model also allows the estimation of the total methane emissions of the biogas plant stock. Furthermore, the model allows the measured emissions at real plants to be classified and conclusions to be drawn about reduction strategies at these plants. Additional milestones are the implementation of operator training and workshops, the organisation of a webinar and the publication of national position papers to disseminate knowledge on methane emissions and possible reduction measures. A voluntary operator initiative will be tested and developed within the project in Germany, Austria and Switzerland. A European recommendation by EBA on such an operator initiative will also be published.

PERSPECTIVES

The project provides a model, which estimates the emissions of the biogas plant stock. This provides a much better understanding of emissions in the biogas sector and can contribute to the long-term reduction of emissions. The data and the model acquired in the project can be used and further developed after the project term to calculate national emission factors for the biogas plant stock. The model will be used to identify low-emission technologies. This knowledge can contribute to sustainable emission reduction in the biogas sector.
On the one hand, the identification of suitable reduction measures at the investigated plants leads to concrete emission reductions at these plants and thus also

in the existing stock. On the other hand, the knowledge generated in the project can contribute to a lower-emission operation of the entire stock. For example, the transfer of the knowledge gained in the project in the form of operator training and position papers can have a sustainable effect on the reduction of methane emissions by informing operators on how to keep emissions as low as possible during operation of the biogas plant through appropriate operational management. The developed concepts for the implementation of a voluntary operator initiative to reduce methane emissions in the biogas sector can be established after the project and thus lead to a sustainable reduction of methane emissions in the biogas sector.

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[2.] Clauß, T.; Reinelt, T.; Liebetrau, J.; Vesenmaier, A.; Reiser, M.; Flandorfer, C.; Stenzel, S.; Piringer, M.; Fredenslund, A. M.; Scheutz, C.; Hrad, M.; Ottner, R.; Huber-Humer, M.; Innocenti, F.; Holmgren, M. A.; Yngvesson, J. (2019). *Recommendations for reliable methane emission rate quantification at biogas plants*. [online]. (DBFZ-Report, 33). Leipzig: DBFZ. XII, 103 S. ISBN: 978-3-946629-43-6. Available online at: www.dbfz.de/index.php?id=837

Project summary

Duration:	01.04.2018–31.03.2021
Project partner:	University of Stuttgart; Fachverband Biogas e.V.; University of Natural Resources and Applied Life Sciences Vienna; BEST Bioenergy and Sustainable Technologies GmbH; Abwasser und Abfalltechnik GmbH; Kompost & Biogas Verband Österreich; Ökostrom Schweiz; Bern University of Applied Sciences; Oester Messtechnik GmbH; Research Institutes of Sweden; Avfall Sverige; Svenskt Vatten; Technical University of Denmark
Scientific contact:	Dr. rer. nat. Tina Clauß
Project number:	22407917
Funding body:	Funding via 11th ERA-NET Bioenergy call; Federal Ministry of Food and Agriculture/ Agency for Renewable Resources e.V. (FNR)

With support from

ERA-NET Bioenergy

Federal Ministry of Food and Agriculture

FNR

by decision of the German Bundestag

THE RESEARCH FOCUS AREA “ANAEROBIC PROCESSES”

Processes for the conversion of biomass by microorganisms under anaerobic conditions are the basis of a large number of biotechnological processes for the provision of energy sources and materials. In the “Anaerobic Processes” research focus area, efficient and flexible processes for biogas production are developed to meet the requirements of the future energy system. Coupling these processes with processes for material utilisation leads to a higher added value. The research focus area develops tools for process monitoring and control, concepts for flexible, low-emission plants and operating regimes, methods for evaluating and optimising efficiency and processes for maximising material conversion, especially for difficult substrates.

Important reference projects and publications

Project: PaplGas – Biomethan und Torfersatzstoff aus Pappelholz, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.04.2019–31.03.2021 (FKZ: 22038318)

Project: NovoHTK – Neuartiges Verfahren zur Mono-Vergärung von Hühnertrockenkot, Federal Ministry for Economic Affairs and Energy/Project Management Jülich, 01.09.2018–31.08.2021 (FKZ: 03KB137A)

Project: Nred – Verstärkte energetische Nutzung stickstoffreicher landwirtschaftlicher Abfallstoffe durch biologische Stickstoffreduzierung; Teilvorhaben 1: Verfahrensentwicklung im Labormaßstab, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.11.2019–31.10.2022 (FKZ: 22042118)

Project: SIAAP – Klärschlamm und Abfall Paris, Marktprojekt, 01.01.2018–31.12.2019

Publication: Hofmann, Josephine; Müller, Liane; Weinrich, Sören; Debeer, Lies; Schumacher, Britt; Velghe, Filip; Liebetrau, Jan (2020): Assessing the Effects of Substrate Disintegration on Methane Yield. In: Chemical Engineering & Technology 43 (1), S. 47–58. DOI: 10.1002/ceat.201900393.

Publication: O’Keeffe, Sinéad; Franko, Uwe; Oehmichen, Katja; Daniel-Gromke, Jaqueline; Thrän, Daniela (2019): Give them credit. The greenhouse gas performance of regional biogas systems. In: GCB Bioenergy 11 (6), S. 791–808. DOI: 10.1111/gcbb.12603.

Publication: Reinelt, Torsten; Liebetrau, Jan (2020): Monitoring and Mitigation of Methane Emissions from Pressure Relief Valves of a Biogas Plant. In: Chemical Engineering & Technology 43 (1), S. 7–18. DOI: 10.1002/ceat.201900180.

Publication: Wedwitschka, Harald; Gallegos, Daniela; Tietze, Michael; Reinhold, Jürgen; Jenson, Earl; Liebetrau, Jan; Nelles, Michael (2020): Effect of Substrate Characteristics and Process Fluid Percolation on Dry Anaerobic Digestion Processes. In: Chemical Engineering & Technology 43 (1), S. 59–67. DOI: 10.1002/ceat.201900404

Publication: Weinrich, Sören; Koch, Sabine; Bonk, Fabian; Popp, Denny; Benndorf, Dirk; Klamt, Steffen; Centler, Florian (2019): Augmenting Biogas Process Modeling by Resolving Intracellular Metabolic Activity. In: Frontiers in Microbiology 10. DOI: 10.3389/fmicb.2019.01095.

Head of the research focus area

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5.3
BIOBASED PRODUCTS AND FUELS

"The primary objective of the DEMO-SPK project was to investigate and verify the behaviour of mixtures of several renewable kerosene with fossil JET A-1 under realistic conditions in the supply infrastructure of a major airport. Among other things, it could be shown that the use of Multiblend JET A-1 not only reduces greenhouse gas emissions but also local emissions measurably and significantly."

Dr.-Ing. Franziska Müller-Langer, Project Coordinator

DEMO-SPK – RESEARCH AND DEMONSTRATION PROJECT: USE OF RENEWABLE KEROSENE AT LEIPZIG/HALLE AIRPORT

In the Mobility and Fuel Strategy (MKS), the need to reduce and avoid emissions is laid down for German aviation. In addition to technical and operational measures to reduce emissions, the focus is on the substitution of conventional fossil aircraft fuel with renewable aircraft fuels (so-called synthetic kerosene, SPK). For this purpose, new manufacturing processes specified in an international ASTM standard are used instead of conventional oil treatment and processing. Since, depending on the process, the composition of SPK can differ from that of conventional fossil kerosene, the marketing of SPK is subject to conditions. For example, SPKs may not be placed on the market in their pure form at present, but must first be blended with JET A-1 petroleum-based kerosene (so-called "blending").

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Fig. 10 The DEMO-SPK project is testing renewable kerosene at a major airport

Today, various SPK production processes have already been approved in accordance with ASTM (e.g. HEFA-SPK, ATJ-SPK, FT-SPK, SIP); others (e.g. HFP-HEFA) are in the approval process. In the medium term, it is expected that airports in Germany will be supplied with kerosene, which also contains SPK of various types in variable proportions. As individual kerosene batches of different origins are usually transported and stored together within an airport's supply infrastructure, there is no physical separation of the batches delivered, which inevitably leads to mixing. Since only JET A-1 that conforms to specifications may be used, this is formally permissible. However, the mixing behaviour and compatibility of JET A-1 blends containing different SPK in variable proportions ("multi-blending") has not yet been investigated in Germany or internationally. A multiblend JET A-1 is a mixture ("blend") of conventional fossil JET A-1 according to ASTM D1655 and at least two other ("multi") renewable kerosene according to ASTM D7566.
The primary objective was to investigate and verify the behaviour of mixtures of several renewable kerosene under realistic conditions at a major airport. To this end, the aim was to successfully demonstrate for the first time internationally the

use of Multiblend JET A-1 in the general fuel supply infrastructure, i. e. from procurement to in-flight refuelling. In addition to analyses of the kerosene properties, emission measurements, life-cycle analyses, practicable sustainability documentation and studies on the verification and crediting of renewable fuels in the European emissions trading system were also carried out. In addition, legal issues had to be clarified and organisational framework conditions created.

METHODS/MEASURES

DEMO-SPK comprised three main pillars:

- Preliminary investigations on different compositions of Multiblend JET A-1 and on storage behaviour over a longer period of time with corresponding accompanying analysis. In addition, the preparation of PTL-SPK was carried out.
- Demonstration of the production of Multiblend JET A-1, its provision via the existing supply infrastructure of an airport as well as further handling with regard to refuelling in aircraft, similar to fossil JET A-1. In addition, comparative emission measurements were carried out on an aircraft turbine in ground run with Multiblend JET A-1 and JET A-1.
- Furthermore, life cycle analyses, practicable sustainability documentations as well as studies on the verification and crediting of renewable fuels in the European emissions trading system were carried out. In addition, legal issues had to be clarified and organisational framework conditions created.

MILESTONES/CHALLENGES

Thanks to the commitment of the project partners, the procurement of renewable kerosene, its blending with fossil JET A-1 to form Multiblend JET A-1, as well as its provision and use in the fuel infrastructure of a major airport could be successfully demonstrated. Almost 600 tons of Multiblend JET A-1 were provided and flown. The demonstration also included comparative measurements of pollutant emissions in an engine test stand with an A300-600 (cargo version). Two successive

Fig. 11 The DEMO-SPK team at the aireg conference (October 17–18, 2019)

ground runs were carried out according to a defined measurement protocol, whereby first a reference measurement with a fossil JET A-1 and then a measurement with the Multiblend JET A-1 was performed. The expected soot reduction could be proven by using the Multiblend JET A-1; this was approx. 30 to 60 % for different operating points in relation to the particle mass.
Since the majority of GHG emissions are caused by the combustion of fossil kerosene, the fossil part in the multi-blend JET A-1 can be identified as the main driver of total GHG emissions. Multiblend JET A-1 thus has the lowest GHG emissions with the highest share of renewable kerosene and the highest GHG savings of 35 % compared to fossil JET A-1.
The dedicated cost considerations for renewable kerosene confirm that, in the future, even large-scale production of renewable kerosene alone will not be sufficient to bring costs closer to conventional kerosene costs. The same applies to the life cycle costs of the Multiblend JET A-1, which were examined in the different supply chains.
Various sustainability frameworks and certification systems have been established for biofuels in recent years. These systems differ, in some cases significantly, in terms of the criteria they contain and their target markets. Within the DEMO-SPK framework, the sustainability documentation could be traced as the basis for a comprehensive sustainability certification for all investigated alternative aircraft fuels. Sustainability certification from existing systems and structures can thus also be presented for renewable kerosene and does not represent a fundamental obstacle to its market implementation. The work in DEMO-SPK also

shows that the sustainability requirements and standards differ significantly on a global scale.

PTL is regarded as an important renewable kerosene for the aviation of the future and has already been approved in principle in ASTM via the Fischer-Tropsch synthesis route. The proof that intermediates from the Fischer-Tropsch synthesis of CO_2 and electrolytically produced hydrogen from renewable electricity can be processed to FT-SPK on a pilot plant scale could be provided for the first time in DEMO-SPK.

PERSPECTIVES

From the experiences of the model project not only numerous hints for the operative project management can be derived, but also concrete need for clarification, which is important for a successful broader market implementation. These include (i) the extension of ASTM D7566 by the option of simultaneous, i. e. simultaneous production of Multiblend JET A-1, (ii) the simplified REACH registration for renewable kerosene and (iii) the addition in the Energy Tax Act on the so-called similarity principle according to section 2, paragraph 4 EnergieStG (German Energy Tax Act). In addition, specific recommendations for the international institutions (ASTM, JIG, ETS, etc.) were derived and transmitted to them for consideration in the further development of the respective specifications and guidelines. Thus, DEMO-SPK has an effect beyond the actual project and provides recommendations to facilitate the operational handling of renewable kerosene as part of multiblended kerosene on an international level and thus to enable market implementation.

Notwithstanding the successful investigations in the DEMO-SPK model project, the fact remains that, in addition to the above-mentioned recommendations for a broad market implementation of renewable kerosene, a massive expansion of production capacities as well as the expansion of infrastructural conditions (e. g. for the production of Multiblend JET A-1) is required.

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Further information:
www.dbfz.de/en/demo-spk (german language)

The research and demonstration project on the use of renewable kerosene at Leipzig/Halle Airport (DEMO-SPK for short) was initiated as a model project of the Mobility and Fuel Strategy (MKS) and financed by the Federal Ministry of Transport and Digital Infrastructure (BMVI).

www.mks-dialog.de

Supported by:
Federal Ministry of Transport and Digital Infrastructure
on the basic of a decision by the German Bundestag

Project summary

Duration:	04.11.2016–30.06.2020
Project partner:	More than 20 international partners, e. g. Adeptus Green Management GmbH; aireg e.V.; ASG Analytik-Service GmbH; BP Europa SE; DHL/European Air Transport Leipzig GmbH; Dettmer Rail GmbH; Deutsches Zentrum für Luft und Raumfahrt (DLR) e.V.; GEVO Inc.; IFOK GmbH; knoell Germany GmbH; Meo Carbon Solutions GmbH; Neste Corporation; Petro Lab GmbH; Sunfire GmbH; Tanquid GmbH & Co. KG; TOTAL S.A.; Technical University Bergakademie Freiberg; Technical University Hamburg; Varo Energy; VTG AG; Wehrwissenschaftliches Institut für Werk- und Betriebsstoffe (WIWeB); World Energy LLC.
Scientific contact:	Dr.-Ing. Franziska Müller-Langer, Stefan Majer
Funding body:	Federal Ministry of Transport and Digital Infrastructure (BMVI)

RESEARCH FOCUS AREA "BIOBASED PRODUCTS AND FUELS"

The research focus area is an important part of the overall process chains from the raw material biomass to biofuels and chemical bioenergy carriers as products of biorefineries. In addition to process and concept development, it also includes implementation on laboratory and pilot plant scale as well as technology evaluation. The overarching goal is to contribute to flexible, highly efficient and sustainable biorefinery concepts with innovative technological approaches, thereby also taking into account the requirements in the context of the bioeconomy. To this end, chemical refining processes are being further developed with a focus on hydrothermal processes (HTP). The development of fractionation processes for solid-liquid and liquid-liquid separation plays an important role as a link between the individual research priorities (especially in connection with anaerobic processes and HTP intermediates). A further component is the development of synthesis gas processes for the production of high-quality products, with the focus on biomethane in the form of Bio-Synthetic Natural Gas (Bio-SNG). In the short term, an exemplary HTP-based biorefinery concept will be developed. To this end, the work in the research focus area concentrates on (i) the analysis of relevant individual processes and necessary system components, (ii) preliminary tests for selected individual processes (e. g. HTP, gasification, methanisation to SNG) and (iii) the preparation of an accompanying technology assessment (focus: material and energy balance, costs and economic efficiency, environmental effects).

Important reference projects and publications

Project: abonoCARE – Wachstumskern – abonoCARE – VP2: Schadstoffreduzierung und Phosphoranreicherung in Düngervorprodukten; TP 2.5: HTC-Phosphorabscheidung/Trocknung HTC-Kohle, Federal Ministry of Education and Research/Project Management Jülich, 01.04.2019–31.03.2022 (FKZ: 031B0139A)

Project: BioFit – Bioenergy retrofits for Europe's industry, EU/Horizon2020, 01.01.2019–31.12.2021 (GA 817999)

Project: Fermenthen – Alkenproduktion aus Biogas zur Nutzung von Überschussstrom, Sächsische Aufbaubank, 01.10.2016–31.03.2020 (FKZ: 100244827)

Project: HTC-liq – Entwicklung eines hocheffizienten Kaskadenprozesses zur Aufbereitung von Prozesswässern aus hydrothermalen Prozessen, insbesondere der hydrothermalen Carbonisierung mit Gewinnung von organischen Säuren, anschließender energetischer Nutzung und Prozesswassserreinigung, Sächsische Aufbaubank, 01.04.2017-31.12.2020 (FKZ: 100283029)

Project: Pilot-SBG – Forschungs- und Demonstra-

tionsvorhaben Bioressourcen und Wasserstoff zu Methan als Kraftstoff – Konzeptionierung und Realisierung einer Anlage im Pilotmaßstab, Federal Ministry of Transport and Digital Infrastructure (Inhouse), 01.09.2018–31.12.2021

Publication: Naumann, K.; Schröder, J.; Müller-Langer, F.; Oehmichen, K.; Remmele, E.; Thuneke, K.; Etzold, H.; Raksha, T.; Schmidt, P. (2019). Monitoring Biokraftstoffsektor. 4. Aufl. (DBFZ-Report, 11). Leipzig: DBFZ. ISBN: 978-3-946629-36-8.

Publication: Nitzsche, R.; Gröngröft, A.; Kraume, M. (2019). "Separation of lignin from beech wood hydrolysate using polymeric resins and zeolites: Determination and application of adsorption isotherms". Separation and Purification Technology (ISSN: 1383-5866), Vol. 209. S. 491–502. DOI: 10.1016/j.seppur.2018.07.077.

Publication: Köchermann, J.; Schreiber, J.; Klemm, M. (2019). "Conversion of d-Xylose and Hemicellulose in Water/Ethanol Mixtures". ACS Sustainable Chemistry & Engineering (ISSN: 2168-0485), Vol. 7, H. 14. S. 12323–12330. DOI: 10.1021/acssuschemeng.9b01697.

Publication: Kröger, M.; Klemm, M.; Nelles, M. (2019). "Extraction Behavior of Different Conditioned S. Rubescens". Energies (ISSN: 1996-1073), Vol. 12, H. 7. DOI: 10.3390/en12071336.

Publication: Müller-Langer, F.; Oehmichen, K.; Dietrich, S.; Zech, K. M.; Reichmuth, M.; Weindorf, W. (2019). "PTG-HEFA Hybrid Refinery as Example of a SynBioPTx Concept: Results of a Feasibility Analysis". Applied Sciences (ISSN: 2076-3417), Vol. 9, H. 19. DOI: 10.3390/app9194047.

