Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ

DBFZ Research, Development and Innovation Concept

Period: 2021 - 2026

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PREFACE

Bioenergy as a key component of a climate-neutral biobased circular economy

Climate change and its environmental, economic and social consequences represent the greatest challenge of our time. In 2015 a "2°C target"[1] was globally agreed on as part of the Paris Climate Agreement[2], which was to serve as a development guide for all of the world's nations. The EU's current "Green Deal"[3] initiative aims to make Europe the first climate-neutral continent by 2050. This will only succeed if Germany takes on a leading role and consistently advances the transformation process from a linear economy based on fossil fuels, to a sustainable circular economy driven by renewable energies. In Germany we have been talking about a circular economy and renewable energy for more than 25 years, but in practice we are not yet able to sustainably meet 20 % of our society's needs for resources and energy. This shows that we still have much to achieve in the next 30 years!

This transformation of the energy system can only succeed by massively reducing energy consumption, increasing energy efficiency, and steadily expanding renewable energies. A climate-neutral circular economy is based on optimised, closed "green" carbon cycles, making the development of a sustainable bioeconomy critically important. This is where bioenergy, with its flexible and wide-ranging technologies, can and must step in and contribute, e. g., to the flexibilisation and sector coupling of the energy system of the future.

The DBFZ (Deutsches Biomasseforschungszentrum) was founded in 2008 as a limited liability company (GmbH) and develops practical solutions along the value chains and cycles of biomass that are based on the "Smart Bioenergy Approach"[4]. Through applied R&D of technologies for the utilisation of biomass to produce energy and integrated materials, we are contributing to the achievement of a climate-neutral society, which, according to our vision, should become a reality by no later than 2050.

By networking closely with numerous partners from science, industry and society, the DBFZ plays a key role in the development of rural areas as well as regions in Germany affected by the coal phase-out. Its cooperation with international partners fosters the global transfer of knowledge and technologies.
The DBFZ's research, development and innovation concept provides a framework for the long-term direction that research will take at the DBFZ. The DBFZ roadmap sets out how this will specifically be implemented.

Prof. Dr. Michael Nelles
Scientific Managing Director

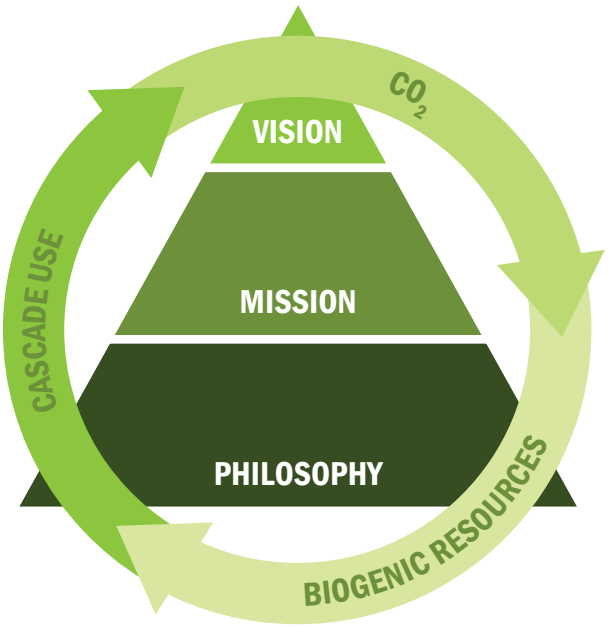
1 A long-term global target to limit the rise in the average global temperature to "well below" 2 °C compared to the pre-industrial age, with some efforts being made to even limit this to 1.5 °C.

2 www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/paris_abkommen_bf.pdf, accessed on 6 December 2019

3 www.ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_de, accessed on 2 July 2020.

4 Further details on the Smart Bioenergy Approach can be found on page 4.

Mission Statement



VISION

Our research is key to achieving a climate-neutral society by 2050. By this time, the bioeconomy's closed carbon cycles will have replaced the fossil fuel-based economy.

MISSION AND TARGET GROUPS

- We conduct applied research and development.
- We investigate, develop and assess technologies for the integrated use of biogenic resources in energy and materials production.
- Our findings pave the way for the innovation of sustainable products and services already on the market to ensure a rapid transition to a climate-neutral society.
- We advise and prepare scientifically based information for the federal government.
- Our findings contribute to the development in rural areas, which are the points of departure for the bioeconomy.
- We are guided by the United Nation's Sustainable Development Goals (SDG)[5].
- Our research is directed towards stakeholders from science, politics, the economy and society with a focus on bioenergy, the bioeconomy and sustainable supply systems.
- We network with our partners in Germany and abroad, sharing our knowledge with them.

OUR PHILOSOPHY

- To fulfil our mission, we are constantly working on fostering our dedicated staff, our interdisciplinary expertise and our outstanding research infrastructure.
- As an independent federal research organisation committed to neutrality, we provide a scientifically based foundation for decision-making as well as design and initiate research strategies.
- We support young scientists by supervising their bachelor, master and doctoral theses.
- Our employees benefit from a broad training programme.
- We support our employees in the establishment of spin-offs and start-ups.
- We attach great importance on combining a career and family.
- We regularly consult a research advisory council made up of international members and a cross-departmental supervisory board from federal and state ministries with the aim of continuously improving our organisation.
- Our processes are constantly optimised based on the ISO 9001 quality management system and the Guidelines for Safeguarding Good Research Practice.
- We strive to achieve climate-neutral operations by no later than 2030.

5 www.un.org/sustainabledevelopment/sustainable-development-goals/

PREMISES

01 Climate-neutrality by 2050 requires a sustainable bioeconomy.

Climate neutrality can only be achieved through systematic energy saving policies, a complete switch to renewable energy and CO_2 removal[6]. The coupled and cascade use of biogenic resources is key to a sustainable closed-loop bioeconomy. Carbon and nutrient cycles must be closed. Bioenergy must be supplied from sustainable raw materials and residual material flows. It needs to be used in combination with other sources of renewable energy to achieve the greatest benefits to the system in an increasingly digitalised society „Smart Bioenergy“ Apporach.

02 Further biomass potentials must be mobilised to meet a growing demand for renewable carbon.

The demand for biomass as a renewable carbon source and the competition associated with its use will increase. Precise knowledge about its supply, use, ecosystem functions and social impacts is required for a conflict-free and efficient use of the limited raw material. Comprehensive ecosystem assessments and cross-sectoral exploitation concepts are needed in order to sustainably mobilise the renewable resource.

03 Technology development must be in alignment with the UN’s sustainability goals.

Analysing and assessing the sustainability of the value chains in the renewable carbon cycle is becoming increasingly complex. The development of processes and technologies must be aligned with the UN’s Sustainable Development Goals. Measurable parameters need to be integrated into the bioeconomy’s monitoring instruments.