Abbreviations:

ASTM = American Society for Testing of Materials
ATJ-SPK = Alcohol-to-JET
ETS = Emissions Trading System
FT-SPK = Fischer-Tropsch
HEFA-SPK = Hydroprocessed esters and fatty acids
HFP-HEFA = High-freeze-point
JIG = Joint Inspection Group
SIP = Synthesized iso-paraffins
SPK = Synthetic paraffinic kerosine

Head of the research focus area

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5.4 SMARTBIOMASSHEAT

"With the help of the developed system controller, which is superordinate to the heating and CHP controller, the operator can decide between the operating modes 'self-consumption optimization' (local) and 'grid support' (power generation preferably in high load phases) and thus meet different requirements."

Dr.-Ing. Steffi Theurich, Project Manager SNuKR

SNUKR – INCREASING THE BENEFITS OF SMALL, BIOMASS-FIRED CHP THROUGH DEMAND-BASED CONTROL

The transformation of energy supply in the course of the energy transition towards GHG neutrality is characterised by a number of megatrends: (i) a large number of decentralized energy suppliers, (ii) a dominant role of solar and wind energy in the electricity sector and (iii) the associated high volatility of generation, (iv) an increasing electrification of the heat and mobility sector, and (v) a rapid digitalisation of more and more areas of life [1].

In the course of the transformation of the energy system to date, the number of decentralised electricity generators from renewable energy sources has increased continuously in recent years. Depending on the considered region, the distribution of the number and type of plants and thus the feed-in voltage level used is heterogeneous, as is the energy consumption potential. At the same time, changes in the landscape of conventional power plants and the increase in the number of wind power plants that are relatively far away from the load (on- and offshore),

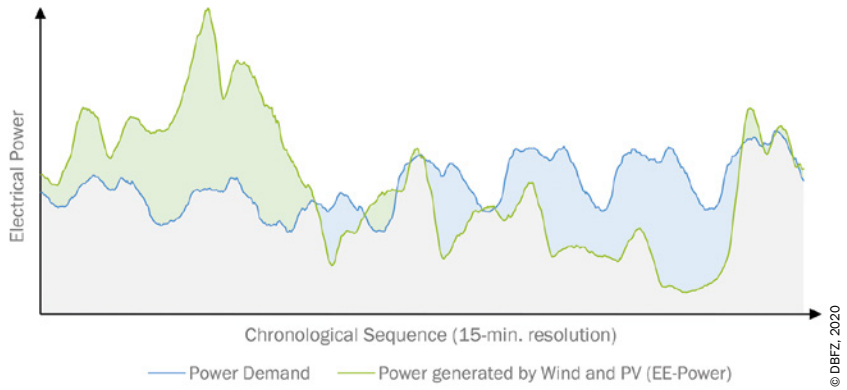

Fig. 12 Course of power demand and power generation to wind and photovoltaic (RES-E) power for an exemplary week and the resulting operating times of the investigated components e. g. decentralised heat pumps and biomass-based CHP plants

coupled with delays in the expansion of the transmission and distribution grids, mean that more grid-stabilising measures must be taken (e. g. redispatch, feed-in management) [2]. Since solar energy shows generation maxima depending on the season and time of day, and since power generation from wind energy can also be subject to weather-dependent supply gaps, it is necessary to hedge the electricity and heat requirements for the periods in question. Therefore, there is much discussion in the public debate about cost and investment-intensive storage methods to bridge these supply gaps. The potential of biomass firing systems as a cross-sectoral flexibility option is often missed out, although these systems could also contribute to cover peak loads.

Even with the growing importance of heat pumps and electromobility and the resulting need for additional, secure electricity generation capacity, the timed use of biomass combustion systems could, through targeted load management in peak load periods with low electricity input from wind power and PV systems, contribute significantly to secure electricity supply capacities, and reduce the otherwise necessary use of fossil power plants or other electricity storage options [3, 4]. Figure 12 shows the exemplary course of the total electricity demand as well as electricity generation by wind and solar energy in Germany and the resulting, preferred grid-supporting operating times for decentralised heat pumps and biomass-based CHP plants.

Due to these changes in the energy system, several research projects in the research focus area “SmartBiomassHeat” are concerned with the development of solutions for decentralised provision of energy from renewable energy sources. The overarching goal of all projects is to identify the most economical and climate-protecting concepts and applications that make the greatest contribution to the energy system. The following aspects play an important role:

- the current and future potential of biomass burning stoves to avoid electricity and gas demand peaks (**Project: OptDienE**) and
- decentralised generation and load management for local compensation of the volatilities of wind and solar power in power and heat generation (**Project: SNuKR**)

METHODS/MEASURES

The various studies can be divided into three groups: (i) device level, (ii) plant level and (iii) grid level. For the identification and avoidance of non-optimal operating conditions, an exchange of information between and within the different levels, which is as standardised as possible, is additionally required.

The device level comprises the individual biomass-fired heat and/or electricity generators, such as individual room firing appliances, boiler plants, CHP plants. Within the SNuKR project, the extent to which heat and electricity can be provided with a micro-CHP unit using a precise operational forecast is being investigated, among other things.

The plant level extends the device level by additional components, including heat pumps, heat and electricity storage tanks and solar collectors, and their interaction. The research activities at plant level primarily comprise optimised storage management based on load and weather forecasting to determine the required charge state of the storage and the energy quantities needed to be generated by the various producers. These questions are also currently being addressed within the SNuKR project.

The investigations on the grid level comprise the interactions of the plant level with heat and electricity distribution grids as well as the possibilities of shaping the influence of the plant level on the grid level. The OptDienE project is currently investigating the contribution of biomass burning stoves (BBS) to avoid peak loads in the electricity and/or gas network. For this purpose, selected reference buildings and their heat supply are modeled using TRNSYS. The comparison of the

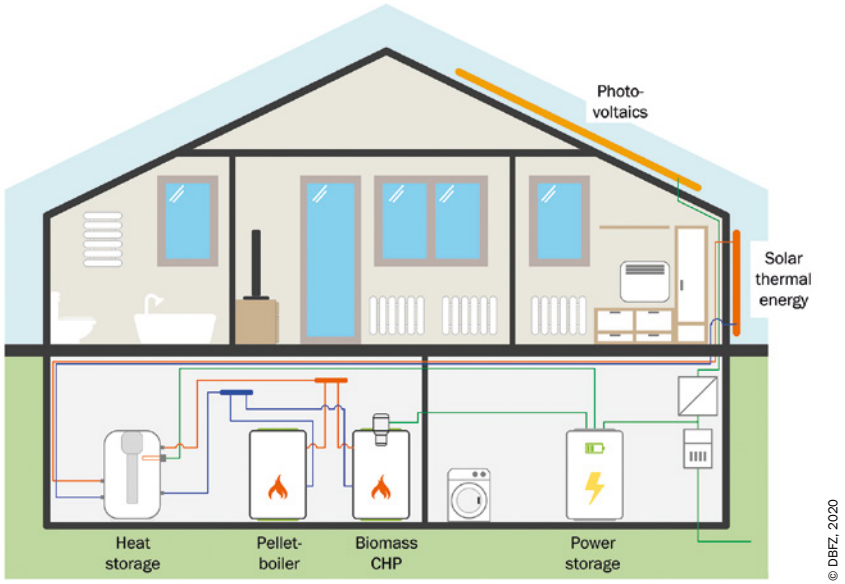

Fig. 13 Overview of the plant structure investigated in the SNuKR project

electricity and/or gas supply profiles of the reference buildings equipped with and without BBS under different operating concepts provides information on the potential for grid support, on the basis of which strategies for increasing this potential are discussed. In this project, the term “grid support” is understood primarily as decentralised flexibility management in the event of bottlenecks caused by renewable energies in the electricity grid (i. e. at peak load times) and, analogously, also in the gas grid.

In the SNuKR project, the option of decentralised power generation also provides the opportunity to consider the targeted generation of electricity in addition to the avoidance of power procurement. In addition to peak load times, the share of renewable energies in the respective electricity mix and the residual load are also taken into account for the assessment of grid support. The control algorithm developed within the project determines the optimal storage management and operating regime of the cogeneration unit for different operating modes (heat-controlled, own consumption-optimised, grid-supporting), which is necessary for a high target achievement. To evaluate the suitability of the developed approach for different applications, the control approach is investigated for different buildings (private, municipal and commercial) by simulation.

MILESTONES/CHALLENGES

An essential milestone in the processing of the different questions is the development and practical evaluation of control algorithms with different operating modes (own consumption, grid support, high load phases) for different applications (single-family house, multi-family house, commercial) and different supply concepts.

As mentioned above, the SNuKR project focuses on the development and evaluation of an algorithm that independently determines the optimal operating window for the cogeneration unit depending on the selected operating mode and additionally adapts the storage management to the respective requirements. Prerequisite for this is the practical implementation of the control algorithm in a demonstration unit and the practical validation on a Hardware-in-the-Loop (HiL) simulator. All real-time-capable models of the devices at system level (e. g. CHP, heat storage, heat sinks, solar thermal) as well as the standard heating circuit control are simulated on the HiL. The demo controller exchanges real generated analog and digital data with the HiL. With the intended configuration, the control algorithm can be tested extremely efficiently on very different system configurations.

Furthermore, it is expected in this project that concrete statements can be determinded on the economic and environmental properties of the different operating modes and on the suitability of the combination of plant configuration and control algorithm for different applications as well as for the provision of system services.

The focus of the work in the OptDienE project is on the simulation of the plant level in TRNSYS. The control approach implemented here determines the respective operating window for the BBS depending on the assumed user behavior and the specification of the heating system. For this purpose, users with different readiness for the grid-supporting operation of the BBS are defined, who are willing depending on their motivation to operate their furnace in the morning and/or evening within the time window determined by the controller. Furthermore, different locations (rural and urban areas) and scenarios for the fuel procurement (self-promotion and purchasing) are defined. In addition, different burn-up characteristics are examined in the simulations to identify the influence of different furnace controls.

For the derivation of the possible system contribution of grid-supporting operat-

ed BBSF, additional studies on the motivation and mobilisation of furnace users are essential. From the results determined for individual reference buildings, an extrapolation is then made to the stock of BBS installed in Germany by means of a corresponding assessment of the frequency and distribution of the various operating and user concepts.

PERSPECTIVES

Within the framework of the various projects, a modular controller platform is developed as a basis for prototyping and testing of the various controlling approaches. It should contain essential, generic basic functions and be adaptable to the respective application and the associated operating regime with little effort. The use cases investigated in the OptDienE and SNuKR projects are to be modelled and validated with the HiL simulator in a practice-oriented manner. In addition to the actual controller, the corresponding simulation models will be developed in Matlab/Simulink. Based on this work, further functionalities and use cases can be implemented, examined and evaluated in the future.
With the projects described and the development of the controller platform, the DBFZ has a flexibly expandable basis for the development and evaluation of decentralised supply concepts with a focus on device, system and network level. The operating mode of the different generators in interaction with other devices orcomponents can be weighted and defined according to requirements in order to enable an optimal solution for the respective application.

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[4.] Fraunhofer Institut für System und Innovationsforschung (ISI), “Langfristszenarien für die Transformation des Energiesystems in Deutschland – Modul 0: Zentrale Ergebnisse und Schlussfolgerungen”, Karlsruhe, 2017

Project summary

Title:	SNuKR – Increasing the benefits of small, biomass-fired CHP through demand-based control
Duration:	01.07.2017–30.06.2020
Project partner:	European Institute for Energy Research – EIFER; ÖkoFEN Heiztechnik GmbH
Scientific contact:	Dr.-Ing. Steffi Theurich
Project number:	03KB121
Funding body:	Federal Ministry for Economic Affairs and Energy, Project Management Jülich

Supported by:
Federal Ministry for Economic Affairs and Energy
Projektträger Jülich Forschungszentrum Jülich
on the basis of a decision by the German Bundestag

Project summary

Title:	OptDienE – Options for mains operation of biomass burning stoves
Duration:	01.08.2018–31.03.2021
Project partner:	ISFH Institut für Solarenergieforschung GmbH
Scientific contact:	Kerstin Wurdinger
Project number:	03KB138
Funding body:	Federal Ministry for Economic Affairs and Energy, Project Management Jülich

Supported by:
Federal Ministry for Economic Affairs and Energy
Projektträger Jülich Forschungszentrum Jülich
on the basis of a decision by the German Bundestag

RESEARCH FOCUS AREA “SMARTBIOMASSHEAT”

The research focus lies on the small-scale, renewable heat supply in individual objects and small object networks up to village communities or districts using other renewable energy sources and networking intelligent heat technologies based on biomass, which primarily originates from residual materials, by-products and waste. The overarching goal is to develop the supply of all renewable heat sources in a technologically and economically optimal way by a flexible and demand-adapted use of heat technologies based on biomass. For this purpose, the entire chain from the refinement of the biomass fuels and new conversion plants to the integration of the biomass heating systems, which will in future also be designed as combined heat, power and refrigeration plants, into the heat and power grid, is to be depicted, examined individually and in combination, simulated and optimized. The necessary technical development of component as well as the connecting control research and development enhance a flexible operation (also of micro and small CHP) to an efficient, environmentally friendly, economic, safe, demand-adapted, flexible and sustainable (smart) operation.

Further information:
www.smartbiomassheat.com

Important reference projects and publications

Project: BioGrid – SmartBioGrid – Optionen zum Einsatz fester Biomasse in dekarbonisierten Wärmenetzen, Federal Ministry for Economic Affairs and Energy/Project Management Jülich, 01.09.2019–31.08.2022 (FKZ: 03KB159A)

Project: IraSIL – Untersuchung des Ascheverhaltens während der thermo-chemischen Konversion vorbehandelter, siliziumreicher Biomassesortimente zur Strom- und Wärmeerzeugung und Nutzung der dabei anfallenden Aschen zur Gewinnung anorganischer Gerüstverbindungen mit vielfältigen Anwendungsmöglichkeiten, Federal Ministry of Food and Agriculture/Federal Office for Agriculture and Food, 01.01.2018–30.06.2021 (FKZ: 2816D0KI03)

Project: OBEN – Ölersatz Biomasse Heizung, Federal Ministry for Economic Affairs and Energy/Project Management Jülich, 01.09.2019–28.02.2022 (FKZ: 03KB156)

Project: ONIreduce – Emissionsminderung durch angepasste Kesselsteuerung auf der Basis von Daten aus der kontinuierlichen inline-NIR-Brennstoffanalyse, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.07.2019–31.12.2021 (FKZ: 22033218)

Project: Vabiflex – ERA-Net-Verbundvorhaben: Wertoptimierte Nutzung von Biomasse in einer flexiblen Energieinfrastruktur; Teilvorhaben 1: Theoretische und experimentelle Untersuchungen, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.09.2018–31.03.2021 (FKZ: 22408317)

Project: WKK – Demonstrator – Erforschung und Errichtung eines Technologie-Demonstrators zur stromnetzstabilisierenden Heizung auf Basis biogener Festbrennstoffe (Mikro-Wärme-Kraft-Kopplung), 01.08.2016–31.07.2020

Publication: Dernbecher, A.; Dieguez-Alonso, A.; Ortwein, A.; Tabet, F. (2019). “Review on modelling approaches based on computational fluid dynamics for biomass combustion systems: Focus on fixed bed and moving grate systems”. Biomass Conversion and Biorefinery (ISSN: 2190-6815), Vol. 9, Nr. 1. S. 129–182. DOI: 10.1007/s13399-019-00370-z.

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5.5
CATALYTIC EMISSION CONTROL

"In the project 'KaRo' a plant consisting of a gasifier and a catalytic tube bundle reactor is to be developed for low-emission and regenerative heat generation from biogenic residues. The development of a thermally and chemically stable catalyst will enable fuel-flexible, almost pollutant-free operation."

Dr. rer. nat. Bettina Stolze, Project Manager

KARO – CATALYTIC TUBE BUNDLE REACTOR FOR THE TOTAL OXIDATION OF FUEL GASES FROM THE THERMAL CONVERSION OF SOLID BIOFUELS FOR LOW-EMISSION REGENERATIVE HEAT GENERATION

The establishment of biomass as a valuable resource for a sustainable and efficient energy supply requires innovative process concepts. To reduce emissions from bioenergy plants, intensive research has been conducted for many years on catalysts for total oxidation. Extensive knowledge and numerous scientific publications and patents are available on this subject. It can be stated that the extraction and energetic use of the released reaction heat of catalytic oxidation is a challenge which has not yet been sufficiently investigated and which must be mastered in a tube bundle reactor.

The project "Catalytic Tube Bundle Reactor", short "KaRo", aims at the development and investigation of a plant for the fuel-flexible energetic utilisation of biogenic residues, consisting of a gasification unit and a catalytic tube bundle reactor. The scientific investigations are carried out both theoretically, including

Fig. 14 Apparatus for the characterisation of solids (powders and monoliths) using methods of physical and chemical absorption.

simulations, and practically. The conversion of the solid biomass into fuel gases at the lowest possible temperatures is intended to inhibit the release of mineral constituents such as potassium from the biomass. Since such substances act as aerosol precursor, the amount of dust emitted can be significantly reduced compared to current combustion processes. Compared to typical gasifier product gases, the resulting fuel gas contains a larger proportion of hydrocarbons, which are to be completely converted catalytically to CO_2 and H_2O by total oxidation. In this way an almost pollutant-free combustion can be realised.

A sub-topic of the project is the synthesis, characterisation and application of novel high-temperature stable catalysts. In addition, materials are being researched that can withstand the new requirements resulting from the recycling of biogenic residues with high levels of corrosive compounds.

The high oxygen content of the biogenic residues is to be used to minimise the glowing bed temperature in the gasifier while at the same time achieving a high carbon yield. The use of waste gas as reaction gas by recirculation into the gasifier leads to an increase of the inert gas content in the gasifier, whereby a positive influence on the temperature level and temperature distribution in the gasifier and in the catalytic tube bundle reactor is expected. Strategies to predict the reaction

Fig. 15 Sample of the catalyst support used in the project

kinetics in the gasifier of the plant are developed by simulations with Chemkin and OpenFOAM.
The project also focuses on the optimisation of the heat transfer at the catalytic tube bundle. The efficiency of the heat transfer at the tube bundle will be modelled and tested in detail by calculating different design variants with ANSYS Fluent. Thus, a novel reactor type will be developed which efficiently converts the reaction enthalpy released in the tube bundle into heat. The practical implementation of the most efficient design variant promises the development of a practical plant model.

METHODS/MEASURES

DBFZ acts as project coordinator and is responsible for the catalytic aspects of the project. IWTT of the TU Freiberg has a high expertise in the field of gasifier technology and will work on this part of the project as a focal point. Synergies will then arise in the simulation work and the combination of the gasifier and catalyst components. In particular, catalytic exhaust gas treatment directly in the heat exchanger zone has so far received little attention in the literature. By means of total catalytic oxidation in the heat exchanger zone, the energy released in the form of reaction heat can be made directly usable for the oxidation of the gas produced in the gasifier.

The catalysts to be developed must have a sufficiently high activity, selectivity and stability despite increased proportions of corrosive components in the exhaust gas by using biogenic residues. To achieve this, the catalyst must be designed in such a way that the chemical reactions taking place release enough heat to prevent the formation of deposits on the catalyst and the resulting deactivation. Thus, different synthesis routes are tested and varied in order to obtain a suitable specific surface area by varying the porosity and to stabilise a highly dispersed active phase.

MILESTONES/CHALLENGES

In particular, the design challenges to the gasifier unit associated with the planned use of various biogenic residues as gasification materials pose a high risk with regard to their implementation in the model reactor. The high oxygen content of biogenic residues is to be used, where the consideration of biogenic residues as oxygen carrier is an innovative idea whose use is risky.
The construction of a demonstrator, based on a gasification and heat transfer concept to be worked out, which takes into account the complex framework conditions, is an essential milestone for the success of the project.
The intended use of different biogenic residues leads to a complex and varying exhaust gas composition. Despite this variation, the catalyst to be developed must have a sufficiently high activity and stability to reduce the harmful components. The demonstration on laboratory scale represents a further milestone.
If the gasification gas is catalytically converted, a significant amount of heat can be released locally due to the catalyst structure and flow control as a result of the exothermic reaction processes, which can cause local overheating, so-called hotspots. Temperatures in excess of 1,100 °C can occur. In particularly active areas of the catalyst bed, therefore, a lining stable at high temperatures would have to be used. Since ceramic linings have a negative influence on the heat transfer and thus on the efficiency of corresponding plants, it is necessary to further develop the process in such a way that hotspots are avoided and maximum temperatures of around 1,100 °C at the reactor wall are safely undercut.

PERSPECTIVES

The research into high-temperature stable catalysts for the conversion of waste and fuel gases from biomass gasification will enable technical developments for emission-free regenerative biogenic residue utilisation in the future. Thus, residual and by-products from the bioeconomy can be used in an environmentally friendly and climate-neutral way. If the project results are positive, the results can also be transferred to other catalytic and energy applications.

Project summary

Duration:	01.10.2019–30.06.2022
Project partner:	TU Bergakademie Freiberg (IWTT)
Scientific contact:	Dr. rer. nat. Bettina Stolze
Project number:	100332481
Funding body:	Sächsische Aufbaubank – SAB

SAB
Sächsische AufbauBank

RESEARCH FOCUS AREA “CATALYTIC EMISSION CONTROL”

The vision of a climate-neutral and sustainable bioeconomy and the associated premises result in very high demands on the research focus area “Catalytic Emission Control” in terms of a pollutant-free use of bioenergy. In particular, the future increased use of biogenic residual and waste materials of increasingly varying quality poses a challenge for emission-free use. The focus here is on reducing emissions from combustion processes for bioenergy sources by using and combining solid catalysts. In particular, climate-relevant methane (CH_4), toxic volatile organic compounds (VOC), semi- and low-volatile hydrocarbons such as polycyclic aromatic hydrocarbons (PAH) and polychlorinated dioxins and furans (PCDD/PCDF), soot particles (black carbon) and nitrogen oxides (NO_x) must be removed to a large extent. The main research objective of the “Catalytic Emission Control” research focus area is the investigation of long-term and high-temperature stable, recyclable and cost-effective catalysts with no or significantly lower proportions of noble metals. In particular, the combination of catalysts with additional emission reduction processes will be investigated in detail.

Important reference projects and publications

Project: Bio-Mini – Verbundvorhaben: Entwicklung einer marktnahen emissionsarmen Biomasse-Kleinstfeuerung für Niedrigenergie- und Passivhäuser; Teilvorhaben 1: Feuerungstechnische Entwicklung (Gesamtkonzept) und Charakterisierung einer Biomasse-Kleinstfeuerung für Niedrigenergie- und Passivhäuser, Federal Ministry of Food and Agriculture/Agency for Renewable Resources e.V., 01.10.2017–31.03.2020 (FKZ: 22000417)

Project: GASASH – Thermo-chemische Konversion von Reststoffen in einem Vergaser-BHKW mit gekoppelter Aschegewinnung; Teilvorhaben: Untersuchungen zur Produktgasqualität, den BHKW-Emissionen, Emissionsminderungsmaßnahmen und der Ascheverwertung, Federal Ministry for Economic Affairs and Energy/Project Management Jülich, 01.09.2018–31.08.2020 (FKZ: 03KB139A)

Project: Pellwood – Entwicklung einer Hybrid-Kleinfeuerungsanlage unter 5KW für Scheitholz und Holzpellets; Entwicklung des Pelletvergaserbrenners und der Verbrennungsregelung, Federal Ministry for Economic Affairs and Energy/German Federation of Industrial Research Associations “Otto von Guericke” e.V., 01.05.2017–31.10.2019 (FKZ: ZF4077203ST7)

Project: SCRCOAT – Optimierung u. Validierung von Verfahren zur kombinierten Reduktion von Feinstaub u. sauren Schadgasen an Biomassefeuerungen; Teilvorhaben: Experimentelle Untersuchungen zur Kombination von SCR- u. Precoatverfahren an einem Gewebefilter, Federal Ministry for Economic Affairs and Energy/Project Management Jülich, 01.09.2017–31.08.2020 (FKZ: 03KB128A)

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Publication: Dernbecher, A.; Dieguez-Alonso, A.; Ortwein, A.; Tabet, F. (2019). “Review on modelling approaches based on computational fluid dynamics for biomass combustion systems: Focus on fixed bed and moving grate systems”. Biomass Conversion and Biorefinery (ISSN: 2190-6815), Vol. 9, Nr. 1. S. 129–182. DOI: 10.1007/s13399-019-00370-z.

Publication: König, M.; Eisinger, K.; Hartmann, I.; Müller, M. (2019). “Combined removal of particulate matter and nitrogen oxides from the exhaust gas of small-scale biomass combustion”. Biomass Conversion and Biorefinery (ISSN: 2190-6815), Vol. 9, Nr. 1. S. 201–212. DOI: 10.1007/s13399-018-0303-0.

Publication: Liu, D.; Seeburg, D.; Kreft, S.; Bindig, R.; Hartmann, I.; Schneider, D.; Enke, D.; Wohlrab, S. (2019). “Rice Husk Derived Porous Silica as Support for Pd and CeO2 for Low Temperature Catalytic Methane Combustion”. Catalysts (ISSN: 2073-4344), Vol. 9, Nr. 1. DOI: 10.3390/catal9010026.

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6 COOPERATION AND NETWORKS

The DBFZ is a member of numerous scientific networks and research alliances related to bioenergy and bioeconomy. The strong networking within the national and international research landscape is essential to be able to solve the complex challenges of the energy and raw material transition comprehensively and sustainably.

In addition to the existing national networks, international activities with the IEA Bioenergy were further expanded in 2019. Highlights were a one-day international workshop entitled “Roles of Bioenergy Technologies in Energy System Pathways Towards a WB2/SDG World” and the two-day meeting of Task 40 – Deployment of Biobased Value Chains, which took place at the DBFZ in November. During an excursion to the Delitzsch biomass power plant, national and international colleagues were able to get an idea of the energetic utilisation of waste wood in Germany.

The IEA Bioenergy is an organisation founded in 1978 by the International Energy Agency (IEA). It aims to improve cooperation and the exchange of information between countries that have national programmes for research, development and use of bioenergy. The IEA Bioenergy currently has 24 member states and the Eu-

Fig. 16 Meeting of the IEA Bioenergy Task 40 at the DBFZ (28/29 November 2019)

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Fig. 17 Dr. Elena H. Angelova (left) and Prof. Dr. Daniela Thrän (right) represent the DBFZ at EERA Bioenergy

ropean Commission, with the approximately 200 participating scientists grouped thematically in 11 tasks. Since the beginning of 2019, DBFZ scientists have been working as national team leaders in a total of five working groups (tasks).
As a newly elected full member of the European Energy Research Alliance (EERA), the DBFZ has represented various aspects of bioenergy in five sub-groups of the EERA Bioenergy Programme since the end of 2019. The overall objective of the EERA Bioenergy is to develop into a solid research and development tool to assess the research challenges and priorities for bioenergy set out in the roadmap of the Strategic Energy Technology Plan (SET-Plan) of the European Union. The DBFZ is even more involved in European bioenergy research through its membership in the European Energy Research Alliance. The membership complements the EERA's portfolio, among other things, by adding the know-how of the "Smart Bioenergy" concept developed by the DBFZ.

Further network activities take place in the following research associations:

- Renewable Energy Research Association – FVEE
- BioEconomy Cluster
- BMWi Research Network Bioenergy/Accompanying project of the BMWi funding programme "Biomass energy use"
- Research Network "Energy Saxony"
- Leipzig Network Energy and Environment – NEU e. V.
- TREC Danube Network (EU level)

SCIENTIFIC COOPERATION WITH UNIVERSITIES AND RESEARCH INSTITUTES

The scientific cooperation with universities and other research institutions in the field of energetic and integrated material use of biomass is another essential part of the network activities of the DBFZ. The focus of the activities is on the implementation of the defined research objectives within the framework of applied research and development (R&D).
For questions of system evaluation of bioenergy as well as the microbiological basics of biochemical processes there is a long-standing cooperation with the Helmholtz Centre for Environmental Research – UFZ. Here, the DBFZ department "Bioenergy Systems" works closely with the UFZ department "Bioenergy" (head of both departments: Prof. Dr. Daniela Thrän). On the other hand, the research department "Biochemical Conversion" cooperates with the UFZ department of microbiology "MicAS". In the field of energy recovery from organic waste and residual materials, there is also a strategically oriented cooperation between the DBFZ research focus areas and the Rostock Chair of Waste and Material Flow

UFZ HELMHOLTZ Centre for Environmental Research · UNIVERSITÄT LEIPZIG · Universität Rostock Traditio et Innovatio

Management (ASW), represented by the scientific managing director of the DBFZ, Prof. Dr. Michael Nelles. Against this background, the University of Rostock in cooperation with the DBFZ organises joint events such as the annual Rostock Bioenergy Forum.
Already since the end of 2011, the deputy scientific managing director of the DBFZ, Prof. Dr. Daniela Thrän, has been closely connected to the University of Leipzig through the Chair of Bioenergy Systems of the Faculty of Economic Sciences (IIRM – Institute for Infrastructure and Resource Management). In addition, the DBFZ's "Biorefineries Department" is linked to the Leipzig Institute of Technical Chemistry (Chair of Heterogeneous Catalysis). Besides the University of Leipzig, national universities such as Chemnitz University of Technology, Dresden University of Technology, Anhalt University of Applied Sciences and Leipzig University of Applied Sciences are linked to the DBFZ through lecturing activities of DBFZ scientists. In addition to the national networks and research cooperation described above, the scientific cooperation with non-European countries, especially China, has been greatly expanded in recent years. Scientists of the DBFZ work as visiting professors at the University of Hefei and other renowned universities in China.

R&D COOPERATIONS WITH THE LOCAL ECONOMY

The research and development work (R&D) of the DBFZ is carried out in close cooperation with partners from industry and other research institutions. This ensures the necessary practical relevance, access to important market information and a focus on innovative and feasible solutions. In cooperation projects with industry, the DBFZ guarantees a neutral and holistic view and approach and can thus contribute its expertise extensively to market-oriented R&D projects. Especially in third-party funded projects, strong corporate participation is the rule. For this purpose, the four research deaprtments of the DBFZ have national and international networks with R&D driving companies as well as industry-relevant contacts from the bioenergy sector.

7
PRESS AND PUBLIC RELATIONS

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Fig. 18 **Federal Minister Julia Klöckner and the Prime Minister of Saxony Michael Kretschmer visit the DBFZ (30 July 2019)**

As every year, numerous visitors from Germany and the world visited the DBFZ in 2019. A total of 21 national and 16 international visitor groups from Africa, Belorus, Japan, China, Canada, Turkey and a large number of other countries were able to find out about research work in the field of bioenergy and view the wide range of technical facilities. The visitor highlight of the year 2019 was the reception hosted by Federal Minister Julia Klöckner and the Prime Minister of Saxony Michael Kretschmer. On 30 July 2019, the two top politicians took the opportunity to gain an overview of the newly created infrastructure of the DBFZ in addition to the research activities. Mrs Klöckner in particular was very impressed: “It was a great day here today, above all it was an insight into great know-how. It is a young team with a lot of future”, said the Federal Minister responsible for the DBFZ.

EVENTS IN THE NEW CONFERENCE CENTRE OF THE DBFZ

In addition to various other events coordinated by the DBFZ, the event activities in 2019 focused in particular on two specialist events on the subject of “Hydrothermal Processes”. With the 5th expert forum “Hydrothermal Processes” on 25/26 September 2019, more than sixty experts were attracted to Leipzig and the newly opened conference centre of the DBFZ for an exchange of experience. In technical terms, the event was characterised by the three pillars scientific results, regulatory and social framework conditions, and reports from practical plants and implementation concepts. It was unmistakable that the field of hydrothermal processes and procedures is increasingly seeking and finds its place in the future topics of bioeconomy and decarbonisation of the economy.

Following a successful premiere in London, the “2nd International Symposium on Hydrothermal Carbonization” was held in Berlin in spring under the organisational leadership of the DBFZ and ATB Potsdam. From 14 to 16 May 2019, a total of 126 international participants met at the Saxon state representation and intensively discussed the topic of hydrothermal carbonisation. The next conference will probably take place in Seoul (South Korea) in 2021. Further information as well as the conference readers of both events can be found on the website **www.dbfz.de/htc2019**.

Fig. 19 5th expert forum “Hydrothermal processes” in the new conference centre of the DBFZ

Fig. 20 Workshop in the context of the 8th status conference "Biomass energy use" on 17/18 September 2019 in Leipzig's KUBUS

For the eighth time now, the accompanying project of the BMWi funding programme "Biomass energy use" hosted its biennial status conference on 17/18 September in Leipzig's KUBUS. The conference included keynote speeches in the field of tension between energy and climate policy, pitches of more than 20 new projects, a "hot chair" on pressing issues of the energy system transformation, 30 expert lectures, 20 posters and a bioenergy slam. A review as well as the conference documents can be found at **www.energetische-biomassenutzung.de/en**.

The 4th International conference on "Monitoring & Process Control of Anaerobic Digestion Plants" from 26/27 March 2019 has successfully concluded the 2019 event year. We would like to take this opportunity to draw your attention to the diverse events of the year 2020. You can find an overview of our events at **www.dbfz.de/en/events/events-of-the-dbfz**. We look forward to your participation!

HERE YOU CAN MEET THE DBFZ IN 2020

Woche der Umwelt (Week of the environment)	Berlin	9/10 June 2020
DBFZ Annual Conference 2020	Leipzig	16/17 September 2020
3rd Doctoral Colloquium BIOENERGY	Leipzig	17/18 September 2020
2nd Forum Science Management	Leipzig	September 2020
FVEE Annual conference 2020	Berlin	3/4 November 2020
6th Expert forum on "Hydrothermal processes"	Leipzig	25/26 November 2020

Further information:
www.dbfz.de/en/events/events-of-the-dbfz
www.flickr.com/photos/dbfz/albums
www.dbfz.de/en/events/event-newsletter
www.energetische-biomassenutzung.de/en/events

Fig. 21
The event team of the DBFZ

NEW PUBLICATIONS

New scientific publications have supplemented the portfolio of the DBFZ publication series. Within the DBFZ Report series, four new issues were published in 2019 on the topics of “Monitoring the Biofuels Sector” (4th edition), “Development of a method to use the data of the chimney sweep trade for energy industry reporting”, “Heat Utilisation in Biogas Plants” and “Recommendations for reliable methane emission rate quantification at biogas plants”. In addition to the specialist events organised by the DBFZ, three conference readers on the “HTP Expert Forum 2019”, the “2nd International Symposium on Hydrothermal Carbonization” and the “10th Expert Discussion on Particle Separators in Domestic Combustion Systems” as well as various brochures have been published.
The accompanying project of the BMWi funding programme “Biomass energy use” also published new publications in 2019. The focus booklet “Focus on: Bioenergy in the Electricity and Heat Market” presents project results for the period 2017–2018, and a collection of biogas measurement methods in Chinese has been compiled for the Chinese market. Conference readers were provided for the events “IV. International Conference Monitoring & Process Control of Anaerobic Digestion Plants” as well as the 8th Status Conference “Biomass energy use: Bioenergy – The X-Factor”. All publications are available online free of charge via the following links:

www.dbfz.de/en/reports
www.dbfz.de/en/conference-reader
www.dbfz.de/en/brochures
www.energetische-biomassenutzung.de/en/publications

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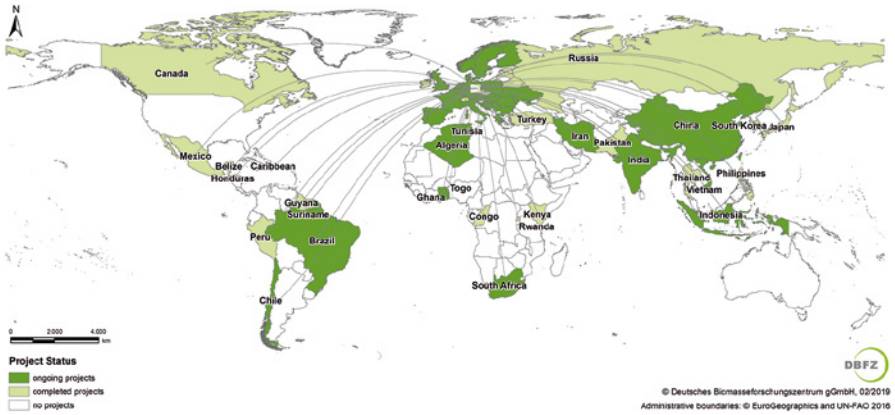
8
EXECUTIVE SUPPORT TEAM

"The Executive Support Team makes a significant contribution to the successful scientific work at the DBFZ. In addition to controlling and press and public relations work, the scientific staff units in particular ensure successful synergies within the research work at the DBFZ and the continuous development of our R&D networks in Germany and abroad."

Prof. Dr. Michael Nelles, Scientific Managing Director of the DBFZ

The staff units of the DBFZ report directly to the scientific management of Prof. Dr. Michael Nelles. In addition to the Departments of Press- and Public Relations and Controlling, the coordinators for research, innovation and international knowledge and technology transfer work closely with the four research departments of the DBFZ and the heads of the five research focus areas. The aim is to develop synergies in strategic research and project orientation, consortium formation and internationalisation for the entire research centre.



INTERNATIONAL KNOWLEDGE AND TECHNOLOGY TRANSFER

The goal of the scientific staff unit “International Knowledge and Technology Transfer”, headed by Dr. Sven Schaller, is the distribution of the scientific results of the DBFZ research to international partners using different instruments like joint research projects, the exchange of doctoral students and the implementation of reciprocal research visits. A further goal of the staff unit is to establish cooperation with top international universities and research institutes. In addition, non-European networks are to be consolidated and selectively expanded. This also includes the initiation and arrangement of mutual visits and the organisation of workshops and conferences.