04 Technologies and processes must be designed site-specific and flexible in scale.

The design and scale of the plants are determined by the biogenic resources available at a specific location. Technologies and processes for products that can be stored and flexibly used must be integrated into the context of the respective rural or urban area. Modular plant concepts should be considered when developing market-oriented and environmentally friendly technologies.

6 CO_2-removal can be achieved, for example, through separation, utilisation or permanent storage of carbon compounds from the production of energy from biomass.

Definition of the “Smart Bioenergy” Approach

Smart Bioenergy involves the further development of modern biomass utilisation systems up to integrated systems that are optimally harmonised with various renewable energy sources and the utilisation of energy and raw materials within the bioeconomy. This presupposes a change in consumption patterns, energy savings and an increasing demand for sustainability with ever-changing target values. Because a climate-neutral economy increasingly requires materials made from renewable carbon compounds and, in particular, biomass, there is a need for greater interlinkage with the coupled and cascading use of biomass, further use of CO_2 from biogenic sources, and special consideration for natural carbon sinks. The approach of Smart Bioenergy (Figure 1) contributes greatly to a sustainable energy supply in the future and is thus key to closed carbon cycles in a bioeconomy.

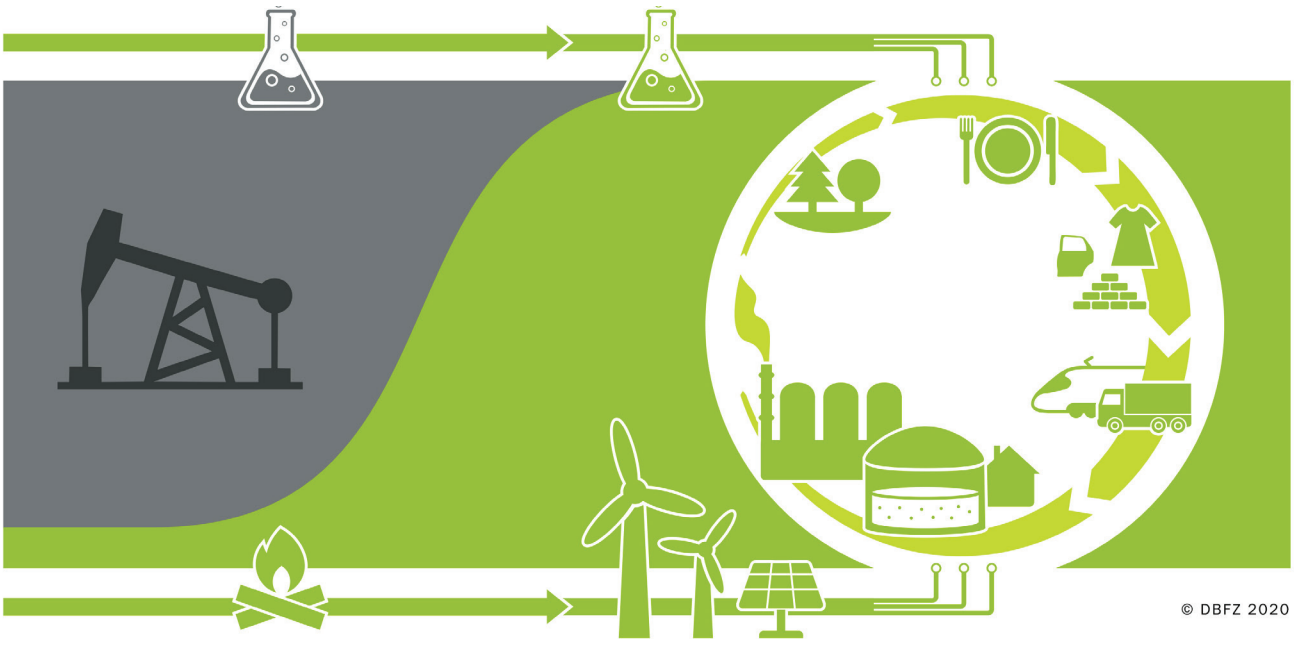


Figure: „Smart Bioenergy“ in a sustainable bioeconomy

Position in the Research Landscape – in 2020

More than ten years after it was founded, the DBFZ has achieved a prominent position within the national research landscape. The DBFZ is also active internationally and occupies a position of excellence with regard to specific bioenergy topic like the flexibilisation of biogas plants or the development of small-scale, low-emission combustion plants. Through its participation in approx. 100 different national and international committees and associations, the DBFZ also helps shape developments in the bioenergy sector worldwide.

The DBFZ also fosters young scientists through its doctoral programme, which has over 40 doctoral candidates. The DBFZ organises the "Doctoral Colloquium BIOENERGY" [7], which is held annually on a rotating basis together with over thirty-five other leading research institutions and universities from Germany, Austria, Switzerland, Norway and Sweden. It aims to bring together the knowledge bearers and decision-makers of tomorrow at an early stage, while at the same time achieving better networking between the scientific institutions that are intensively involved in the field of bioenergy. It currently is reaching and connecting nearly 200 doctoral students in the various fields of bioenergy research.

Employees at the DBFZ are regularly honoured for their outstanding research achievements through various prizes and awards, such as the Biogas Innovation Prize of German Agriculture and the Gert von Kortzfleisch Prize. The prize winners in categories such as "Outstanding Academic Achievement" or "Best Thesis" include experienced postdocs and doctoral students as well as bachelor's and master's students whose theses were supervised at the DBFZ. This is another way for the knowledge generated at the DBFZ to be distributed to a wider (specialist) audience and to be publicly acknowledged.

Every year, the DBFZ cooperates with numerous partners from science, industry and society as part of more than 130 bioenergy and bioeconomy-related joint projects and market projects. This enables it to continuously strengthen its leading position as a top national research institution. The DBFZ has continuously expanded its international position for more than ten years as part of 21 EU projects with more than 184 partners and as an active member and national team leader in prominent international research networks such as IEA Bioenergy Technology Collaboration Programme (TCP), the European Energy Research Alliance (EERA) and the European Technology and Innovation Platform Bioenergy (ETIP Bioenergy).

Project results from collaborative research projects are published annually in more than 50 peer-reviewed publications in conjunction with co-authors from around 60 scientific, economic and social institutions. The DBFZ is involved in more than 100 publications per year. This includes articles in technical journals as well as statements and position papers that provide information to interested practitioners and users.

Research funds represent a significant funding basis for the DBFZ and are acquired in direct competition with other outstanding research institutions. Application-oriented knowledge and findings are put into practice through the direct transfer of know-how or through commercial exploitation.