CONSTRUCTION OF A BIOGAS RESEARCH LABORATORY IN TOGO: RESEARCH PROJECT STARTED

On 1 December 2019, a research project funded by the German Federal Ministry of Education and Research (BMBF) officially started in Togo. The DBFZ’s largest foreign project to date focuses on the establishment of a biogas research laboratory at the University of Lomé by December 2023, which is to be integrated into the research network of the West African Science Service Center on Climate

Fig. 22 Delegation from Togo at the DBFZ (25 March 2019)

Change and Adapted Land Use (WASCAL). The aim of the scientific network is to build up long-term know-how and scientific capacities on the topics of climate change and dealing with the effects on land use within the framework of the Africa Strategy.

CONSTRUCTION OF A PILOT PLANT FOR ENERGY RECOVERY FROM WASTE IN GHANA

The DBFZ is part of a consortium of five implementation partners from Ghana and Germany to implement the project “Hybrid Waste to Energy as a Sustainable Solution for Ghana (W2E)” with a funding of up to 5.8 million euros by the German Federal Ministry of Education and Research. The project, which runs until 31 December 2023, was initiated by the Ghanaian Minister of Environment for Science and Technological Innovation, Prof. Kwabena Frimpong-Boateng, and the German Federal Minister Anja Karliczek (BMBF) during their bilateral talks in 2019.

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Fig. 23 Signing of the contract in the presence of the German Education Minister Anja Karliczek (l.)

The main objective of the project is the development of concepts for the treatment of municipal solid waste in Ghana through research and development and the construction of a pilot plant for the generation of energy from waste in Gyankobaa at the municipal assembly of Atwima Nwabiagya in the Ashanti region. The DBFZ will play an important role in the establishment of a bioenergy laboratory for the project in Ghana and will assist in the training of technical staff in laboratory procedures. It is expected that the project will have a positive impact on Ghana's efforts to move from a waste collection and landfill system to a closed loop economy. In addition, the project is expected to increase the integration of renewable energies into the national power generation mix and support the country's climate protection strategy.

DBFZ PRESENT ON MAJOR WASTE DISPOSAL IN INDIA

The big challenge in India is the establishment of a waste and recycling management system. Particularly in the field of sustainable recycling of biogenic waste – household waste still consists of more than 50 % organic residues – the DBFZ is making an effective transfer of knowledge and has now established a very good reputation in India. Against this background, we were again asked to co-organise the International Conference on Solid Waste Management towards Circular Economy (9th IconSWM-CE 2019) in Bhubaneswar/India in 2019. The scientific managing director Prof. Dr. Michael Nelles also acted here as waste expert of the University of Rostock and representative of the German Association for Waste Management (DGAW) and the German export initiative German RETech Partnership. More than 400 scientists and industry representatives took part in the conference.

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Fig. 24 Opening ceremony of the 9th IconSWM-CE 2019 with Prof. Dr. Michael Nelles (centre) on 27 November 2019

SCIENTIFIC EXCHANGE BETWEEN GERMANY AND CHINA

In 2019, Chinese guest researchers started research stays of several months at the DBFZ. Topics included the fermentation of poultry excrement in the field of “Biochemical Conversion” and agricultural residues and biogenic silica in the field of “Thermochemical Conversion”. Furthermore, numerous Chinese delegations visited the DBFZ again in 2019. Through DBFZ staff members, teaching activities were carried out at various Chinese universities as well as active networking of actors within the German-Chinese research project “ChinaRes” (**www.dbfz.de/en/chinares**).

The IEexpo Workshop “Sino-German Cooperation on Waste to Energy” on 15 April 2019 was jointly organised by the DBFZ, the University of Rostock, the German RETech Partnership, the German Society for Waste Management (DGAW), the International Solid Waste Association (ISWA) and Messe München. In his function as scientific managing director of the DBFZ, Prof. Michael Nelles chaired the event, which focused on waste-to-energy concepts in Germany and China. Afterwards, entrepreneurs from both countries gave the participants a concrete insight into how waste concepts can be implemented in China. The Middle Kingdom is currently well on the way to establishing a functioning recycling economy and avoiding plastic waste.

Further information:
www.dbfz.de/en/research/international-activities

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INNOVATION COORDINATION

Bioenergy is an elementary part of the bioeconomy we are striving for. It drives industrial processes, supplies renewable fuels and provides electricity on demand. Its use must be integrated into the energy system and the biobased production processes in such a way that there is minimal competition for resources and environmental impacts with maximum economic effects. The cascade use of biomass and the coupled production of material and energy products should lead to the highest possible resource efficiency.
The scientific staff unit “Innovation Coordination” is responsible for identifying and developing innovation potential in the above-mentioned research fields. To this end, it links the application-oriented research of the DBFZ with partners and R&D&I structures from other sectors of the bioeconomy in the regional and supra-regional environment. The DBFZ’s research partners from small and medium-sized enterprises (SMEs) are also included in these structures. Memberships in R&D-related networks such as the Central German “BioEconomy Cluster” based in Halle/Saale or the “Energy Saxony e. V.” as well as the moderation of working

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Fig. 25 Lignite mining areas are to become model regions for the bioeconomy

groups or workshops are managed by the Innovation Coordination Department with the aim of further networking of R&D&I actors. Further tasks lie in knowledge and technology transfer, in the management of industrial property rights as well as the development and expansion of own innovation structures and the support of spin-offs.

CONTACT PERSONS FOR COMPANIES

In order to make it easier for companies to get an overview of the scientific services of the DBFZ or to access its research infrastructure, the innovation coordinator is the first point of contact. In this way, even companies with little R&D experience can quickly get in touch with the DBFZ experts and save time in finding the right contact person. The joint development of ideas for possible joint R&D projects is actively supported by the innovation coordinator.

RESEARCH PROJECT “MODEL REGIONS FOR THE BIOECONOMY”

“Model regions for the bioeconomy” is a research project commissioned by the BMEL as part of the immediate programme of the Structural Law for Coal Regions. The restructuring of the energy system is leading to profound social change in regions with lignite-based electricity generation. This process of change is to be shaped in the Lusatian and Central German coal-mining districts as a directed transformation process towards model regions of the bioeconomy. The model regions should become highly attractive business locations where industrial and knowledge-based value creation takes place. Innovations are to be rapidly translated into industrial application and the former coal regions are to become visible worldwide pioneers of the biobased economy. Industry, science, agriculture and forestry will find ideal conditions for the development of new value creation chains. Based on a comprehensive as-is analysis, implementation recommendations for the establishment of model regions will be worked out with local stakeholders by the end of 2021.

EXPANSION OF INNOVATION NETWORKS

Together with a consortium from BioEconomy e. V. and more than 80 partners from industry and science, a platform for the rapid scaling and industrial implementation of biobased innovations was developed in 2019. First projects have been planned and will be implemented in the near future. The DBFZ has contributed its R&D competences and infrastructure among many others.

Further information:
www.dbfz.de/en/services/research-with-companies
www.energiemetropole-leipzig.de/en/energy-metropolis-leipzig

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RESEARCH COORDINATION

The manifold tasks in the field of science management are supervised by the scientific staff unit Research Coordination headed by Dr. Elena H. Angelova. The focus is on medium- and long-term planning as well as ensuring the quality of research at the DBFZ. In addition, the staff unit supports and coordinates the networking of scientists of the five research focus areas of the DBFZ among themselves and with other research institutions and partner organisations. With the aim of implementing research ideas, the synergies and expertise available in-house can thus be better exploited, promising research cooperations initiated and suitable funding found. In her capacity as doctoral advisor, Dr. Elena H. Angelova also takes care of the implementation of the DBFZ doctoral programme and supports the doctoral students working at the Research Center.

SCIENTIFIC INDICATORS

Last year, DBFZ staff members published more than 130 scientific articles, 53 of which were published in scientific journals with strict peer review processes. In particular, the number of open access publications involving DBFZ scientists has increased significantly in recent years. In addition, the DBFZ was represented at a large number of international and national scientific events in 2019 with 136 scientific presentations by its scientific staff. An overview of the publications of DBFZ staff members can be found in the appendix of this annual report starting on page 161.

BMWI 7. EFP – ENERGY RESEARCH PROGRAMME, FUNDING AREA "3.7 ENERGETIC USE OF BIOGENIC RESIDUAL AND WASTE MATERIALS"

In 2019, a total of 56 project proposals were submitted as part of the above-mentioned BMWi 7th EFP funding programme. In particular, they dealt with the topics development of biogenic residual and waste materials, technologies and concepts for system integration, sector coupling, power and heat generation, and their coupled use. In addition, projects for the production of sustainably produced liquid and gaseous biofuels were funded for the first time. A total of 24 research projects were funded, in seven of which DBFZ is coordinator or a project partner.

EU PROJECTS

n the twelve years of its existence, the DBFZ has so far worked on 20 EU projects together with a total of 175 partners and 14 other research networks, mainly from Europe. These include industrial partners and SMEs (39 %), other research institutes (21 %), universities (19 %), public law institutions (3 %) and a number of agencies, associations, networks, etc. (18 %). In this way, more than six million euros in funding income have been acquired in recent years. Further information on the DBFZ's EU projects as well as scientific key figures can be found on the EU Funding & tender opportunities portal (**www.dbfz.de/en/eu-projects/**)

MEETING AND NEW APPOINTMENT OF THE RESEARCH ADVISORY COUNCIL

During the 11th meeting with the international Research Advisory Council (RAC) on 5 November 2019, the DBFZ presented the most important progress and scientific milestones of the last year. The members were impressed by the developments of the past years, praised the implementation of the recommendations of the 2018 RAC meeting and made further recommendations. These include for example a closer interaction of DBFZ with agricultural and forest-based research Institutions, further focus on achieving the UN sustainability goals, sharing research infrastructures with research partners to a greater extent, and further developing

Fig. 26 The Research Advisory Council of the DBFZ at its meeting on 5 November 2019

international cooperation beyond the borders of the EU. As of 1 January 2020, the Research Advisory Council was reduced to a total of twelve members, including six renowned scientists from Germany and six from abroad.

DOCTORAL COLLOQUIUM BIOENERGY

The topics of climate protection and energy system transformation will continue to shape the discourse in German society as a whole in the coming decades. In this context, bioenergy as a versatile energy source can make a decisive contribution to reducing greenhouse gas emissions. The research on this topic is outstanding and diverse. Against this background, the aim is to bring together the knowledge and decision-makers of tomorrow at an early stage and to better network the scientific institutions in the field of bioenergy – these are the concerns of the Doctoral Colloquium BIOENERGY, which has been held annually since September 2018 under the patronage of Prof. Dr. Daniela Thrän (DBFZ/UFZ/University of Leipzig).

BIOENERGY DOC2020 | 3RD DOCTORAL COLLOQUIUM BIOENERGY

Fig. 27 2nd Doctoral Colloquium BIOENERGY in Nuremberg (30 September/1 October 2019)

The 2nd event in the series was held in Nuremberg on 30 September and 1 October 2019. Organised by the Friedrich-Alexander-University Erlangen-Nuremberg (FAU), the 2nd Doctoral Colloquium BIOENERGY counted 57 participants in five sessions on the topics of thermochemical conversion, system analysis of bioenergy, biochemical conversion, biorefineries and biofuels as well as energy crop production and utilisation. The event thus continued the success of the previous year. The numerous members of the scientific advisory board include representatives from 19 universities, six research institutions and two public-law institutions. These institutions supervise a total of 176 doctoral students on bioenergy topics. The next edition of the Doctoral Colloquium BIOENERGY is planned for 17/18 September 2020 following the DBFZ Annual Conference 2020 in Leipzig.

Further information:
www.doc-bioenergy.de

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9 DOCTORAL PROGRAMME

"I am doing my doctorate because I am interested in future-oriented topics and at the same time I want to apply my acquired knowledge practically!"

The DBFZ doctoral programme offers scientists who are doing their doctorate at the DBFZ the best opportunities to deal with a topic in the field of bioenergy in depth and intensively and to apply their acquired knowledge and findings practically at the same time. For the research of their PhD topics, PhD students will find state-of-the-art technology in the laboratories, pilot plants and offices of the DBFZ. The modern equipment and infrastructure enable scientific work at a high level. The professional supervision of the doctoral candidates by one or two experienced scientists of the DBFZ is an additional guarantee for the quality of the research. The academic supervision is usually provided by renowned universities in Germany, with which the DBFZ maintains close research cooperations. Doctoral students participate in the research life of the DBFZ from the very beginning and are in-

volved in ongoing projects. Through regular participation in high-ranking scientific events, they are also introduced to the scientific community. In addition, they are given the opportunity to consolidate their experience within the framework of committee work.

A successful example of the efforts to integrate young researchers into the scientific community is the Doctoral Colloquium BIOENERGY initiated by the DBFZ, which is held annually in cooperation with over 30 leading research institutions and universities rom Germany, Austria, Switzerland and Norway in the field of bioenergy.

A total of about 70 doctoral projects are carried out annually at and in cooperation with the DBFZ. For this purpose, the DBFZ cooperates with eight universities and one university of applied sciences from Germany, as well as two foreign universities. Of a total of 72 PhD projects in 2019, 41 PhD projects were supervised directly at the DBFZ. Most of the external doctoral students are supervised in cooperation with the Leipzig Helmholtz Centre for Environmental Research (UFZ) and in cooperation with the Chair of Waste and Material Flow Management at the University of Rostock (12 doctoral students). Five of these doctoral projects[2] were successfully completed in cooperation with the University of Rostock and one in cooperation with the University of Stuttgart in 2019.

[2] Two of them within the DBFZ doctoral program

DOCTORAL EXAMPLE FROM DR. CORNELIA RÖNSCH

DEVELOPMENT OF A METHOD TO USE THE DATA OF THE CHIMNEY SWEEP TRADE FOR ENERGY INDUSTRY REPORTING

Fig. 28 Dr.-Ing. Cornelia Rönsch

One of the major social challenges is the restructuring of energy supply. This can only succeed if the heating/cooling sector, which accounts for half of final energy consumption, is also taken into account. The German Government's declared goal is a 14 % share of renewable energies in the heating/cooling sector by 2020. 13 % in 2016 means that this goal has almost been achieved, largely through the use of biomass (88 %). More than half of the biogenic heat is based on the use of solid fuels (logs, wood pellets, etc.) in small-scale combustion plants, which include not only individual room firing systems such as wood-burning stoves but also central heating systems (= boilers) with a thermal output of up to 1 MW. Meanwhile, this figure is subject to uncertainties, as there is no legally anchored data collection to quantify the number of small-scale combustion plants and the associated fuel input. However, this knowledge is fundamental not only for evaluating the share of renewable energies and reporting emissions, but also as a basis for market observations and political decisions (design of laws and support programmes).

Against this background, the aim of the work was to develop a method for quantifying and characterising the plant stock and the associated fuel use of bio-

Fig. 29 DBFZ Report No. 34

mass-based small-scale combustion plants in Germany. This method is founded on an extrapolation model using a data collection based on the electronically sweeper books of the chimney sweep trade. During the reference year 2014, 11 % of all district chimney sweeps took part in the survey. The 844 participants provided information on the technology, biogenic fuel used, installed capacity, year of commissioning and sweeping frequency for 1.2 million biomass-based small combustion plants. The extrapolation model based on the results of the sweeping survey was additionally fed with data from regional statistics at the municipal level. Thus, the influence of the regional sweeping district characteristics on the small-scale combustion plant stock could be investigated and taken into account in the multiple linear regression. In addition, the survey allows a characterisation of the plant stock. These include statements on the significance of the technologies and fuel assortments, but also on the distribution of the output classes and commissioning years. Since the sweeps do not provide any information on fuel use, an additional online survey was conducted with representatives of the chimney sweep trade.

Various regional parameters influence the stock of small combustion plants, whereby a differentiation must be made between the technologies. While parameters of the regional and building structure have the strongest influence in the case of single room firing systems, regional parameters with reference to the regional availability of wood must be mentioned above all for central and special heating systems. Taking regional conditions into account, the stock in 2014 is estimated at approximately 11.3 million biomass-based small-scale combustion plants. With almost 10 million installations, single-room furnaces clearly dominate the stock,

in which almost exclusively firewood (99 %) is used and every second installation is a wood-burning stove. The age structure of the plant stock is strongly dependent on the technology. For example, 80 % of open fireplaces have been in operation for at least 20 years, whereas this applies to only 11 % of wood-burning stoves. While just under 90 % of the small-scale combustion plants are single-room furnaces, this technology group uses only 47 % of the estimated 279 PJ/a biogenic solid fuels. At 52 %, more than half of the fuel input is attributable to central heating systems and the remaining 1 % to special firing systems. This is due to the significantly higher average fuel input of the approximately 1.15 million central heating systems. The importance of the two sectors households and GHD is also estimated. A large share of small firing installations (92 %) is operated in households. Since central heating systems with higher output and the associated higher plant-related fuel input are more likely to be operated in the GHD sector, the share of fuel input in small-scale furnaces in households is estimated at 80 %, which is somewhat lower than the percentage share of the plant stock.