7 The first Doctoral Colloquium BIOENERGY took place on 20/21 September 2018 in Leipzig.

The year 2019 in numbers

113
WORKED PROJECTS

53
PEER REVIEWED PUBLICATIONS
thereof 26 Open Access

72
DOCTORAL PROJECTS
41 of which were supervised directly at the DBFZ as part of the DBFZ doctoral programme supervised

98
COMMITTEES AND ASSOCIATIONS
66 national and 32 international

26
TRAINEES AND RETRAINEES

49
BACHELOR, MASTER AND DIPLOMA THESES

39
GUEST RESEARCHER, FOREIGN INTERNS AND SCHOLARSHIP HOLDERS

Organisation and Development

The DBFZ is a federal research organisation with a thematic focus on the integrated use of biogenic resources for bioenergy and material production. It was founded in 2008 as a non-profit limited liability company. Its Supervisory Board is responsible for the groundbreaking substantive and organisational decisions surrounding the development of the federal research organisation and is chaired by the Federal Ministry of Food and Agriculture (BMEL) as the sole shareholder of the DBFZ. Other members of the Supervisory Board include 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 for Energy, Climate Protection, Environment and Agriculture (SMEKUL).

The international Research Advisory Council (RAC) advises the DBFZ on the direction of its scientific activities. The Research Advisory Council is made up of internationally renowned scientists working in the fields of bioenergy and bioeconomy research. The members of the Research Advisory Council are appointed by the Supervisory Board.

The technical infrastructure of the DBFZ has been continuously updated since the foundation of the research institution and corresponds to the current state-of-the-art in 2020. The DBFZ's unique selling point is the ability to perform all development steps under one roof - from lab experiments to the development of complex processes. The scalability of the processes ranges from laboratory and technical scale, to pilot-, demonstration plant and industrial scale. The development of the infrastructure and technical equipment is in line with the recommendations of the German Council of Science and Humanities and other bodies.

As a result of investment and the expansion of research capacities, the number of employees has increased steadily since 2008. The DBFZ had 95 staff members (47 of these being scientific staff) at the end of the year in which it was founded; by the end of 2019 this number had increased to 248. This corresponded to around 76 full-time equivalents (FTE) in 2008 and 188 FTE in 2019, of which about 41 (in 2008) and 82 FTE (in 2019) were or are researchers . Against this backdrop, we are looking forward to the new technical centre, which after some delays, was taken over by the DBFZ at the end of 2020. Fundamental to this very successful expansion are the versatility, competence, productivity and motivation of our employees, who are adept at combining their research and consulting activities. The operating expenses of the DBFZ for personnel and materials were taken on by the BMEL at just under € 8 million as part of shortfall financing. In addition, the BMEL is currently financing the construction of a new building at the DBFZ in the order of € 60 million. The DBFZ raised an additional € 13 million in third-party funds in 2019 through project funding and market orders.

CONSTRUCTION HISTORY AT THE DBFZ

2010

Renovation measures begin

The extensive reconstruction and renovation measures from the economic stimulus package II begin at the DBFZ.

2012

Research biogas plant opens

In July 2012, former Agriculture Minister Ilse Aigner inaugurates the research biogas plant at the DBFZ.

2014

Everything is becoming new

The preliminary planning of the new technical centre and office building for the DBFZ is progressing.

8 List of members: www.dbfz.de/en/the-dbfz/bodies-of-the-organisation/research-advisory-council/

9 Please see the DBFZ website for a detailed description. (www.dbfz.de/en).

10 Based on the terminology used by the German Council of Science and Humanities, “scientific staff” or “scientists” means all employees (including the management) of the organisation who hold a university degree and are in paygrade 13 or higher, unless they work predominantly in administration.

2016

Laying of the foundation stone

The foundation stone for the DBFZ‘s extensive new building is laid on 31 August 2016.

2018

The goal is getting closer

The DBFZ has a day care centre, a new office building, an event centre and a large technical centre.

2020

Handover of new building

The new office building was handed over to the user in spring 2020. The technical centre followed in autumn 2020.

Research Infrastructure of the DBFZ

A range of state-of-the-art equipment is available in the DBFZ's laboratories, technical centres and offices, which enables (visiting) researchers to achieve scientific work of the highest degree.

Biogas lab

The biogas lab is designed and equipped to simulate large-scale technical processes on a laboratory and semi-technical scale - complete with the relevant analytical processes. The aim is to optimise processes and to improve our basic understanding of the individual sub-processes involved in methane formation. Extensive (continuous and discontinuous) pilot plants with reaction volumes between 0.25 and 500 litres, as well as a research biogas plant are available.

Research biogas plant

The research biogas plant extends the range of application-oriented research at the DBFZ and allows to improve our understanding of processes and the efficiency of biogas production. The large-scale fermenters enable experiments to be conducted on a practical scale, thus ensuring that the results can be easily transferred to implementation.

Combustion lab

In the combustion lab, the DBFZ conducts experimental research on the thermo-chemical conversion of raw or pre-conditioned biomass. Exhaust gas emissions and particulate formation processes are also analysed. Pilot plants of our own design, as well as operational plants are used to conduct research on combustion processes and combustion plants. In the DBFZ's fuel-conditioning lab and analytical lab, various tests and experiments are carried out using extensive and proven know-how.

The combustion lab also has equipment and facilities to investigate emission reduction processes for the development of solid catalysts and dust separators.

Biorefineries technical centre

The biorefineries technical centre at the DBFZ investigates and develops basic chemicals as well as the essential process steps for the conversion of biomass resources into solid, liquid and gaseous bioenergy sources. Hydrothermal processes (HTP), biomass gasification, gas purification/conditioning and catalytic syntheses as well as various treatment technologies can be studied using a wide range of testing facilities and measurement technology. Measurements can also be conducted at external plants.

Engine test bed

In response to the complex demands on motor fuels in the transport sector, the engine test bed at the DBFZ includes a single cylinder research engine for testing (new types of) renewable fuels, a catalyst-ageing test bed to evaluate the requirements of exhaust aftertreatment systems, a test bed for range extender modules and an electric vehicle, in real operation, with an integrated range extender to examine its technical potentials.

Analytical lab

The analytical lab characterises liquid fuels, solid biofuels, biogas substrates, waste and residual materials, as well as their conversion products, like ash, filter dust and process water. Analyses are carried out according to current standards as well as problem-oriented development and adaptation of methods.

Data lab

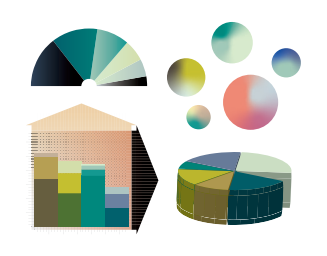
All DBFZ employees have access to a modern IT infrastructure that includes service support, a computer centre and assistance

in matters pertaining to research data management. A high-performance environment is in place to efficiently process our research data, including the use of various programming languages and models, a relational database management system, geographic information systems and the ability to create web applications. A research data structure is currently being developed for the systematic storage of essential data on bioeconomy research.