Contact Doctoral Programme

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Tab. 1 List of ongoing doctoral theses at the DBFZ
*** Successful completion in 2019 (as per 28 February 2020)**

Name	Dissertation subject	Institution / University
Adam, Roman	Production of Small Size Pellets	Approval procedure open
Beidaghy, Hossein	Ash-Related Aspects During the Thermo-Chemical Conversion of Leached Silicon Rich Biomass Assortments for the Production of Heat and Power and the Combined Transformation into Valuable Inorganic Multipurpose Chemical Compounds	University of Leipzig/ Iran University
Bindig, René	Procedure for Developing Catalysts for Emissions Reduction in Incineration Plants	University of Leipzig/ Iran University of Science and Technology (IUST)
Brosowski, André	National Resource Monitoring for Biogenic Residues, Wastes and By-Products – Development of a Systematic Data Collection, Management and Assessment for Germany	University of Leipzig
Butt*, Saad	High Temperature Oxidation of Pollutants on Solid State Catalysts	University of Leipzig
Büchner, Daniel	Optimised Control Strategies for Combination Pellet/ Solar Plants to Improve System Efficiency While Minimising Environmental Impact	Technical University Dresden
Dernbecher, Andrea	Method for Modelling Thermochemical Biomass Conversion in a CFD-Based Simulation	Technical University Berlin
Dietrich, Sebastian	Biogas Upgrading to H-Gas by Direct Synthesis of Short-Chain Hydrocarbons	Technical University Berlin
Dietrich, Steffi	Evaluation of Policy Instruments to Promote Bio-Economic Solutions for Agricultural Residues	Martin Luther University Halle-Wittenberg
Dotzauer, Martin	Numerical Input/Output Model of Plants for Electricity Generation from Biomass in Germany and Derivation of Medium-Term Trend Scenarios	University of Leipzig
Gallegos, Daniela	Potential of Water Plants for Water Cleaning and Sustainable Energy Production for Mexico	University of Rostock
Gebhardt, Heike	Heating Networks 4.0	Technical University Dresden
Gökgöz, Fatih	Development and Optimisation of Self-Sufficient Biogas Treatment Plants with Integrated Filling Station Technology for a Local Biomethane Fuel Supply	University of Rostock
Gröngröft, Arne	Optimising the Conversion Efficiency of Bioethanol Refineries	Technical University Hamburg
Hahn, Alena	The Role of Smart Bioenergy in Combination with CO_2 Removal in Decarbonisation Scenarios	University of Leipzig
Haufe, Henryk	Rural Regions as a Catalyst for the Bio-Economic Policy Strategy and an Efficient Regional Use of Raw Materials for Electricity and Heat production	Approval procedure open
Herrmann, André	Combined High-Temperature Combustion Gas Cleaning via Moving Bed Reactor	Technical University Hamburg
Horschig*, Thomas	Using System Dynamics to Model the Scenario-Based Development of the German Biomethane Market	University of Leipzig
Kar, Indrani	Maintaining Regional Soil Quality for a Biobased Economy	University of Leipzig
Karras, Tom	Working Topic: Biomass Supply Costs	University of Leipzig
Kirsten, Claudia	Contribution to Optimising the Pelleting Behaviour of Fermentation Residues and Landscape Conservation Hay and Mixtures Thereof	Technical University Berlin
Kirstein, Niels	Future Use of Biogenic Solid Fuels against the Background of the Two-Degree Target	University of Leipzig
Köchermann, Jakob	Hydrothermal Conversion of Wood Pulp Solutions for the Production of Furan Derivatives	Technical University Berlin
König, Mario	Investigation of the Development and Utilisation of Novel SCR-Catalysts to Reduce Nitrogen Oxides from the Waste Gas of the Thermo-Chemical Conversion of Biogenic Solid Fuels	Martin Luther University Halle-Wittenberg
Kröger*, Michael	Thermochemical Use of Algae with the Focus on Hydrothermal Processes	University of Rostock
Krüger*, Dennis	Development and System Integration of a Micro-Scale Combined Heat and Power Plant for Solid Biomass	Technical University Chemnitz
Kurth, Matthis	Development, Characterisation and Modelling of a Water-Separating Membrane to Increase the Turnover of the Methanation Process	Technical University Berlin
Lauer*, Markus	Macro-Economic Assessment of Biogas Plants as an Option to Enhance Flexibility in the Electricity System of the Future	University of Leipzig
Mauky*, Eric	Supply of Biogas According to Demand through Process Control	University of Rostock
Müller*, Mirjam	Emissions Reduction in Small-Scale Biomass Furnaces Based on Integrated Catalysis	Leipzig University of Applied Sciences (HTWK)

Name	Dissertation subject	Institution / University
Ngoumelah, Daniel Dzofou	Development of Microbial Electrochemical Technologies for Material and Energetic Use of Humans' and Animals' Raw Liquid Manure	University of Leipzig
Nieß, Selina	Investigation of Methanation Catalysts for the Upgrading of Purified Biogas in Continuous Operation	Approval procedure open
Nitzsche, Roy	Adsorption and Membrane Filtration for the Treatment of Aqueous Product Solutions in Lignocellulose Biorefineries	Technical University Berlin
Prempeh, Clement Owusu	Thermo-Chemical Conversion of Silicon-Rich Biomass Residues for the Production of Heat and Power, and the Combined Generation of Mesoporous Biogenic Silica for Material Application (BiOx)	University of Leipzig/ University of Stellenbosch, South Africa
Pujan, Robert	Modelling of Biorefinery Processes	NTNU Trondheim, Norway
Reinelt, Torsten	Monitoring of Locally Unknown and Time-Varying Methane Emissions from Biogas Plants	Technical University Dresden
Röder, Lilli Sophia	Implementation of Demand Side Management in Biorefineries	Approval procedure open
Rönsch*, Cornelia	Development of a Method to Use the Data of the Chimney Sweep Trade for Energy Industry Reporting	University of Leipzig
Sumfleth, Beike	Measurement of Low ILUC Risk Indicators with a LCA for the Implementation in Sustainability Certification Schemes of Biobased Products	University of Leipzig
Theurich*, Steffi	Unsteady-State Operation of a Fixed-Bed Recycle Reactor for the Methanation of Carbon Dioxide	University of Ulm
Undiandeye, Jerome Anguel	Fermentation of Agricultural Residues for Energetic and Material Utilization	University of Rostock
Zeng, Thomas	Targeted Treatment of Wood-Type Biomass Residues for Use as Fuel in Small-Scale Furnaces for Heat Supply	University of Rostock

Tab. 2 List of ongoing doctoral theses with the cooperation partner Helmholtz-Centre for Environmental Research – UFZ
*** Successful completion in 2019 (as per February 28, 2020)**

Name	Dissertation subject	Institution / University
Baleeiro, Flávio César Freire	A Biorefinery on Sugarcane By-Products Based on the Carboxylate and Syngas Platforms	Karlsruhe Institute of Technology
Boldt, Christin	Transformative Change and Pathways to a Sustainable Bioeconomy	University of Leipzig
Budzinski*, Maik	Towards Ex-Post Monitoring and Ex-Ante Evaluation of the Bioeconomy in Germany – the Example of Wood Use	University of Leipzig
Chan, Katrina	Modelling of Energetic and Material Biomass Use in Sustainable Agriculture and Food Scenarios	University of Leipzig
Grosch Schröder, Bruna	Development of a Biogas Production Process Inspired by the Pachnoda Marginata Larvae Gut System	University of Leipzig
Jordan, Matthias	The Future Role of Bioenergy in the German Heat Sector in Competition with other Renewable Technologies	University of Leipzig
Jusakulvijit, Piradee	Sustainable Bioethanol Development for an Approach to Circular Economy in Thailand – an Evaluation by Multi-Criteria Decision Making	University of Leipzig
Liu, Bin	Applied Microbial Ecology of Anaerobic Reactor Microbiomes	University of Leipzig
Logroño, Washington	Flexible Alkalitolerant Biomethanation of Renewable Hydrogen Derived from Excess Electricity	University of Leipzig
Musonda, Frazer	Modelling of Bioenergy and Bioeconomy Futures: The Optimal Allocation of Biomass to Competing Sectors	University of Leipzig
Reißmann, Daniel	Regional Value Chains Through the Cascade Use of Biomass Resources in Hydrothermal Processes (HTP)	University of Leipzig
Siebert*, Anke	Socioeconomic Evaluation of Wood-Based Products from Germany: Development of a Regional, Social LCA' Method and Application in a Bioeconomic Region	University of Leipzig
Tafarte, Philip	Energy System Modelling – Focus System Integration EE	University of Leipzig
Zeug, Walter	A Holistic Life Cycle Sustainability Assessment Approach for the Bioeconomy Regions (preliminary)	University of Leipzig

10 CONTRACT RESEARCH AND SCIENCE-BASED SERVICES

As a research institute with predominantly applied research, the DBFZ strives for close cooperation with project partners from industry and offers extensive contract research and a wide range of science-based services. These go beyond the main research areas and are directed equally at politics and industry, associations, experts and committees. The content of the work is implemented in a cross-departmental and interdisciplinary manner so that the entire expertise of the DBFZ can be used comprehensively and efficiently for the following consulting and technical services.

Fig. 30 Work in the biorefineries technical centre of the DBFZ

10.1 POLICY RECOMMENDATIONS AND ADVICE

The DBFZ offers a wide range of consulting services in the fields of bioenergy and bioeconomy for political decision-makers in ministries, for members of parliament or associations. In order to meet the increasing number of inquiries and the demand for political recommendations for action, two DBFZ staff members support the house in matters of political communication. The core task of the work is to comprehensively and consistently introduce R&D results into the political process in the form of statements on current legislative projects, responses to ministerial inquiries or in the form of lectures and expert discussions.

In addition, the "Policy Recommendations and Advice" section observes the long-term development of bioenergy markets within various monitoring projects (for electricity generation from biomass and for biofuel use) and supports the design of regulative frameworks for the use of biomass for energy and materials (e. g. EEG, KWKG, Biokraft-NachV, etc.). Expertise is also provided in the form of status papers and analyses, for example on the current potential of imported biomass for energy use, on national strategies or on the mobilisation of previously unused potentials, but also on the development of support instruments.

Since January 2017, policy advice has also been provided in the form of direct secondment of DBFZ staff to the Federal Ministry of Food and Agriculture (BMEL). The aim is to support BMEL Department 524 "Bioenergy and Energy Affairs" and in part Department 525 "Bioeconomy, Material Biomass Use", including the package of measures under the Climate Protection Act and the merger of the Bioeconomy Policy and Research Strategy into the National Bioeconomy Strategy published in January by BMEL and the Federal Ministry of Education and Research (BMBF).

The package of measures in the Climate Protection Act sets out concrete targets

Fig. 31 Federal Minister of Agriculture Julia Klöckner and the Prime Minister of Saxony Michael Kretschmer visiting the DBFZ (30 July 2019)/Member of Parliament Sepp Müller (2nd from right) visiting the research biogas plant of the DBFZ (17 April 2019)

and measures for reducing greenhouse gases in the transport, building and energy sectors, among others. Within the framework of the departmental negotiations on the package of measures, many ad-hoc inquiries were made directly to the DBFZ, which was able to respond competently, comprehensively and quickly.

The PeGGÜ project, in which perspectives for the development and energetic use of liquid manure potentials were worked out, provided important impulses. Another very practical project, DEMO-SPK, tested the use of biokerosene in flight operations (more on this from page 40). The results obtained show the potential of using bioenergy for a wide range of applications and provide decision-makers with important insights into the design of the energy system transformation and the package of measures for the Climate Protection Act.

Tab. 3 Key position papers in the area of "Policy Recommendations and Advice" in 2019 (selection)

Subject	Recipient
PeGGÜ – Perspectives of energetic manure utilisation	BMEL
NECP – National Energy and Climate Plan	BMWI
National Bioeconomy Strategy	BMEL/BMBF

In addition to the collection, evaluation and presentation of data and information on market development, available biomass potentials or typical parameters of bioenergy technologies, the DBFZ has also developed suitable tools to develop medium and long-term bioenergy scenarios and supports the scientific monitoring of strategy projects.

Further information:
www.dbfz.de/en/services/policy-recommendations-and-advice

AN OVERVIEW OF SERVICES

- Scientific monitoring of strategic policy development and derivation of recommendations for action
- Opinions on legislative procedures and provision of expertise in the context of parliamentary questions as well as support in the further development of laws and other standards
- Development and implementation of suitable monitoring systems under changing (research) political conditions

Contact

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10.2 MARKET ANALYSES AND DATA PROVISION

Bioenergy plays a decisive role in the substitution of fossil fuels. Accordingly, and following the trend of recent years, regional as well as international paths of use are being further expanded. With the parallel development of the bioeconomy sector, the number of market players is increasing and with it the competition for the limited available biomass. Against the background of continuously increasing demands on efficient utilisation technologies for sustainable bioenergy supply and biomass use, a comprehensive and up-to-date database is the strategic basis for individual planning and the further development of political framework conditions. This includes the analysis of the development of markets, trade and raw material flows and prices. In addition, the DBFZ aims to collect technological,

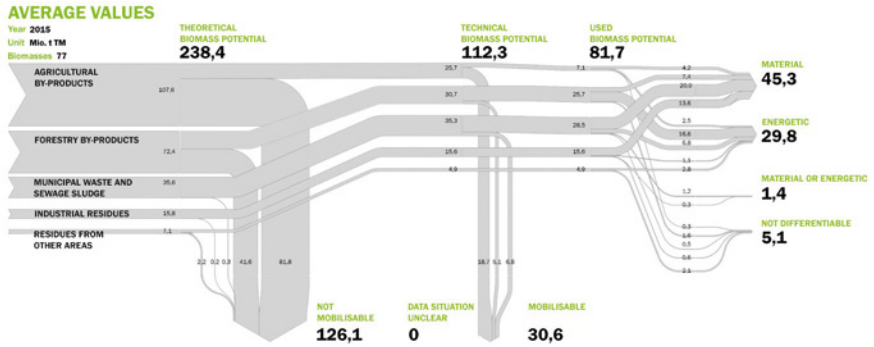

Fig. 32 A large amount of bioenergy data is collected at the DBFZ (source: DBFZ resource database)

economic and environmental data and to integrate them into the analysis and evaluation of biomass supply concepts and technology options. Furthermore, established and potential market players as well as other interested parties can be provided with transparently prepared information on the continuously increasing quality and sustainability requirements. Data management and provision at the DBFZ is supported by a structured research data management.

AN OVERVIEW OF SERVICES

- Determination of biomass potentials and development of use scenarios and exploitation strategies for various players in biomass markets (material and energy use)
- Monitoring of market and technology development, including systematic recording in databases and the preparation of market and technology overviews (including economic data)
- Forecast of future development trends in the field of bioenergy and bioeconomy
- Provision of data on trade in biomass/bioenergy (costs, prices and quantities) and cost analysis of biomass supply (so-called cost-supply curves)
- Provision of structural data on the electricity, heat and fuel market and analysis of the marketing strategies of plant and network operators (e. g. for demand-oriented energy supply)

Efficiency and sustainability considerations can be carried out within the framework of economic, environmental and technical assessments, depending on the issue at hand, and can be underpinned by sensitivity considerations and scenario analyses. This also applies to the evaluation of concepts for market and system integration for flexible bioenergy supply.

10.3 TECHNICAL, ECONOMIC AND ENVIRONMENTAL ASSESSMENT

The increasing competition for limited biomass resources as well as continuously rising and changing demands on economic and environmental performance lead to a growing pressure on bioenergy plant operators to innovate and optimise. The DBFZ offers market players various services related to analysing and optimising existing and future bioenergy technologies and concepts. In addition to the assessment of technical, economic and environmental parameters of bioenergy plants, such analyses provide a suitable basis for process and concept optimisation.

AN OVERVIEW OF SERVICES

Technical evaluation

- Material and energy balancing
- Technical feasibility
- Technology screening and learning curves
- Characteristic-based evaluation (e. g. specific efficiencies, availabilities, quality level, classification according to technical development status)

Economic evaluation

- Feasibility studies and evaluation of use/operation concepts including costs of new plants, plant extensions or conversion projects
- Analyses of costs and profitability for biogenic supply concepts (electricity, heat, fuels, chemical bioenergy sources)

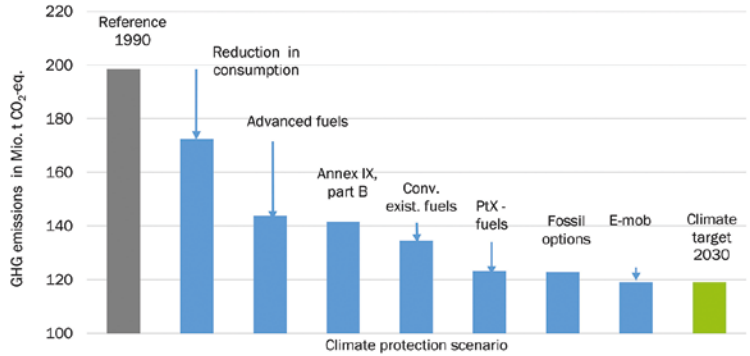

Fig. 33 GHG savings due to the minimum requirements set out in RED II

- Analysis of value chains using life cycle cost analyses (LCC, Social Life Cycle Assessment) and assessments of the regional added value of the contribution of biomass use concepts

Environmental evaluation

- Life cycle assessment (LCA) with regard to greenhouse gas emissions and other environmental impacts (including water balance, humus, eutrophication, acidification) and primary energy consumption
- Land use competition

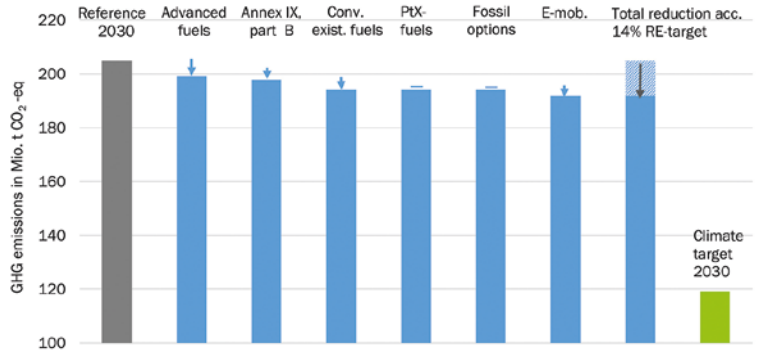

Fig. 34 Measure-specific GHG savings to achieve the climate protection target in transport

10.4
CONCEPT AND PROCESS DEVELOPMENT AND OPTIMISATION

In order to meet the challenges of changing political and societal conditions, concept and process development plays a special role in the field of bioenergy research. Constantly updated knowledge of the state of the art is used to develop processes further. In addition to our own experimental facilities, computer-aided analyses are important tools to investigate material and energy flows as well as flow conditions, heat and mass transfer processes or the influence of various operating parameters. Such parameters may relate to entire biorefineries or individual components such as combustion, gasification and synthesis plants. In this way, the experiments are supported and completed by numerical investigations. Depending on the object of investigation, flow sheet simulations, e. g. in Matlab and Aspen Plus, or CFD models in Open FOAM and ANSYS Fluent are used to describe and calculate processes and procedures precisely. The simulation of processes involving biomass is particularly challenging because commercial simulation tools often do not have models for the different biomasses. In these cases, models are extended in-house and validated by comparing them with measured results. The predictive accuracy of the models is continuously improved in various research projects.

Flow diagramme simulations can be used to investigate the interaction of the different process steps. Especially the investigation of mass and energy balances of complete biorefineries or parts of them offers early possibilities to increase efficiency. In addition, the results provide an essential basis for economic and environmental analyses. The effects of adjustments in existing plants can also be well illustrated by flow sheet simulations. With CFD simulations, plants of any size can be represented three-dimensionally and the physical and chemical processes taking place in them can be simulated. Special attention is paid to the investigation of flow processes, taking into account the chemical reactions taking place. By varying various parameters, processes can be improved and optimal fluid dynamic operating conditions can be determined, for example to reduce emissions from combustion or to increase the efficiency of synthesis plants.

AN OVERVIEW OF SERVICES

- Development of new process concepts
- Calculation of material and energy flows (process balancing)
- Creation of flow diagramme simulations
- Creation of DGL models of individual plant components
- Upscaling of processes
- Test and development of new technologies and process steps
- Optimisation of existing technologies, process steps and material flow management concepts
- Creation of CFD simulations (stationary and dynamic)
- Performance of kinetic measurements for catalysts
- Development of control concepts
- Numerical description of mass transport mechanisms in porous layers like ceramic membranes or catalysts

10.5 SCIENTIFIC SUPPORT FOR R&D PROJECTS

One example of comprehensive scientific support for R&D projects is the accompanying project of the BMWi funding area “Energetic use of biogenic residues and waste materials” (short “Biomass energy use”), which has been running at the DBFZ for ten years. By way of conferences and workshops of the funding area, over 160 joint projects and 400 project partners from small and medium-sized enterprises and research institutions have been successfully networked so far.
A further focus is the consolidation of the participants scientific output and the transfer of research results to different target groups (politics, research, practice). For this purpose, a series of publications, in which more than 20 volumes as well as seven focus booklets on various priority topics (biogas, solid fuels, hydrothermal processes, bioenergy technologies etc.) have been published so far. Furthermore, the accompanying project organises the cross-project working groups of the funding area, which discuss the harmonising of methods and current scientific and political issues. So far, the collections of measurement methods on the topics of biogas, particulate matter and gasification as well as a method handbook (in German and English) have been further developed. Furthermore joint political statements have been developed in the course of an intensive discussion process with the participants of the funding area. Since 2016, the funding area has been a member of the BMWi Energy Research Network with currently over 660 members. In the frame of this network, the accompanying project coordinated the preparation of future R&D recommendations as part of the consultation process for the 7th Energy Research Programme.