The establishment of a data laboratory for the development, maintenance, enhancement and long-term preservation of digital, scientific structures and products is driven forward. Systematic updating and compiling of data sets in databases provides the basis for further processing with modern data analysis methods, models or visualizations.

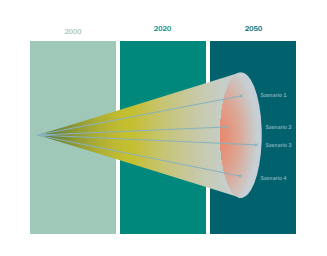
Further information on the DBFZ's research infrastructure

Tools, databases and methods



Assessment methods

The DBFZ offers comprehensive methods and data for technology and system assessment, taking into account ecological, social, technical and economic criteria.



Scenario tool

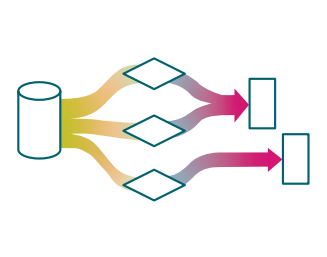
The tool provides an overview of 150 energy scenario studies and makes it possible, among other things, to compare studies and to identify gaps in bioenergy modelling.

Resource database

The DBFZ operates a monitoring system on biogenic raw materials and makes the latest data available free of charge in an interactive online data repository.

Regionalised information

The DBFZ collects, analyses and provides regionalised information on raw material availability and plant locations to create synergies.



Bioenergy models

Together with the UFZ, models are being developed for the cross-sectoral analysis of future relevant and optimal biomass use, with a focus on GHG reduction and costs.

Knowledge transfer

Knowledge transfer tools and formats are developed and tested for relevant scientific content, trends and findings from DBFZ projects.

Position in the Research Policy Framework

The DBFZ transfers its knowledge primarily through research reports, journal articles and other scientific publications. Research results are also transferred to industry in the form of products and services. Building on our research and development work, knowledge is transferred directly to society and public policy.

Due to its prominent position within the scientific community, the DBFZ often takes on a leading role in national and international research associations in order to strengthen and disseminate the consensus on various research topics through statements and position papers. This not only provides decision-makers with a basis for making scientifically sound decisions, but also raises awareness of socially relevant issues (e. g. the energy transition) through multipliers.

When drawing up policy recommendations, due consideration is given to the technically relevant tasks and policy priorities, as well as the internal and interdepartmental priorities of the ministries (see also the section on knowledge transfer). DBFZ staff members also lend their scientific support to the development of various research and policy strategy papers issued by the German government, e. g. the development of the German government's strategy on the bioeconomy[11].

As a member of the European Technology and Innovation Platform Bioenergy (ETIP Bioenergy) and the European Energy Research Alliance (EERA Bioenergy) and through its participation in consultation processes, the DBFZ actively supports the development of research policy in Europe, for instance through its involvement in the Renewable Energy Directive (REDII) and the European Strategic Energy Technology Plan (SET Plan). These documents outline Europe's new Research and Innovation Energy Agenda, which encompasses the entire European energy system.

Research associations, networks and cooperating universities (selection)

11 www.bmbf.de/files/bio%c3%b6konomiestrategie%20kabinett.pdf (cabinet version, 15 January 2020)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Applied Research and Development at the DBFZ

RESEARCH FOCUS AREA 1 | SYSTEMIC CONTRIBUTION OF BIOMASS

The vision of a climate-neutral, sustainable bioeconomy - and the premises associated with this - require a comprehensive transformation process concerning to the use of biomass and the framework conditions surrounding it. Supporting and shaping this transformation process in a system-oriented way, i.e. across sectors, technologies and disciplines, and by means of forward-looking impact assessments, is fundamental to its success. In this context, societal challenges[12], innovative technologies, economic impact and environmental concerns[13] must be fully taken into account. Resources and value chains must be integrated by spatial aspects and viewed as part of a complex relationship with other renewable resources (especially solar and wind).

The overarching research goal of the Research focus area (RFA) "Systemic contribution of biomass" is to contribute to the UN's sustainability goals through the sustainable integration of renewable raw materials and biogenic residual and waste materials in the bioeconomy to produce energy and materials. The following goals are derived from the premises mentioned above:

Strategic Goals

Goal A | Resource mobilisation
Goal A aims to improve biomass availability and accessibility within the context of renewable resources. High importance is placed on the establishment of a reliable data basis as well as the development and implementation of resource monitoring systems and mobilisation strategies for unused or inefficiently used biomass - taking into account various sustainability aspects.

Goal B | Applied sustainability analysis
Goal B focuses on the extensive and dynamic evaluation of the bioenergy production and utilisation. Bioenergy and bioeconomy-technologies are analysed in a context that might change over time and regional context. Wherever possible, scientific methods and instruments are developed for use by bioeconomy stakeholders outside the scientific community. One example is the development of tools for certifying the sustainability of bio-based products.

Goal C | Integration of biomass into the energy system
Goal C aims to develop and implement concepts for the integrated material and energetic use of biomass as part of a climate-neutral renewable-based economy. To do this, analytical tools, assessment methods, models and simulations are developed and applied and data is gathered periodically (monitoring).

Goal D | Data structures, visualization and knowledge transfer
Goal D consists of the development and implementation of different formats and channels of knowledge sharing. The data lab will advance the development, maintenance and enhancement of digital, scientific structures and products.

Scientific Basis

Various methods and models that build upon one another are used to answer open research questions. The RFA staff possess the interdisciplinary scientific background, extensive knowledge and the networking crucial to achieving the set goals.

The methods and models are tailored as a toolbox to the respective tasks and include analyses of the potentials of biogenic raw, residual and waste materials and of the areas where they are cultivated.

These serve as a way to evaluate the resource base and establish how these materials can be sustainably mobilised for material and energy use. GIS-based analyses are used to locate the resource potentials and investigate the future energy supply (with analyses on wind and solar energy conducted by BEN-Bioenergy Department of UFZ). Life cycle assessments and economic efficiency calculations help to analyse the different options of biomass use, for example as an energy source, as a raw material for the chemical industry or as BECCS (development of methods in cooperation with BEN). Pathways for the use of biomass as energy and materials, as well as the socio-economically optimal target systems are derived with the help of analyses and the development of scenarios. Simulation models of variable power generation resulting from fluctuating renewable energies (with simulation and optimisation models of the energy system by BEN) are used to supply bioenergy based on demand. In addition, the development of multi-criteria evaluation approaches and indicator systems help to gauge the development of the transformation process and to evaluate it using monitoring systems. Analyses and proposals for designing control instruments are issued at vari-

ous levels (policy analyses, certification processes). Highly condensed information (key messages), storylines, policy recommendations and new forms of stakeholder communication are developed for transferring the key results. Targeted stakeholder and target group analyses are carried out which are used to identify and implement the specific formats for transferring the scientific results. Methods used to automated systematise interfaces and catalogue data provide extensive support in the development of know-how.

One important medium-term goal is the gradual development of a (joint) model system by the Bioenergy Systems Department and the BEN department at UFZ. This system will be able to simulate functional relationships and generate, with a high temporal and spatial resolution, scientific statements about the overall system of renewable resources where technology meets the environment.

Methods are developed based on case studies, which are used in the cross-case evaluation and compilation of meta-information. The results are stored in databases as reliable data that is transparent, updateable and retrievable online, and organised using data management systems. Using this reliable data, key information is compiled as aggregated results with transparent sources. Reference is made to any uncertainties.

„Smart bioenergy use will be a building block for the integrated supply systems in small, very precisely controlled plants and will be able to contribute to the sustainable energy supply of tomorrow.“

Prof. Dr. Daniela Thrän
Head of the Research Focus Area

12 This encompasses a wide range of stakeholders including those along the value chain (producers, processors, service providers, users, and users within clusters) as well as more far-reaching stakeholders who shape, evaluate and further develop the framework conditions (scientists, NGOs, trade associations, politicians, media, etc.).

13 The availability of land and resources is crucial for establishing the most efficient value-added chains possible. These chains need to meet rising supply requirements through innovative technologies.

Applied Research and Development at the DBFZ

RESEARCH FOCUS AREA 2 | ANAEROBIC PROCESSES

„Biogas plants must become more flexible with regard to their substrates and the provision of energy. Only then, will they continue to make a contribution to securing the energy supply in the future. .“

Dr. Peter Kornatz
Head of the Research Focus Area

The vision of a climate-neutral and sustainable bioeconomy - and the premises associated with this - provide the framework for the research focus area “Anaerobic Processes”. New processes using micro-organisms to convert biomass under anaerobic conditions form the basis of a wide range of biotech processes for supplying energy and materials in the future. Coupling the utilisation pathways of energy and materials will increase the added value, support nutrient recycling and achieve a circular economy. The transformation process requires flexible and location-specific plant concepts that have the lowest possible methane emissions.

The overarching research goal of the RFA “Anaerobic Processes” is to contribute to a sustainable bioeconomy through the use of innovative technological approaches for biochemical conversions. The following goals are derived from the premises listed above:

Strategic Goals

Goal A | Process monitoring and control

Goal A consists of the development and validation of models for process- and plant control in lab- and practical scale as well as sensor development and sensor-based process monitoring. Mass and energy balances for integrated processes are also investigated.

Goal B | Process development and integration

Goal B focuses on applying and evaluating substrate treatment processes, product diversification and flexibilisation as well as on technical and economic aspects in the development, evaluation and demonstration of coupled processes. Furthermore, modular plant design concepts are developed and assessed with regard to their cost-effectiveness.

Goal C | Emission reduction

Goal C aims at the identification and examination of emission sources at existing plants as well as the development and validation of methods for measuring and determining emissions at biogas plants. Measures for reducing emissions are also being investigated.

Scientific Basis

The technical equipment in the biogas lab and the research biogas plant, as well as the highly qualified technical and scientific staff, form the scientific basis of the RFA “Anaerobic Processes”. The wealth of experience and the good networking capabilities of the RFA staff members are pivotal for achieving the set goals.

Biochemical conversion processes can be tested and investigated at different scales, from the model and laboratory scale up to plant scale (research biogas plant) under practical relevant conditions. Samples and measurements can also be taken on site at operational plants. The technology required for measuring emissions is on hand and the appropriate software is available for modelling processes. Our employees’ modelling expertise ranges from technical approaches (processes, emissions) to economic processes (business models). The values from laboratory and field measurements are used to validate models. This enables the simulation of entire process chains and the identification of integrated energy and material product lines with high added value. The biogas and biomethane plant inventory is continuously examined with an eye to the market. The data generated from annual surveys of plant operators is recorded in a database. This enables identification of market requirements which have to be considered when successfully establishing a technology. Thus, the requirements of the application-oriented scientific work are met as well as the need for a

practical application with economic relevance.

The biogas lab conducts high-quality standard analysis as well as substrate-specific and process-specific analysis. This allows the input materials and additives used in the biogas process to be analysed and characterised. A range of proven methods are used in the tests and analyses. Further development with ongoing documentation is an important element of the RFA's scientific work. Continuous and discontinuous fermentation experiments are carried out in laboratory fermenters with the aim of understanding substrate properties and processes. New substrates, in particular agricultural residues and waste materials, as well as other biogenic substrates, are examined in specially adapted test beds. The developed processes, such as substrate-specific storage options, substrate pre-treatment options and the fermentation process itself, find their way into practical applications.

The research biogas plant enables processes to be transferred to practical scale. Process controls and plant equipment can be adapted to the respective object under investigation. In contrast to embedding experiments in operational plants, the advantage of the research biogas plant is that only planned, target-oriented and scientifically monitored experiments are carried out. There is no pressure to generate revenues, which ensures scientific independence.

Applied Research and Development at the DBFZ

RESEARCH FOCUS AREA 3 | BIOBASED PRODUCTS AND FUELS

The vision of a sustainable climate-neutral bioeconomy - and the premises related to this – sets the framework for the direction of the research focus area "Biobased Products and Fuels". This framework is crucial to the overall process chains - from biomass as a renewable source of carbon through to biobased products and fuels as biorefinery components. Also taken into account is the integration of other renewable energy sources. As a result, carbon-based material cycles are closed. The development of closed-loop bioenergy sources, especially in the transport sector and industry, requires R&D of processes and concepts, implementation of these on a lab and pilot plant scale, as well as comprehensive technology assessment. Process development for overall biorefinery concepts is supported by transferring experimental results computationally to production scale.

The overarching research goal of the RFA "Biobased Products and Fuels" is to use innovative technological approaches for biorefinery concepts as part of a sustainable bioeconomy. The following goals are derived from the premises mentioned above:

Strategic Goals

Goal A | Development and application of bioenergy sources for transport and industry

Goal A pursues monitoring on fuels for transport and on biobased products from and/or to industry. This includes investigating the behaviour of fuel mixtures in engines, the development and analysis of decentralised supply concepts for synthetic biomethane, as well as potential applications for special fuels.

Goal B | Development of innovative and competitive biobased processes and products

Goal B comprises the evaluation of industry requirements for (i) biobased products, (ii) the respective raw materials and (iii) specific process parameters. Focus is on developing, simulating and assessing these for hydrothermal processes, full separation cascades for processing valuable materials, thermo-chemical gasification, gas conditioning and synthesis gas processes, as well as the hydrotreatment of fuel precursors. This is flanked by enhancing and establishing of analytical procedures for reactants, intermediates and products.