AN OVERVIEW OF SERVICES

- Scientific accompanying research of complex R&D networks
- Scientific monitoring of research programmes by:
  - networking between projects
  - consolidation of scientific output and knowledge transfer (public relations and press work)
  - increasing the visibility and external image of the programmes
  - coordination of cross-project working groups
  - coordination and moderation of (socio)political discourses
- Coordination of (specialist) events and preparation of publications
- Support of current specialist dialogues
- Coordination of harmonisation processes

Further information:
www.forschungsnetzwerke-energie.de (german language)

Fig. 35 Workshop in the context of the 8th Status Conference “Biomass energy use”

Fig. 36 Leipzig Biogas Expert Talk on 27 November 2019

10.6 KNOWLEDGE AND TECHNOLOGY TRANSFER

The DBFZ and the accompanying project of the BMWi funding programme "Biomass energy use" organise conferences on specific focus topics (e.g. hydrothermal processes, process measurement technology of biogas plants, dust separators in domestic furnaces). In addition, current topics and research results on the topics of biogas, biofuels and solid biomass are presented and discussed within the framework of the series "Leipziger Fachgespräche". Through publications (final reports, dissertations, guidelines, handbooks and conference proceedings, reports), an extensive portfolio of scientific reports is additionally made available and can be downloaded free of charge from the DBFZ website (**www.dbfz.de/en/press-media-library/publication-series**). Through cooperation projects in Germany and abroad, a continuous knowledge and technology transfer takes place in the form of workshops, guidelines and staff training.

AN OVERVIEW OF SERVICES

- Organisation and implementation of specialist events (technical discussions, symposia, workshops)
- Coordination of innovation processes
- Preparation of guidelines and manuals
- Development and creation of web-based information platforms or open source portals
- Further training (summer school)

11 TECHNICAL AND SCIENTIFIC SERVICES

In addition to the services mentioned above, the DBFZ offers a special R&D infrastructure in the three technical research departments of “Biochemical Conversion”, “Thermo-Chemical Conversion” and “Biorefineries” as well as in the analytical lab. The technical and scientific services are aimed at plant and mechanical engineering, process development companies, plant operators and other companies and institutions engaged in R&D activities.

Fig. 37 Work in the engine test bed of the DBFZ

AN OVERVIEW OF SERVICES

Biochemical Conversion Department:

- Market analysis (based, among other things, on the annual operator survey), forecasting and strategy consulting
- Scientific monitoring of the development of plant components
- Balancing and evaluation of processes in terms of efficiency, technical and economic feasibility
- Experiments (batch and continuous experiments, microbial-electrochemical experiments)
- Concept development for specific site conditions
- Biogas process analytics
- Determination of energy quantities (electricity, heat) and of optimisation potentials

Thermo-Chemichal Conversion Department:

- Development, characterisation, pre-treatment and addition of fuels
- Combustion tests and comparative classification of combustion properties
- Separator measurement
- Fine particle and CO measurements
- CFD simulation of thermodynamic processes
- Investigation of catalyst technologies for furnace integration
- Catalyst investigations in test beds and in practice, with regard to efficiency and emissions
- Catalyst screening in model and real gas
- Catalyst characterisation by physico and chemisorption measurement
- Catalyst synthesis

Fig. 38 Fuel conditioning and combustion lab of the DBFZ

Biorefineries Department:

- Pilot plant trials on:
  - hydrothermal carbonisation and liquefaction
  - fixed bed and entrained flow gasification
  - synthesis gas process
  - gas cleaning
  - solid-liquid/liquid-liquid separation process for biogenic valuable substances from aqueous media
- Investigation of the behaviour of fuels and their emissions in an engine test bed

ANALYTICAL LAB

In order to assess the potential applications of different types of biomass, the chemical composition and fuel properties of liquid and solid biofuels, biogas substrates, by-products and residues as well as conversion by-products such as ashes, filter dusts and process waters are investigated in the analytical laboratory of the DBFZ. Analyses are carried out according to current standards as well as problem-oriented development and adaptation of methods.
With the existing equipment, the following parameters can be determined: pellet density, bulk density, particle size distribution, fines, abrasion resistance, fuel/heat value, water content, volatile matter, fixed, elemental and organic carbon, CHNS composition, ash content, elemental composition with regard to main and trace elements, total contents of sulphur and chlorine as well as concentrations of elutable components, density, viscosity, refractive index, flash point, degree of copper corrosion, acid and saponification number for glycerine as well as the pH value. Polycyclic aromatic hydrocarbons (PAHs), fatty acid methyl esters (FAMEs) and phenols can be identified and quantified by GC analysis and the concentrations of sugars and furan derivatives can be determined by HPLC. In the foreseeable future, a method to determine volatile organic hydrocarbons (BTEX) by GC will also be established.

The central contact person for contract research and science-based services is the coordinator for knowledge and technology transfer.

Contact

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Fig. 39 Work in the analytical lab of the DBFZ

12 RESEARCH INFRASTRUCTURE

Fig. 40 The research biogas plant

The DBFZ carries out applied biomass research for the most part. For this purpose, the DBFZ has a large number of technical facilities and test beds. Below you will find a tabular overview of the facilities and the respective scientific contact persons.

Detailed information on the technical infrastructure of the DBFZ on the internet at:
www.dbfz.de/en/research-infrastructure

Tab. 4 Tabular overview of contact persons in the laboratories, test beds and technical facilities of the DBFZ

Department	Description	Contact
Biochemical Conversion	Research Biogas Plant	Ulf Müller E-Mail: ulf.mueller@dbfz.de Christian Krebs E-Mail: christian.krebs@dbfz.de
	Biogas lab	Dr.-Ing. Liane Müller E-Mail: liane.mueller@dbfz.de Katrin Strach E-Mail: katrin.strach@dbfz.de
	Emission measurement	Dr. rer. nat. Tina Clauß E-Mail: tina.clauss@dbfz.de Torsten Reinelt E-Mail: torsten.reinelt@dbfz.de
Thermo-Chemichal Conversion	Combustion lab	Michael Junold E-Mail: michael.junold@dbfz.de
	Fuel conditioning lab	Claudia Kirsten E-Mail: claudia.kirsten@dbfz.de
Biorefineries	Biorefineries Technical Centre	André Hermann E-Mail: andre.herrmann@dbfz.de
	Engine test bed	Jörg Schröder E-Mail: joerg.schroeder@dbfz.de Thomas Hirsch E-Mail: thomas.hirsch@dbfz.de
Bioenergy Systems	Data bases/Research data	Dr. rer. nat. Kai Radtke E-Mail: kai.radtke@dbfz.de
	Assessment methods	Stefan Majer E-Mail: stefan.majer@dbfz.de
	Potential analyses	André Brosowski E-Mail: andre.brosowski@dbfz.de
All departments	Analytical lab	Dr. rer. nat. Jana Mühlenberg E-Mail: jana.muehlenberg@dbfz.de Igor Adolf E-Mail: igor.adolf@dbfz.de

13 ORGANISATION

The DBFZ was founded as a non-profit limited liability company in Berlin on 28 February 2008 against the background of the complex questions regarding the provision and use of bioenergy. The research institute is owned by the Federal Republic of Germany and is represented by the Federal Ministry of Food and Agriculture.

Fig. 41 The new building (House 1) of the DBFZ in March 2019

13.1
CONSTRUCTION WORK

The past few years have been characterised by a large number of construction measures in terms of infrastructure. After extensive redevelopment measures from the economic stimulus package II, the DBFZ and the then Federal Ministry of Transport, Building and Urban Affairs (BMVBS), represented by the Saxon State Ministry of Finance (SMF) and the state-owned company Sächsisches Immobilien- und Baumanagement Niederlassung Leipzig I (SIB), announced the competition for the “New Technical Centre” in 2013. The new DBFZ building realised by the Leipzig architectural office Schulz und Schulz Architekten GmbH is divided into a five-storey office and seminar building and a two-storey pilot plant and laboratory building. At the heart of the ensemble, with approx. 2,400 m², is the pilot plant for measurement and test trials for research and development of new fuels and combustion systems, for pellet processing and for flue gas analysis.

On the ground floor of the new office and seminar building, a representative reception area, a generously designed seminar room for up to 222 people and various function and meeting rooms have been available since the end of 2019. Offices are arranged on the four upper floors, which offer a high degree of flexibility. The construction costs for the new building project amount to a total of 67 million euros (including initial equipment), which are being provided by the Federal Ministry of Food and Agriculture on behalf of the Federal Republic of Germany. The official inauguration of the building complex is scheduled for late summer 2020.

Fig. 42 New conference centre and pilot plant hall (thermo-chemical conversion segment)

13.2
RESEARCH DEPARTMENTS

The DBFZ has four research departments, which cooperate closely with each other in practice, as the organisational framework for the processing of the numerous scientific research tasks. While the departments of Biochemical Conversion, Thermo-Chemical Conversion and Biorefineries are mainly concerned with applied research tasks, the Bioenergy Systems department works on policy advice, analyses of potential, acceptance studies and a wide range of scenarios for biomass use.

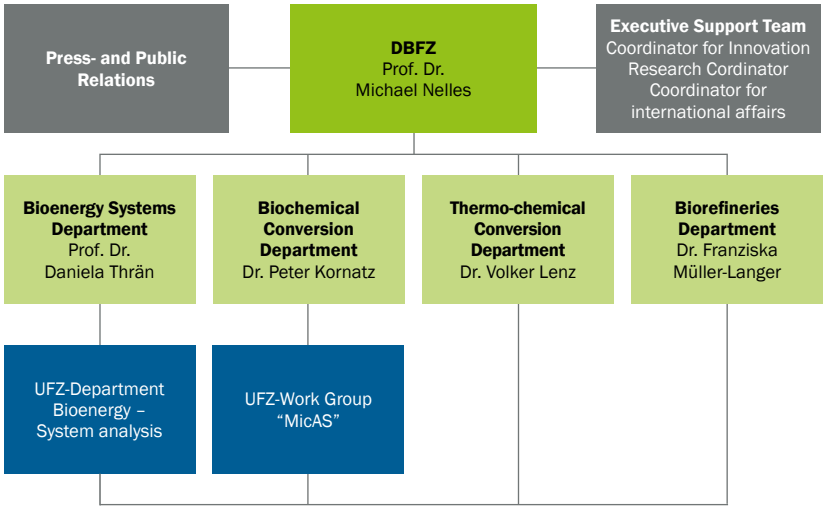

Fig. 43 The research areas of the DBFZ including the cooperation departments with the UFZ

13.3
SUPERVISORY BOARD AND RESEARCH ADVISORY COUNCIL

With regard to the content of its scientific work, the DBFZ is advised by a top-class research advisory council. It consists of six national and six internationally renowned scientists from the field of bioenergy research. The members of the Research Advisory Council are appointed by the Supervisory Board, which consists of representatives of the five most important federal ministries for the work of the DBFZ.

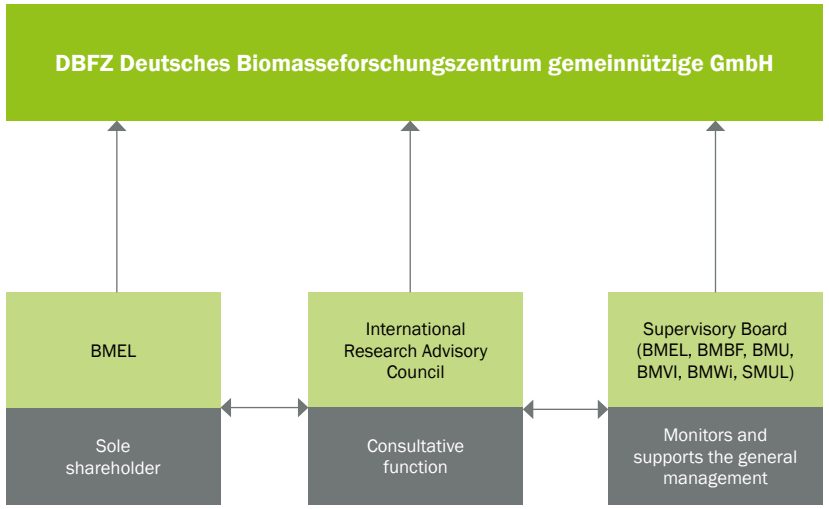

Fig. 44 The regulatory bodies of the DBFZ

THE SUPERVISORY BOARD OF THE DBFZ

The Supervisory Board, chaired by the Federal Ministry of Food and Agriculture (BMEL), takes the decisions on content and organisation regarding the development of the DBFZ. Other members are the Federal Ministry of Education and Research (BMBF), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Transport and Digital Infrastructure (BMVI), the Federal Ministry for Economic Affairs and Energy (BMWi) and the Saxon State Ministry of Energy, Climate Protection, Environment and Agriculture (SMUL). The Supervisory Board meets twice a year at the DBFZ.

Representatives of the Supervisory Board are the persons listed below:

(Status: 1 January 2020)

Olaf Schäfer (Chairman)
Head of Department 52 “Sustainability, Regrowable Resources”,
Federal Ministry of Food and Agriculture (BMEL)

Deputy Director Berthold Goeke (Deputy Chairman)
Head of Department “KI I Climate Protection Policy”,
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

Daniel Gellner
Head of Department “Agriculture and Forestry”,
Saxon State Ministry of Energy, Climate Protection, Environment and Agriculture (SMUL)

N. N.
Head of Department III B, “Renewable Energies in the Electricity Sector”,
Federal Ministry for Economic Affairs and Energy (BMWi)

Andrea Heyn
Head of Division, Department 7 (Provision for the Future), Division 723 “Energy”,
Federal Ministry of Education and Research (BMBF)

Birgit Breitfuß-Renner
Head of Subdepartment G2, “Environment and Noise Control”,
Federal Ministry of Transport and Digital Infrastructure (BMVI)

THE RESEARCH ADVISORY COUNCIL

The Research Advisory Council, made up of nationally and internationally renowned bioenergy experts, advises the DBFZ on the orientation of its scientific activities since its foundation in 2008. This ensures that the research carried out with institutional funding is scientifically sound and highly relevant to the current and future use of bioenergy in the energy system. With the beginning of 2020, five new members (*) have taken up their activities in the Research Advisory Council. The term of the newly appointed committee is the period 2020–2023.

Fig. 45 The Research Advisory Council of the DBFZ at its meeting on 5 November 2019

Tab. 5 Representatives of the Research Advisory Council are the persons listed below (Status: 1 January 2020)

Member	Organisation	City and Country
Chiaramonti, Prof. Dr. David	Polytechnic University of Turin – DENERG – Department of Energy "Galileo Ferraris"; RE-CORD – Renewable Energy Consortium for Research and Demonstration	Turin (Italy)
Dong, Prof. Dr. Renjie (Deputy Chariman)	China Agricultural University (CAU) – National Center for International Research of BioEnergy Science and Technology	Beijing (China)
Dornack, Prof. Dr. Christina (Chairman)	Technical University Dresden – Institute of Waste Management and Circular Economy	Dresden (Germany)
Grzybek*, Prof. Dr. habil. Teresa	AGH University of Science and Technology in Kraków – Department of Fuel Technology	Kraków (Poland)
Hartmann, Dr. Hans	Technology- and Promotion Centre at the Regrowable Ressource Competence Centre (TFZ)	Straubing (Germany)
Kemfert, Prof. Dr. Claudia	German Institute for Economic Research (DIW Berlin)	Berlin (Germany)
Murphy*, Prof. Dr. Jerry	University College Cork – Professorship of Civil Engineering	Cork (Ireland)
Schenk*, Prof. Dr. Joachim (to be confimred by the Supervisory Board)	Leipzig University of Applied Sciences – Chair of Environmental Engineering	Leipzig (Germany)
Teutsch, Prof. Dr. Georg	Helmholtz-Centre for Environmental Research – UFZ	Leipzig (Germany)
Thiffault, PhD Evelyne	Laval University – Department of Wood and Forest Sciences	Québec (Canada)
Wagemann*, Prof. Dr. Kurt	DECHEMA – Society for Chemical Engineering and Biotechnology	Frankfurt am Main (Germany)
Walter*, Prof. Dr. Arnaldo	University of Campinas – Department of Energy	Campinas (Brazil)

13.4
FINANCE AND PERSONELL

The DBFZ was founded as a limited liability company (GmbH) and works predominantly on a non-profit basis. The aim was and is to be able to make flexible and transparent use of public research funding and to work in a research and advisory capacity on behalf of third parties. The DBFZ is financed by institutional funding from the Federal Ministry of Food and Agriculture as well as by project grants and research contracts (market projects) acquired in competition.
In 2019, the DBFZ was financed with 21.3 million euros by the BMEL. In addition, some 13 million euros in third-party funding were raised (see Figure 46). On the expenditure side, investments were clearly in the foreground at approx. 15.5 million euros due to the new construction measure. Further expenses are split between personnel expenses at approx. 11.7 million euros and material expenses at 3.7 million euros. The revenue surplus in 2019 consists of one-off third-party funding for a pilot plant in the amount of approx. 3.4 million euros.

PERSONNEL

As of 31 December 2019, 248 people were employed at the DBFZ. Including the scientific staff units as well as press and public relations department, 197 of these persons were employed in the scientific/technical area and 51 in administration (including the Infrastructure and Property Management and IT).
In 2019, the DBFZ was again in charge of a large number of projects. A total of 26 internships and student research projects as well as 49 bachelor, master and diploma theses were technically supervised. In addition, a total of 39 guest researchers, foreign interns and scholarship holders worked at the DBFZ last year.

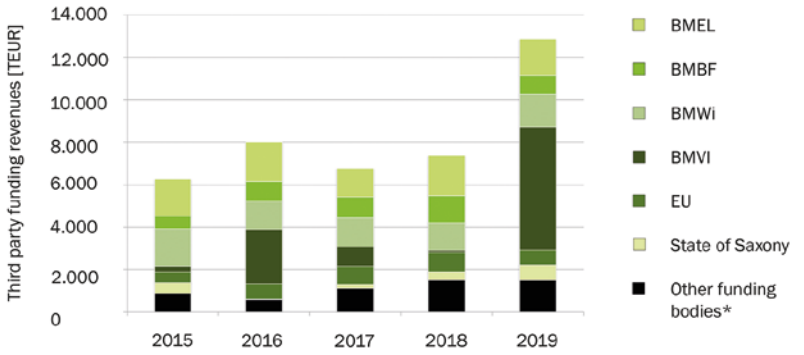

Fig. 46 Overview of third-party funding from 2015–2019 (preliminary figures) (* Contract research and services of private and public clients)

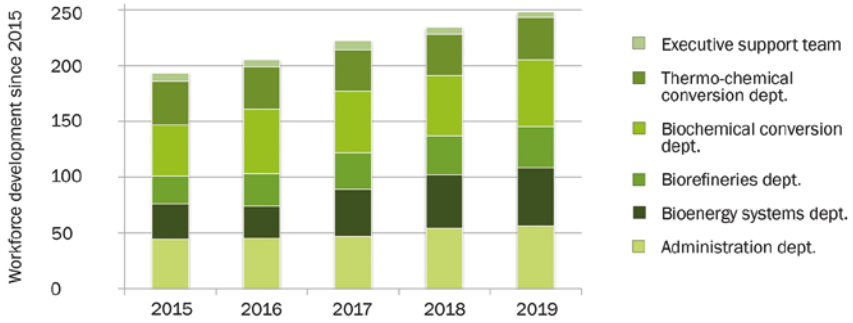

Fig. 47 Personnel development at the DBFZ (2015–2019)

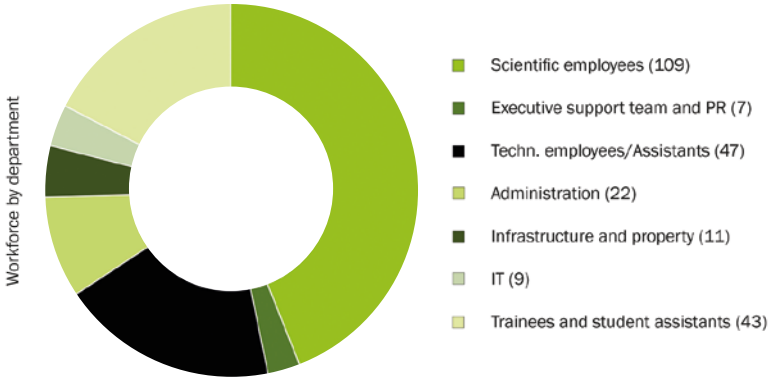

Fig. 48 Number of employees covered by collective agreements by sector (Status: 31 December 2019)

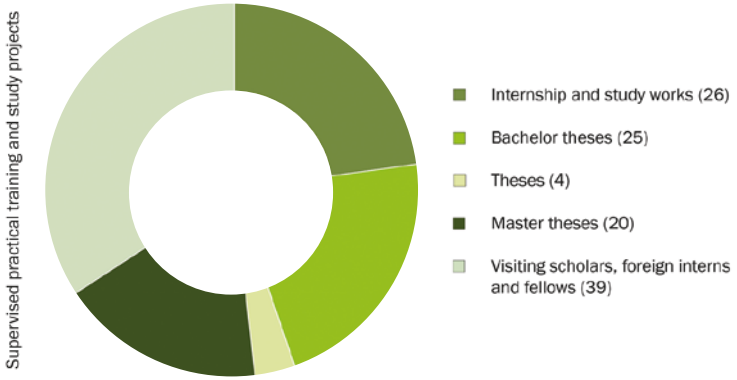

Fig. 49 Overview of the work supervised at the DBFZ in 2019 (as per 31 December 2019)

TRAINEES AT DBFZ

The DBFZ has been a training company since its foundation in 2008. By the end of 2019, a total of 26 trainees and retrainees had successfully completed their qualification. In 2019, nine trainees/retrainees were in apprenticeship in the fields of “Event Management Assistant”, “Office Management Assistant”, “Electronics Technician for Industrial Engineering”, “Personnel Services Assistant” and “Chemical Laboratory Assistant”, as well as six BA students in the fields of “Information Technology”, “Controlling”, “Environmental Technology” and “Biotechnology”. In 2019, the DBFZ was honoured by the Leipzig Chamber of Industry and Commerce as an “excellent training company”.

Fig. 50 Trainees at DBFZ


IHK Industrie- und Handelskammer zu Leipzig

EHRENURKUNDE

Ausgezeichneter Ausbildungsbetrieb 2019

Für herausragende Leistungen
in der dualen Berufsausbildung
wird dem Unternehmen

DBFZ Deutsches Biomasseforschungs-zentrum gemeinnützige GmbH

besondere Anerkennung ausgesprochen.

Leipzig, 1. Oktober 2019
Industrie- und Handelskammer zu Leipzig

Kristian Kirpal
Präsident

Dr. Thomas Hofmann
Hauptgeschäftsführer

13.5 BOARDS, ADVISORY COUNCILS AND COMMITTEES

From the very beginning, the DBFZ strives for an intensive transfer of knowledge with other institutions and the scientific community. This is part of the objectives of applied research and the exploitation of research results. For this purpose, the scientists of the DBFZ are represented in various scientific committees, advisory boards, working groups, networks and committees as well as (guest) professors in Germany and abroad.

Tab. 6 Selected committee activities of DBFZ employees (as per February 2020)

SCIENTIFIC COMMITTEES/EXECUTIVE BOARDS/DIRECTORATES (SELECTION)

Commitee	Role	Country	Since
6th International Conference on Solid Waste Management	Member of the Scientific Committee	India	2014
Bioeconomy Council – Independent Advisory Commitee for the German Government	Member	Germany	2012
BioFuelNet Canada	Member in an RMC Subcommittee	Canada	2014
Biogas from straw – Conferences	Member of the Research Advisory Council	Germany	2017
Biomass to Power and Heat	Member of the Programme Comittee	Germany	2014
BMBF BioEconomy Cluster	Member of the Executive Board	Germany	2012
Bundesverband Bioenergie e. V. (BBE)	Member of the Advisory Board	Germany	2012

Commitee	Role	Country	Since
Chinese-German Centre for Environmental Technology & Knowledge Transfer (CETK) of Anhui Province	Director	China	2005
Detritus – Multidisciplinary Journal for Waste Resources & Residues	Editorial Board Member	International	2018
DGAW – Deutsche Gesellschaft für Abfallwirtschaft e. V.	Member of the Executive Board	Germany	2014
Doctoral Colloquium BIOENERGY	Member of the Programme Advisory Board	Germany	2018
Economic and Scientific Strategy Council Mecklenburg-Western Pomerania	Speaker for the Future Field of Energy	Germany	2014
Energy Advisory Council Saxony, state level	Member of the Committee of Experts	Germany	2012
Energie und Umweltstiftung Leipzig	Member of the Board of Trustees	Germany	2013
Energy, Sustainability and Society	Editor in Chief	International	2017
European Biogas Association (EBA)	Member of the Scientific Advisory Board	Belgium	2014
European Energy Research Alliance (EERA Bioenergy)	Member	EU	2019
European Technology Platform on Renewable Heating & Cooling (RHC-ETB)	Member	EU	2019
Export Initiative RETech “Recycling & Waste Management in Germany” of the German Federal Government (BMU, BMWi, BMZ)	Member of the Executive Board and head of the China working group	Germany	2014
German-Chinese Centre in Anhui Province	Member of the Executive Board	China	2009
Helmholtz-Centre for Environmental Research – UFZ	Member of the Scientific Advisory Board	Germany	2013
IEA Bioenergy, Task 37 “Energy from Biogas”	German Representative	International	2016
IEA Bioenergy, Task 39 “Commercialising conventional and advanced transport biofuels from biomass and other renewable feedstocks”	German Representative	International	2014
IEA Bioenergy, Task 40 “Deployment of biobased value chains”	German Representative	International	2010
IEA Bioenergy, Task 44 “Flexible bioenergy and system integration”	German Representative	International	2019
IEA Bioenergy, Task 45 “Climate and sustainability effects of bioenergy within the broader bioeconomy”	German Representative	International	2019
Institute for Non-Classic Chemistry e. V. (INC) at the University of Leipzig	Member of the Advisory Board	Germany	2013
IUTA e. V. – Project Monitoring Committee: Multiphase anode materials for SOFCs – Development of effective catalyst systems based on ceroxide for the upgrading of biogas and biomethane (KatCe).	Member of the Advisory Board	Germany	2014
LaNDER3 – University of Zittau/Görlitz	Member of the Advisory Board	Germany	2017
Ministry of Agriculture, Environment and Consumer Protection Mecklenburg Western-Pomerania	Member of the Scientific Advisory Council	Germany	2017
Research Association for Emission Control Technologies from Combustion Engines (FAD) e. V.	Member of the Advisory Board	Germany	2013
Research Steering Group for the Federal Ministry of Food and Agriculture (BMEL)	Member	Germany	2012
Scientific Journal “Müll & Abfall”	Member of the Advisory Board	Germany	2007
Scientific Journal “Waste Management”	Co-Publisher	International	2008
State Energy Council Mecklenburg Western-Pomerania	Member and Head of the F&L Working Group	Germany	2012
Steering Committee for the 2nd stage of the 1st Federal Immission Control Act	Member and head of the technology working group	Germany	2014
The Association of German Engineers (VDI), District Association Mecklenburg Western-Pomerania	Member of the Directives Committee	Germany	2013

PROFESSORSHIPS

Commitee	Role	Country	Since
Faculty of Agricultural and Environmental Sciences, University of Rostock	Professorship	Germany	2006
Faculty of Energy and Environmental Sciences, Shenyang Aerospace University	Professorship	China	2011
Faculty of Environmental and Biotechnology, University of Hefei	Professorship	China	2002
Faculty of Environmental and Biotechnology, University of Hefei	Professorship	China	2018
Institute for Infrastructure and Resource Management, Chair of Bioenergy Systems, University of Leipzig	Professorship	Germany	2011
Institute for Renewable Energies, China University of Petroleum Beijing	Professorship	China	2014

WORKING GROUP

Commitee	Role	Country	Since
Agru Interlaboratory Test, Kuratorium für Technik und Bauwesen in der Landwirtschaft e. V. (KTBL)	Member	Germany	2018
European Biofuels Technology Platform (ETIP Bioenergy)	Member, WG1 European Technology & WG4 Policy and Sustainability	EU	2008
German RETech Partnership “Recycling & Waste Management in Germany”	Member in the International Working Group (Emerging and Developing Countries)	Germany	2017
Horizontal Working Group: 100 % RE Cities	Member	EU	2019
Horizontal Working Group: 100 % RE, Individually Heated & Cooled Buildings	Member	EU	2019

Commitee	Role	Country	Since
Method harmonisation, BMWi Bioenergy Research Network	Member	Germany	2010
ProcessNet – Sustainable Production, Energy and Resources (SuPER), “Energy Process Engineering”	Member	Germany	2014
ProcessNet – Sustainable Production, Energy and Resources (SuPER), “Integrated Material and Energy Use of Biomass”	Member	Germany	2013
ProcessNet- Sustainable Production, Energy and Resources (SuPER), “Alternative Fuels and Combustibles”	Member	Germany	2015
Research Association Think Tank, Helmholtz-Association UFZ	Member	Germany	2014
Working Committee “Material Specific Waste Treatment”, ASA e. V.	Member of the Advisory Board	Germany	2009
Working Group 2 Alternative Propulsion Systems and Fuels for Sustainability Mobility (Focus Group 3 “Alternative Fuels for Combustion Engines”), National Platform Future of Mobility (NPM)	Member	Germany	2019
Working Group “Bibliothekskonzepte” of the BMEL Departmental Research Institutes	Member	Germany	2016
Working Group “Bioeconomy of the Structural Commission Technology Assessment and Design” of the Saxon Academy of Sciences at state level	Member	Germany	2014
Working Group “Blauer Engel”, Environmental Action Germany (DUH)	Consultant Function	Germany	2014
Working Group “Heating Market 2.0”, BMWi/ PtJ support programme “Biomass energy use”/ BMWi Bioenergy Research Network	Member	Germany	2017
Working Group “OpenAgrar” of the BMEL Departmental Research Institutes	Member	Germany	2016

NETWORKS/ASSOCIATIONS/PLATFORMS (SELECTION)

Commitee	Role	Country	Since
Association of German Engineers (VDI)	Member of the Executive Board	Germany	2008
Bioeconomy e. V.	Member	Germany	2012
DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e. V.	Member of the Advisory Board	Germany	2015
Dena Biogaspartner (German Energy Agency)	Member	Germany	2017
Energy Committe of Leipzig Chamber of Industry and Commerce (IHK)	Member	Germany	2016
Energy Saxony – the Energy Cluster for Saxony (joint initiative)	Member	Germany	2010
European Bioeconomy Stakeholders' Panel	Member	Belgien	2016
FADk Energy and Environment e. V. (NEU e. V.) – Cluster Bioenergy	Member of the Advisory Board	Germany	2014
International Energy Agency (IEA)	Member	Frankreich	2010
Network for Carbon Cycle Management (NK2)	Member	Germany	2019
RAL – Bundesgütegemeinschaft Brennholz	Member	Germany	2016
Renewable Energy Research Association (ForschungsVerbund Erneuerbare Energien)	Member of the FVEE Management Committee	Germany	2015
Sustainable Development Solutions Network (SDSN)	Member of the Extended Steering Committee	Germany	2016

For further information on committee activities, please contact the research coordinator of the DBFZ.

Research Coordinator

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DIN/ISO – STANDARDS COMMITEES (SELECTION)

Commitee	Role	Country	Since
CEN/TC 454 Algae and algae products	Chairman WG 3 "Productivity"	Belgium	2016
DECHEMA, Division "Measurement and Control in Biotechnology"	Member	Germany	2018
DIN: 33999 Working Commitee "Dust Seperator Test"	Member	Germany	2012
DIN: NA 062-05-82 Working Commitee "Solid Biofuels"	Expert	Germany	2016
Institut für Normung e. V./ German Institute for Standardization e. V.	Member	Germany	2016
ISO TC 238 WG1 + WG2 + WG4 + WG5	Representative WG	Switzerland	2014
ISO TC 255 "Biogas"	Member	Germany	2015
NA 062-05-82 AA, Working Committee "Solid Biofuels"	Member	Germany	2019
VDI 3461 "Emission Reduction of Thermo-Chemical Gasification of Biomass in Combined Heat and Power Generation"	Member	Germany	2012
VDI 3670 "Exhaust Gas Cleaning – Downstream Dust Reduction Device for Small and Medium Sized Solid Fuel Combustion Plants"	Chairman/Member	Germany	2014
VDI 4630 "Fermentation of Organic Substances, Substrate Characterisation, Sampling, Substance Data Collection, Fermentation Experiments"	Member of Directives Committee	Germany	2013
VDI/DIN: AG "Production of Biocarbonisates", Air Pollution Control Commission	Member	Germany	2013

FVEE ForschungsVerbund Erneuerbare Energien Renewable Energy Research Association

IEA Bioenergy

EBA European Biogas Association

GENERAL MANAGEMENT

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Administrative Managing Director

Dipl.-Kfm. (FH), LL. M. Daniel Mayer
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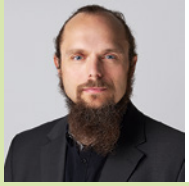

Catalytic Emission Control

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14 PROJECTS AND PUBLICATIONS

The most important projects and publications from 2019 are listed to show the current working areas of the DBFZ. The language of the title reflects the language of the project/publication.

PROJECTS (SELECTION)

Federal Ministry of Food and Agriculture (BMEL)

ABiOx – Thermochemische Umwandlung von siliziumoxidreichen Biomasse-Rückständen zur Erzeugung von Wärme und Strom sowie der gekoppelten Erzeugung von mesoporösem biogenem Silica für die Materialanwendungen, Bundesministerium für Ernährung und Landwirtschaft/Bundesanstalt für Landwirtschaft und Ernährung, 01.10.2019–31.12.2022 (FKZ: 2819DOKA05)

AG Biomassereststoffmonitoring, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 01.07.2016–31.03.2019 (FKZ: 22019215)

BE20PLUS – BIO E Bioenergie: Potenziale, Langfristperspektiven und Strategien für Anlagen zur Stromerzeugung nach 2020, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 01.11.2017–31.10.2019 (FKZ: 22404016)

Bio-Mini – Verbundvorhaben: Entwicklung einer marktnahen emissionsarmen Biomasse-Kleinstfeuerung für Niedrigenergie- und Passivhäuser; Teilvorhaben 1: Feuerungstechnische Entwicklung (Gesamtkonzept) und Charakterisierung einer Biomasse-Kleinstfeuerung für Niedrigenergie- und Passivhäuser, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 01.10.2017–31.03.2020 (FKZ: 22000417)

BioNetz – IE BioNetz, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 01.02.2019–31.01.2021 (FKZ: 22405317)

BKSQuote – Untersuchungen zur Ausgestaltung der Biokraftstoffgesetzgebung, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 01.06.2016–31.03.2019 (FKZ: 22401416)

BMPIII – Biogas-Messprogramm III: Faktoren für einen effizienten Betrieb von Biogasanlagen – Teilvorhaben 1: Energiebilanzierung, Flexibilisierung, Ökonomie, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.12.2015–30.11.2019 (FKZ: 22403515)

ChinaRes – Energetische Nutzung landwirtschaftlicher Reststoffe in Deutschland und China; Teilvorhaben 1: Erarbeitung von Konzepten für zukünftige Biogasanlagenbetreiber, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 15.08.2017–31.01.2021 (FKZ: 22025816)

EFFEKTOR – Prozessinformationssysteme zur kontinuierlichen Überwachung der Energieeffizienz von Biogasanlagen; Teilvorhaben 1: Modellentwicklung und Auswertung, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.10.2019–30.09.2022 (FKZ: 22401318)

EvEmBi – Bewertung und Minderung von Methanemissionen aus verschiedenen europäischen Biogasanlagen; Teilvorhaben 1: Quantifizierung und Minderung von Methanemissionen aus landwirtschaftlichen Biogasanlagen und Wissenstransfer in die Praxis, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.04.2018–31.03.2021 (FKZ: 22407917)

FactComm – Faktensammlung Import Commodities, Bundesministerium für Ernährung und Landwirtschaft (Inhouse), 01.02.2019–31.07.2019 (FKZ: 22030818)

IraSIL – Untersuchung des Ascheverhaltens während der thermo-chemischen Konversion vorbehandelter, siliziumreicher Biomassesortimente zur Strom- und Wärmeerzeugung und Nutzung der dabei anfallenden Aschen zur Gewinnung anorganischer Gerüstverbindungen mit vielfältigen Anwendungsmöglichkeiten, Bundesministerium für Ernährung und Landwirtschaft/Bundesanstalt für Landwirtschaft und Ernährung, 01.01.2018–30.06.2021 (FKZ: 2816DOKI03)

KlimaBioHum – Klimaschutzorientierte Bioabfallverwertung für die Landwirtschaft, Bundesministerium für Ernährung und Landwirtschaft/Bundesanstalt für Landwirtschaft und Ernährung, 01.10.2018–30.11.2021 (FKZ: 281B303316)

LF Flex – Leitfaden Flexibilisierung der Strombereitstellung von Biogasanlagen, Bundesministerium für Ernährung und Landwirtschaft/ Fachagentur Nachwachsende Rohstoffe e. V., 01.11.2017–30.04.2019 (FKZ: 22402615)

MeOH-AMF – IEA AMF Annex Methanol aus Kraftstoff, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 09.01.2019–30.06.2020