Goal C | Development of biorefinery concepts as part of closed material cycles

Goal C includes the usage of residual and waste sources in hydrothermal processes and the utilisation of processed biomass for thermo-chemical gasification. It also considers the development of separation methods for in-process recycling and the closing of nutrient cycles. In addition, SynBioPTx approaches are enhanced to exploit the synergies of biomass- and electricity-based products.

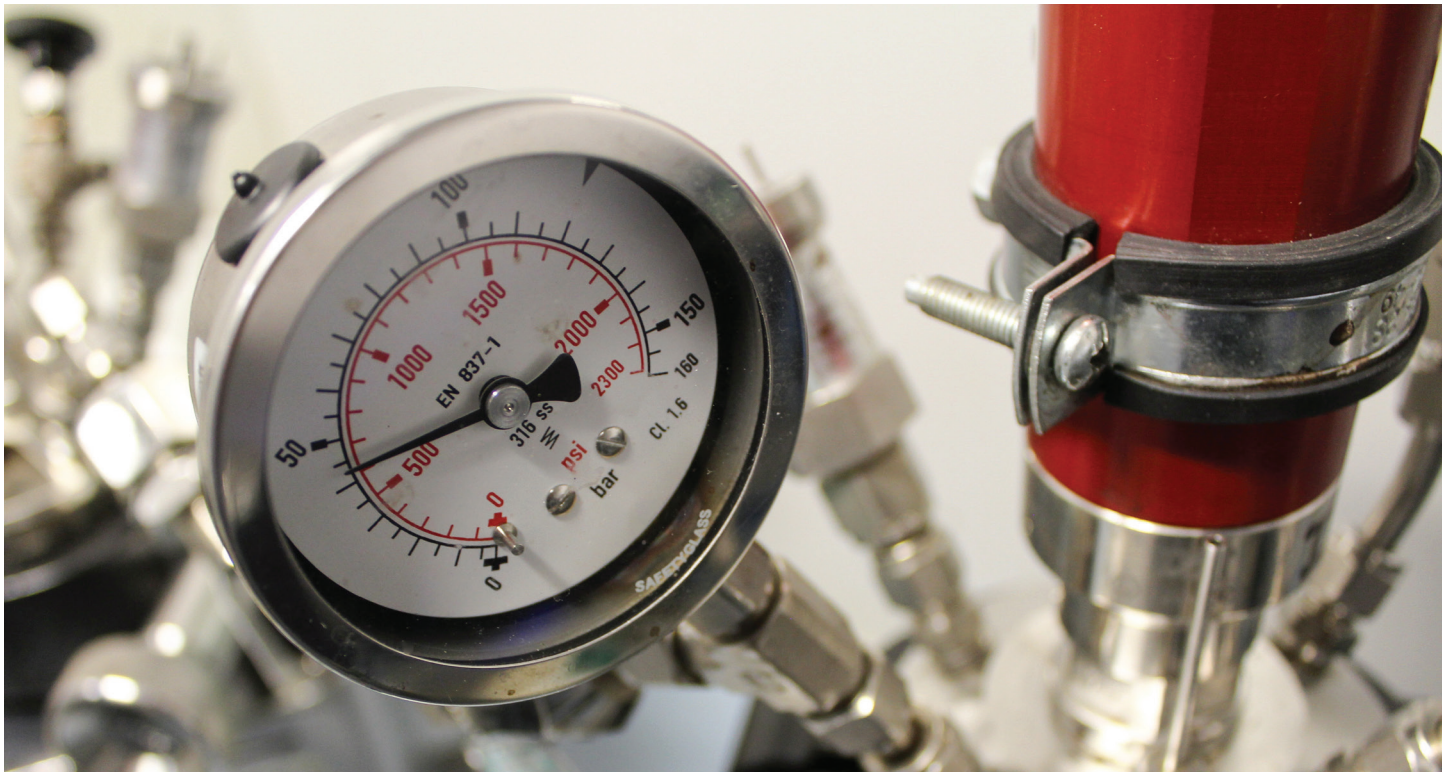
Goal D | Reduction of emissions

Goal D addresses moving process development towards minimising greenhouse gas emissions. This also comprises lowering harmful emissions resulting from the use of fuels in engines, and reducing pollutants in process water and exhaust gases.

Scientific Basis

The RFA "Biobased Products and Fuels" uses the process engineering equipment located at the biorefineries technical centre and a broad range of methods for the multi-criteria-based technology assessment of individual processes and overall concepts for biorefineries. A variety of process engineering equipment and processes are used to simulate the complexity of biorefineries. The appropriate combination of these process steps help to design biorefinery concepts that are capable of producing marketable products. Thus, the technical equipment of the biorefineries technical centre is designed to ensure good compatibility between the equipment so that different processing chains of biogenic raw materials can be investigated. In addition, more emphasis is being placed on the automated gathering of measurement data and automated plant operations. Fundamental to our work are the statistical design and analysis of experiments with a high scientific standard, as well as the use of process simulation, databases and software tools for assessing technologies.

In the biorefineries technical centre, biobased products from wet biomass are investigated using hydrothermal processes (HTP). Furthermore, gaseous products from dry biomass or intermediate products are examined using thermo-chemical gasification. Different reactor concepts are employed for the two conversion steps depending on the type of feedstock and the desired product. Biobased syntheses gas - from thermo-chemical gasification or other sources - can also be used to produce synthetic products. Specific reactors



are developed, used and optimised for these investigations. The separation technology required to purify biobased products and fuels produced from complex mixtures of substances is also investigated and developed. Both solid and liquid products are created. The equipment in the biorefineries technical centre is designed and dimensioned so that it delivers results that are as close to industrial standards as possible. This provides a good basis for the initial operating parameters needed to scale up the biorefinery concepts. The simulation of entire processing chains allows product samples to be produced. Furthermore, the properties of different gas mixtures and tars can be investigated under operating conditions at the industrial partners' plants thanks to mobile measuring equipment that produces results of a scientific quality comparable to those of the biorefineries technical centre.

This centre is supplemented by an engine test bed, which is used to comprehensively analyse the behaviour of different fuel mixtures in engines in addition to the aftertreatment of exhaust gases. Here, hybrid processes are also investigated in connection with electromobility.

Furthermore, the composition of the samples produced at the DBFZ can be examined in the analytical lab using specific methods and equipment.

„Bioeconomy is a central building block for a sustainable, climate-neutral circular-flow economy. Our contribution to this includes the research and development of innovative and competitive technologies for bio-based products and fuels."