Mini-WS – Verbundvorhaben: Emissionsarme kleinskalige Wirbelschichtfeuerungen zur Verbrennung von biogenen Reststoffen; Teilvorhaben 2: Charakterisierung des lastabhängigen Emissionsverhaltens für verschiedene Brennstoffe und Anforderungen an die Abgasnachbehandlung, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.06.2019–31.05.2022 (FKZ: 2219NR010)

MoReBio – Modellregionen Bioökonomie im Mitteldeutschen Revier und im Lausitzer Revier, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V. (Inhouse), 22.08.2019–31.12.2021

Nred – Verstärkte energetische Nutzung stickstoffreicher landwirtschaftlicher Abfallstoffe durch biologische Stickstoffreduzierung; Teilvorhaben 1: Verfahrensentwicklung im Labormaßstab, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.11.2019–31.10.2022 (FKZ: 22042118)

ONIreduce – Emissionsminderung durch angepasste Kesselsteuerung auf der Basis von Daten aus der kontinuierlichen inline-NIR-Brennstoffanalyse, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.07.2019–31.12.2021 (FKZ: 22033218)

PEGGÜ – Studie zu den Perspektiven für die energetische Güllenutzung, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V. (Inhouse), 08.08.2018–31.03.2019

PapIGas – Biomethan und Torfersatzstoff aus Pappelholz, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.04.2019–31.03.2021 (FKZ: 22038318)

OptiFlex – Optimierung des Betriebs und Design von Biogasanlagen für eine bedarfsgerechte, flexibilisierte und effiziente Biogasproduktion unter Berücksichtigung der Prozessstabilität als Post-EEG Strategie, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.10.2017–30.09.2020 (FKZ: 22401717)

REFAWOOD – ERA-NET Bioenergy: Ressourceneffiziente Brennstoffadditive zur Verringerung der verbrennungstechnischen Probleme bei der Rest- und Gebrauchtholzverbrennung, ERANET/Fachagentur Nachwachsende Rohstoffe e. V., 01.04.2016–31.03.2019 (FKZ: 22404215)

RESTFLEX – Untersuchung der Eignung landwirtschaftlicher Reststoffe zur Flexibilisierung des Biogasprozesses mittels modellgestützter Methoden und Verschneidung der Ergebnisse mit vorhandenen Mengenpotenzialen, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.07.2019–30.06.2022 (FKZ: 22041818)

SiTroFen – Entwicklung einer emissionsarmen Einzelraumfeuerung für bedarfsgerecht erzeugte und qualitätsgesicherte Holzhackschnitzel; Teilvorhaben 1: Theoretische und experimentelle Untersuchungen, emissionsrechtliche Evaluierung, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.04.2019–31.08.2021 (FKZ: 22016817)

STM-DE – Auktionsmodell für eine nachhaltige Nutzung von Stroh in Deutschland, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.10.2017–30.04.2019 (FKZ: 22027216)

SubEval – Verbundvorhaben: Bewertung von Substraten hinsichtlich des Gasertrags – vom Labor zur großtechnischen Anlage; Teilvorhaben 1: Durchführung der Labor- und Praxisversuche, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.10.2015–31.01.2019 (FKZ: 22034614)

UVV – Verbundvorhaben: Emissionsminderungsstrategien zur umweltverträglichen Verbrennung (UVV) auf Basis von aktuellen Forschungsergebnissen, Teil vorhaben 1: Theoretische und Experimentelle Untersuchungen, Koordination; Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.04.2019 – 31.03.2022 (FKZ: 22038418)

Vabiflex – ERA-Net-Verbundvorhaben: Wertoptimierte Nutzung von Biomasse in einer flexiblen Energieinfrastruktur; Teilvorhaben 1: Theoretische und experimentelle Untersuchungen, Bundesministerium für Ernährung und Landwirtschaft/Fachagentur Nachwachsende Rohstoffe e. V., 01.09.2018–31.03.2021 (FKZ: 22408317)

Federal Ministry of Education and Research (BMBF)

abonoCARE – Wachstumskern – abonoCARE – VP2: Schadstoffreduzierung und Phosphoranreicherung in Düngervorprodukten; TP 2.5: HTC-Phosphorabscheidung/Trocknung HTC-Kohle, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.04.2019–31.03.2022 (FKZ: 031B0139A)

Agread – Re-use of agricultural residues for energy production by anaerobic digestion, Bundesministerium für Bildung und Forschung/Deutscher Akademischer Austauschdienst, 01.01.2018–31.12.2019 (FKZ: 57387582)

BEPASO – Bioökonomie 2050: Potenziale, Zielkonflikte, Lösungsstrategien, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.12.2016–29.02.2020 (FKZ: 031B0232B)

BioFAVOR 2 – Entwicklung und Evaluierung einer mobilen Demonstrationsanlage für die dezentrale Verwertung menschlicher Fäkalien, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.04.2018–31.03.2020 (FKZ: 031B0483E)

BIOKOFF – Bio-basierte Kohlenstoffe als funktionale Füllstoffe in Polymermischungen (kmu-innovativ), Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.09.2018–31.08.2020 (FKZ: 03XP0160D)

BIOSOL – ERA-NET MED: Entwicklung und Demonstration eines hybriden CSP-Biomassevergaser Systems, ERA-NET MED/Bundesministerium für Bildung und Forschung/Deutsches Zentrum für Luft- und Raumfahrt, 01.10.2016–30.09.2019 (FKZ: 01DH16006A)

CapAcidy – Bio-basierte Capron- und Caprylsäure – Herstellung, Aufreinigung, Vermarktungsstrategie, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.07.2017–30.09.2019 (FKZ: 031B0389A)

CarBioPhos – Entwicklung eines integrierten Verfahrens zur Carbonisierung von Klärschlamm, Erzeugung von Biogas und Rückgewinnung von Phosphor, Teilprojekt 2, Bundesministerium für Bildung und Forschung/Karlsruhe Institut für Technologie, 01.07.2018–30.06.2020 (FKZ: 031B0483E)

CAROFIL – Entwicklung magnetisierbarer Filterkohlen zur hochselektiven Abscheidung von Partikeln, Bundesministerium für Bildung und Forschung/VDI-VDE-IT, 15.07.2017–31.12.2019 (FKZ: 03VNE1031C)

CIP – Entwicklung einer kostengünstigen Wertschöpfungskette für biobasierte Olefine und Komplexnährmedien auf Basis von Insektenbiomasse für die industrielle Anwendung, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.10.2017–31.12.2019 (FKZ: 031B0338A)

E-Boot – IBÖ-06: Entwicklung einer Ernteprozesskette mit Erntetechnologie sowie Transportboot und Anlandeperipherie zur umweltschonenden Ernte von Wasserpflanzen, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.10.2019–30.09.2020 (FKZ: 031B0893)

HTKkChem – Umwandlung von wasser- und kohlenhydratreichen Reststoffen der Biomasseverarbeitung in Chemikalien und Kraftstoffkomponenten durch hydrothermale Prozesse, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.11.2018–30.04.2021 (FKZ: 031B0674A)

MaiD(II) – Entwicklung eines auf Maisspindeln basierenden Einblasdämmstoffes, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 15.12.2017–14.12.2019 (FKZ: 031B480A)

MKM2 – Entwicklung eines Mehrkammerbiomeilers zur effizienten Wärme- und Komposterzeugung, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.04.2018–31.03.2020 (FKZ: 031B0492A)

NEUWERT – stadtPARTHEland, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.09.2014–31.08.2019 (FKZ: 033L119E)

RenewVal – ERA-NET-Verbundprojekt: Lokale nachhaltige Versorgung mit erneuerbarer Energie für gefährdete Gemeinden in ariden und semi-ariden Mittelmeerzonen; Teilvorhaben: DBFZ, Bundesministerium für Bildung und Forschung/Deutsches Zentrum für Luft- und Raumfahrt, 01.05.2018–31.08.2020 (FKZ: 01DH17063B)

SchlauF2 – Entwicklung eines geotextilen, kontinuierlichen, mehrjährig verwendbaren Schlauchfermentierungsverfahrens für TS-arme Biomassen zum automatisierbaren Einsatz für Biogasanlagen, Bioraffinerien und im Tierfutterbereich zur Emissionsminderung, Ressourcenschonung und Kostensenkung, Bun-

desministerium für Bildung und Forschung/ Projektträger Jülich, 01.09.2018–31.08.2020 (FKZ: 031B0578A)

SYMOBIO – Systemisches Monitoring und Modellierung der Bioökonomie, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.03.2017–29.02.2020 (FKZ: 031B0281C)

Togo – Machbarkeitsstudie Bioenergie in Togo/ Ghana, Bundesministerium für Bildung und Forschung/Projektträger Jülich, 01.02.2019–31.07.2019 (GZ 723/60187)

ZEBS – Verbundprojekt: Abgasreinigungsanlage für emissionsfreie Biomasseöfen; Teilvorhaben: DBFZ, Bundesministerium für Bildung und Forschung/Deutsches Zentrum für Luft- und Raumfahrt, 01.09.2017–31.05.2019 (FKZ: 01DN17040A)

Federal Ministry of Transport and Digital Infrastructure (BMVI)

DEMO-SPK – Forschungs- und Demonstrationsvorhaben: Einsatz von erneuerbarem Kerosin am Flughafen Leipzig/Halle, Bundesministerium für Verkehr und digitale Infrastruktur (Inhouse), 04.11.2016–30.06.2020

OpenGeoEdu – Offene Daten für Lehre und Forschung in raumbezogenen Studiengängen; Teilvorhaben e-Learning: Räumliche Verteilung von biogenen Ressourcen, Bundesministerium für Verkehr und digitale Infrastruktur/VdI/VDE/IT + TÜV Rheinland, 01.05.2017–30.04.2020 (FKZ: 19S2007D)

Pilot-SBG – Forschungs- und Demonstrationsvorhaben Bioressourcen und Wasserstoff zu Methan als Kraftstoff – Konzeptionierung und Realisierung einer Anlage im Pilotmaßstab, Bundesministerium für Verkehr und digitale Infrastruktur (Inhouse), 01.09.2018–31.12.2021

Federal Ministry for Economic Affairs and Energy (BMWi)

AbfallE – Abfall-Ende-Eigenschaft naturbelassener, holzartiger Reststoffe durch Aufbereitungsverfahren und Qualitätssicherung; Teilvorhaben: Bewertung der Abfall- und genehmigungsrechtlichen Praxis sowie Umweltwirkung und Wirtschaftlichkeit, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.11.2019–30.04.2022 (FKZ: 03KB160A)

Bio2Geo – Entwicklung und Demonstration eines innovativen ökologischen Hybridkraftwerks für die Kopplung von Bioenergie mit Geothermie zur Versorgung unterschiedlicher Abnehmerstrukturen. Teilvorhaben: Gesamtheitliche Systemanalyse mit Fokus auf ökonomische Aspekte des Anlagenbetriebs, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.10.2018 – 31.03.2021 (FKZ: 03ET1593B)

BioGrid – SmartBioGrid – Optionen zum Einsatz fester Biomasse in dekarbonisierten Wärmenetzen, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.09.2019–31.08.2022 (FKZ: 03KB159A)

Bioplan W – Systemlösungen Bioenergie im Wärmesektor im Kontext zukünftiger Entwicklungen, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.08.2016–31.03.2019 (FKZ: 03KB113A)

Calgonit – Entwicklung biogastoleranter Reinigungs- und Desinfektionsmittel zum Einsatz auf Agrarbetrieben mit Nutztierhaltung; Entwicklung eines stabilen Biogasprozesses auf Güllebasis unter Einwirkung von Stall- und Melkanlagen-Reinigungs- und Desinfektionsmitteln und zugehörigem internen Prüfstandard/ Testverfahrens, Bundesministerium für Wirtschaft und Energie/Arbeitsgemeinschaft industrieller Forschungsvereinigungen, 01.07.2018–31.10.2020 (FKZ: ZF4077205RH8)

Dampf-KWK – Entwicklung eines Klein-KWK-Dampfmotors zur Nachrüstung von Feuerungsanlagen im mittleren Leistungsbereich, Bundesministerium für Wirtschaft und Energie/ Projektträger Jülich, 01.07.2016–30.06.2019 (FKZ: 03KB118A)

FLEXSIGNAL – Konzepte für eine bedarfsorientierte, kosteneffiziente und klimaschonende Stromerzeugung aus Bioenergieanlagen, Bundesministerium für Wirtschaft und Energie/ Projektträger Jülich, 01.01.2019–31.12.2020 (FKZ: 03KB150B)

GASASH – Thermo-chemische Konversion von Reststoffen in einem Vergaser-BHKW mit gekoppelter Aschegewinnung; Teilvorhaben: Untersuchungen zur Produktgasqualität, den BHKW-Emissionen, Emissionsminderungsmaßnahmen und der Ascheverwertung, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.09.2018–31.08.2020 (FKZ: 03KB139A)

EIV – Begleitforschung Energiewende im Verkehr – Teilvorhaben: Ermittlung von Rohstoffpotenzialen strombasierter Biokraftstoffoptionen und ökologische Bewertung von biokraftstoffbasierten Referenzszenarien, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.06.2018–31.05.2022 (FKZ: 03EIV116E)

KoSaTZ – Behandlung und kombinierter Einsatz von Stroh- und Getreideausputzmischungen für eine Biogas-Technologiekette mit Zukunft; Teilvorhaben: Untersuchungen zur alternativen Aufbereitung und Kompaktierung von Stroh-Mischsubstraten, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.01.2020–31.12.2021 (FKZ: 03Ei5403D)

MiniGas – Optimierung u. Validierung v. Verfahren zur kombinierten Reduktion von Feinstaub u. sauren Schadgasen an Biomassefeuerungen; Teilvorhaben: Experimentelle Untersuchungen zur Kombination von SCR- u. Precoatverfahren an einem Gewebefilter, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.09.2017–31.08.2020 (FKZ: 03KB131B)

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OBEN – Ölersatz Biomasse Heizung, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.09.2019–28.02.2022 (FKZ: 03KB156)

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Pellwood – Entwicklung einer Hybrid-Kleinfeuerungsanlage unter 5KW für Scheitholz und Holzpellets; Entwicklung des Pelletvergaserbrenners und der Verbrennungsregelung, Bundesministerium für Wirtschaft und Energie/Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von Guericke" e.V., 01.05.2017–31.10.2019 (FKZ: ZF4077203ST7)

PlasmaCrack – Kläranlage – PlasmaCrack: Nachweis der Faulgassteigerung und Reduktion endokriner Substanzen, Bundesministerium für Wirtschaft und Energie/VDI/VDE-IT, 01.01.2019–31.12.2021 (FKZ: 16KN041344)

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SCRCOAT – Optimierung u. Validierung von Verfahren zur kombinierten Reduktion von Feinstaub u. sauren Schadgasen an Biomassefeuerungen; Teilvorhaben: Experimentelle Untersuchungen zur Kombination von SCR- u. Precoatverfahren an einem Gewebefilter, Bundesministerium für Wirtschaft und Energie/ Projektträger Jülich, 01.09.2017–31.08.2020 (FKZ: 03KB128A)

SmarKt – Bewertung des Marktpotenzials und Systembeitrags von integrierten Bioenergiekonzepten, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.09.2017–30.06.2020 (FKZ: 03KB130)

SNuKR – Steigerung des Nutzens von kleinen, biomassebefeuerten BHKWs durch bedarfsgerechte Regelung, Teilvorhaben: Entwicklung des Regelungsalgorithmus, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.07.2017–30.06.2020 (FKZ: 03KB121A)

STEP – Verwertung strohbasierter Energiepellets und Geflügelmist in Biogasanlagen mit wärmeautarker Gärrestveredlung; Teilvorhaben: Verbesserung der Verbrennungseigenschaften projektspezifischer Gärreste, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.08.2016–31.01.2019 (FKZ: 03KB116B)

VergaOpt – Mittel- u. langfristige Sicherung des Holzvergaseranlagenbestandes u. Beitrag zu dessen weiterem Ausbau durch Erschließung preiswerter Brennstoffsortimente; Teilvorhaben: Brennstoffeigenschaften: Analyse u. Bewertung, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.01.2018–30.06.2020 (FKZ: 03KB135A)

Vergaflex – Flexibilisierung der Biomasseverga-

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ZertGas – Implementierung der RED II und Entwicklung von praktikablen Zertifizierungslösungen und Handlungsoptionen für Betreiber von Biogas- und Biomethananlagen; Teilvorhaben: Methodenentwicklung, Werkzeuge und Handlungsempfehlungen, Bundesministerium für Wirtschaft und Energie/Projektträger Jülich, 01.09.2019–31.08.2021 (FKZ: 03KB164A)

EU projects

BECOOL – Brazil-EU Cooperation for Development of Advanced Lignocellulosic Biofuels, EU/Horizon2020, 01.06.2017–31.05.2021 (GA 744821)

BioFit – Bioenergy retrofits for Europe's industry, EU/Horizon2020, 01.01.2019–31.12.2021 (GA 817999)

DEMETER – Demonstrating more efficient enzyme production to increase biogas yields, EU/Horizon2020, 01.08.2016–31.01.2020 (GA 720714)

DRALOD – Renewables-based drying technology for cost-effective valorisation of waste from the food processing industry, EU/Horizon2020, 01.08.2018–31.12.2020 (GA 820554)

HyFlexFuel – Hydrothermal liquefaction: Enhanced performance and feedstock flexibility for efficient biofuel production, EU/Horizon2020, 01.10.2017–30.09.2020 (GA 764734)

MUSIC – Market Uptake Support for Intermediate Bioenergy Carriers, EU/Horizon2020, 01.09.2019–31.08.2022 (GA 857806)

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STAR-ProBio – Sustainability Transition Assessment and Research of Bio-based Products, EU/Horizon2020, 01.05.2017–30.04.2020 (GA 727740)

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Adsolv – Anaerobic digestion of the hemicellulose fraction from an acetone based organosolv, Marktprojekt, 01.10.2018–01.01.2019

AGEEstat – wiss. Analyse zu ausgewählten Aspekten der EE-Statistik für AGEE-Stat, Marktprojekt, 01.04.2019–30.06.2022

BEF-Sec – Sustainable production of bioenergy and soil conditioners from bio-residues in Pakistan for energy and food supply security, Marktprojekt, 31.12.2017–31.07.2019

BioPotB – Kurzstudie zur Untersuchung des nachhaltigen Biomassereststoffpotenzials im Umkreis von Berlin, Marktprojekt, 17.08.2018–31.01.2019

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CoFire2 – Begutachtung von Biowärme aus Mitverbrennung von Biomasse in konventionellen Heizkraftwerken, Marktprojekt, 01.01.2014–31.08.2019

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Consulting Services for Biogas Project Hebei, Marktprojekt, 01.08.2015–31.12.2019

FS_VIETN – Machbarkeitsstudie Biogaspotenziale in An Giang, Marktprojekt, 01.07.2018–30.06.2019

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SimGuide – Modellierung des Biogasprozesses, Marktprojekt, 01.08.2018–30.07.2020

SUVALIG – Entwicklung eines Bioraffineriekonzeptes im Rahmen des Projekts SUVALIG, Universität Rostock, 01.11.2019–28.02.2021

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