Dr. Franziska Müller-Langer
Head of the Research Focus Area

Applied Research and Development at the DBFZ

RESEARCH FOCUS AREA 4 | SMARTBIOMASSHEAT

„Future heat supply from biogenic solid fuels must become much more efficient, flexible and tailored to system requirements – it needs to get smarter!“

Dr. Volker Lenz
Head of the Research Focus Area

The research focus area “SmartBiomassHeat” pursues the vision of a climate-neutral energy supply in connection with a sustainable bioeconomy. When biomass is burned, climate neutrality can only be achieved if, in addition to the provision of GHG-neutral technology and fuel, the actual conversion process produces no climate-damaging emissions and, in the best case, even promotes negative emissions. To this end, sustainable and tailor-made solid fuels should be produced primarily from residues and waste materials and, if possible, be certified. The development of intelligent heating/cooling (electricity) technologies is vital to transforming the supply of heat - as integral part of the energy transition. The coupling of the heat and power supply requires adapted system and control concepts as well as an effective and efficient interplay with other renewable energies.

The overarching research goal of the RFA “SmartBiomassHeat” is to study and develop climate-neutral solutions for heating, cooling and, where possible, coupled electricity that utilise increasingly challenging biogenic residues and waste materials with high system benefits. Both centralised and decentralised supply structures must be reliably in place, and process heat requirements need to be met by combining other renewable, location-specific energy options with a minimised use of biomass. The following goals are derived from these premises:

Strategic Goals

Goal A | Customised solid input-materials

Goal A involves constantly checking whether enough biogenic feedstocks are available for the various applications. Standardised analysis and processing procedures are specifically developed, taking into account quality assurance measures, prediction models and digital tools. These enable the use of tailor-made solid fuels for a cost-efficient and climate-neutral operation of the conversion plants in accordance with regulations. Sustainable recycling options are to be found and established on the market for the solid residues stemming from the conversion process (e. g. coke).

Goal B | Technology and component development

Goal B focuses on developing the conversion technologies and their respective components for the different biogenic feedstocks. In addition, the costs of the different applications are examined, which involves a high degree of flexibility in designing and adapting these to changing site conditions and operations. The development of successful products requires modular concepts for heat generation, hybrid plants as well as a close link to the electricity sector through systems for monitoring and exchanging data.

Goal C | Integration of energy technologies and components

The focus of Goal C is on the development and design of location-specific, GHG-neutral supply concepts and innovative control systems that enable continuous monitoring of operations and the optimisation of mono- and multivalent supply concepts. The best possible operating mode and control technology is to be identified and implemented based on the participant and the application involved. Smart, automated installation aids are also being developed to support practical planning processes. Standardisation, necessary norms, as well as legal and social aspects need to be taken into consideration when it comes to successful system integration, not forgetting the involvement of qualified partners.

Scientific Basis

In order to achieve the above-mentioned goals, the RFA “SmartBiomassHeat”

relies on the latest research trends and results, as well as the extensive wealth of knowledge and experience of its staff members with their good connections to research and industry. This knowledge is supplemented by specific practice-relevant developments and experiments in real and emulated laboratory environments.

Highly advanced technological developments with a high Technology Readiness Level (TRL) are also regularly tested in real environments and in some cases assessed and improved over longer periods of time.

The combustion lab is equipped with a large number of test beds and measuring instruments to precisely record all the necessary measurement values. Automated processes are used to electronically file and store the extensive amount of raw data. Work processes are continuously improved, and maintenance and traceability of the measuring devices are carried out in accordance with the testing centre in order to produce highly reliable measurement data. Through participation in national and international cooperation projects, in-house procedures are regularly compared and validated with standardised procedures. Mobile measuring devices allow measurements to be taken under real operating conditions.

The DBFZ's analytical lab supports the swift characterisation of fuels, filter dust and ash.

Thanks to our employees' sound knowledge of fuel preparation and compaction, it is possible to process almost any biogenic feedstock into pellets and, in the future, into briquettes. Extensive knowledge about the influence of fuel properties on the conversion process, as well as the need for homogenisation ensures that measurement results are reliable and reproducible in all of the RFA's areas of activity.

In the next six years, data collection will be further automated and raw data will be increasingly stored in publicly accessible databases and made available to all interested parties (OpenData). At the same time new insights will be gained through the increased use of statistical data processing and analysis methods. Initial experience will be gained in using self-learning systems.

Modelling approaches will be used to better support these processes. In order to strengthen the efficiency of our research and development, we have obtained special expertise in TRNSYS and CFD simulation using OpenFOAM and in the simulation of ash behaviour using Factsage, which will become more and more relevant in the future. In addition, DEM will be used to investigate the behaviour of bulk materials in more detail.

The modelling of complete plant concepts using Matlab/Simulink in combination with a hardware-in-the-loop simulator (HiL) allows different design and operation options to be analysed with respect to time and cost-effectiveness. In addition, HiL can be used to examine actual components and control units in specific applications and system configurations under real-life conditions. Furthermore, the software SimulationX enables the heat and power supply of entire neighbourhoods and heating networks to be examined and optimised with regard to different aspects.

Applied Research and Development at the DBFZ

RESEARCH FOCUS AREA 5 | CATALYTIC EMISSION CONTROL

„Researching and developing catalytic processes for emission control in the combustion of biomass energy sources to safeguard the essential eco-friendliness of bioenergy.“

Prof. Dr. Ingo Hartmann
Head of the Research Focus Area

The vision of a climate-neutral and sustainable bioeconomy and the premises associated with it set very high demands on the research focus area “Catalytic Emission Control” in terms of pollutant-free bioenergy use. In particular, the anticipated growing use of biogenic residual and waste materials of increasingly varying qualities for energy generation poses a challenge if an emission-free use is envisaged. Therefore the focus is on reducing the emissions from combustion processes for bioenergy sources through the use of, and in combination with, solid catalysts. A almost complete removal of climate-affecting methane (CH_4), toxic volatile organic compounds (VOC), semi- and heavy volatile hydrocarbons such as polycyclic aromatic hydrocarbons (PAH) and polychlorinated dioxins and furans (PCDD/PCDF), soot particles (black carbon) and nitrogen oxides (NO_x) is required.

The overall research goals of the RFA “Catalytic Emission Control” is the development of long-term and high temperature stable catalysts that are, recyclable, cost-effective and contain no, or significantly lower amounts of noble metals. In particular, the combination of catalysts with additional emission reduction processes also needs to be researched in detail. The goals described below are derived from the premises.

Strategic Goals

Goal A | Research into climate-neutral emission reduction technologies

Goal A comprises the investigation of catalysts based on environmentally friendly chemistry as well as their recycling in an environmentally appropriate manner. The positive effects on the environment are studied and depicted as part of detailed life cycle assessments and development strategies are derived from the results.

Goal B | Complete emission reduction for residual and waste materials

Goal B deals with the investigation of catalytically active systems for combustion processes. The focus is on the selective catalytic reduction of nitrogen oxides from engine combustion and at the combustion of solid materials, combined with dust mitigation. It also includes the abatement of other pollutants such as HCl and SO_2. Investigations will also be undertaken on catalytic soot particle abatement and biomethane oxidation.

Goal C | Development of technology for integrated catalytic emission reduction

Goal C covers studying and developing new catalytic technologies that are integrated into the process to prevent emissions. The costs of catalyst production are to be reduced by lowering the amount of noble metals used. In addition, the durability and robustness of the catalysts also have to be increased.

Goal D | Development of modular components and flexibly scalable processes and parts

Goal D aims to find universal approaches to emissions reduction measures in order to enable transferability to other technologies across all plant sizes, from small to large units. The development of modular components for catalytic processes is the key aspect of this work. Using regional resources to produce catalysts will contribute to a higher sustainability. The process control and monitoring of emission abatement methods is to be investigated across all plant sizes using sensor and actuator technology currently under development.

Scientific Basis

The interdisciplinary composition of the staff in the RFA „Catalytic Emission Control“ from the fields of natural sciences (chemistry, physics, biology) and engineering (energy and environ-

mental technology) is a necessary requirement for the achievement of the objectives.

The development of new catalysts requires the extensive characterisation of materials and reaction technologies in a lab scale using powder and monolith samples, as well as testing in mobile model reactors that simulate practical use, and investigations conducted under real operating conditions.

In the technical centre (small-scale furnaces) and in the research plants (biogas CHP and engine test bed), the effectiveness and stability of catalysts can be investigated using combustion test beds. This enables application-specific suitability studies and sustainability assessments to be conducted before the technology is transferred to industrial scale.

Material characterisation methods in the analytical lab, such as elemental analyses based on ICP-OES, enable catalyst characterization along every phase of the development chain. This knowledge allows conclusions to be drawn about optimized scale-up and catalyst aging under realistic process conditions.

One fundamental requirement of research into novel solid-state catalysts is the characterisation of the catalysts using physisorption and chemisorption methods on both powder and realistic monolith samples. For this purpose, an apparatus with exchangeable measuring cells is also available for larger sample masses and monoliths to enable reliable analyses. These characterisation methods are used in ageing investigations and will increasingly be used to study the recyclability of catalysts.

The effective use of catalysts under practical conditions requires the development of integrated catalyst processes. These are ideally used in combination with other primary and secondary abatement measures in order to achieve bioenergy use that is largely free of air pollutants. CFD simulations (OpenFOAM, Ansys Fluent), which are based on mathematical models currently under development, enable theoretical process development and a comparison with experimental data. This approach will result in faster and more cost-effective computer-aided development based on application and practical situation, and enable an optimized transfer from research to industry.

The results of catalyst development from the laboratory, on the basis of theoretical and experimental process integration and up to practical application are also evaluated on the research side by means of life cycle and environmental assessment analyses, so that sustainable substantially emission-free bioenergy use can be ensured.

Knowledge and Technology Transfer at the DBFZ

As a non-profit organisation, the DBFZ contributes to the generation of new and further development and transfer of existing knowledge and technologies. As a catalyst for research, development and innovation projects, the DBFZ is open to all forms of cooperation, including publicly funded collaborative research with participants from industry, science and society, research contracts directly with industry, and various types of consulting services for different stakeholders.

KNOWLEDGE TRANSFER

In our understanding, knowledge transfer means transmitting scientific findings to society through exchanges with various stakeholders (politics, civil society, administration, associations, industry, education) as well as contributing the science-based viewpoint to public discourse on the respective topics.

In response to continuously increasing demands for efficient technologies for sustainable bioenergy supply and biomass use, a comprehensive and up-to-date database is a strategic requirement both for individual planning and for developing the political framework.

One of the most important transfer services of the DBFZ is the collection, processing and provision of data. The DBFZ identifies and analyses biomass potentials, develops utilisation scenarios and strategies for various traders on the biomass markets, monitors market and technology developments as well as trade in biomass/bioenergy, and prepares summaries of said market and technologies. The forecasting of future market and technology developments in bioenergy and in the bioeconomy, cost analyses of biomass supply, as well as the development and compilation of environmental and social indicators (e. g. emissions, environmental impact, sustainability indicators) and political framework conditions are also part of our portfolio. Furthermore, information on the ever-increasing requirements regarding quality and sustainability can be made available to all sides and in a transparent way.

The DBFZ also offers a wide range of consulting services for policymakers. This includes the long-term observation of bioenergy market developments as part of various monitoring projects (in the field of electricity generation from biomass as well as biofuel production and use). The DBFZ also supports the design of political instruments relevant to the use of biomass in the production of energy and materials (e. g. EEG, EEWärmeG, Biokraft-NachV, BImSchG/BImSchV, etc.).

Expertise is also disseminated in the form of position papers, for example on the current potential use of biogenic waste and residues in energy production, as well as on existing bioenergy plants and the consequences of extending the biofuel quota, by commenting on current legislative procedures and responding to inquiries from political institutions, and via the scientific monitoring of strategy projects.

In addition to collecting, analysing and presenting information and data on market developments, existing biomass potentials and typical bioenergy technology parameters, the DBFZ has recently developed suitable tools for the creation of medium and long-term bioenergy scenarios for strategy development.

Knowledge transfer reaches further target groups, e. g. through special events, networking activities and committee work (see also “Position in the Research Landscape – in 2020”). For example, the DBFZ organises the series “Leipzig Expert Talks” (on the topics of biogas, biofuels, solid biomass) and expert conferences focusing on a specific topic (e. g. hydrothermal processes, monitoring and process control technology of biogas plants, and dust separators in domestic furnaces).

In addition, numerous publications (such as reports, guidelines, handbooks, conference proceedings and dissertations,) provide an extensive collection of scientific information which can be downloaded free of charge from the DBFZ website so that its reach can extend beyond the scientific community.

Various cooperation projects in Germany and abroad enable a continuous transfer of knowledge through workshops, guidelines, employee training, and through the organisation and implementation of specialist events (technical discussions, conferences, workshops).

Furthermore, from 2020 onwards, target group-specific formats are to be developed for the transfer of applicable research results and methods:

- Preparation of guidelines and handbooks
- Development and creation of web-based information platforms and open source portals

One example of comprehensive scientific support for R&D&I projects is a support project of the BMWi funding programme "Biomass energy use" (funded by the 7th Energy Research Programme since 2019) which has been in place at the DBFZ for ten years. More than 160 projects and 400 project partners, particularly from small and medium-sized companies and research institutions, have successfully networked through the funding programme at events, conferences and workshops. In addition, a series of publications has been developed in which more than 20 volumes and six focus brochures on key bioenergy topics have been published.

Furthermore, the support project organises the cross-project working groups of the research network as part of a process to harmonise methods, and it coordinates and moderates relevant political discourse. As part of an intensive discussion process within the network, measurement methods for biogas, particulate matter and gasification have been collected, a methods handbook has been developed, and joint statements have been issued. Since 2016, the funding programme has been a member of the BMWi research networks. Here, the support project has coordinated the development of future R&D&I recommendations as part of the consultation process for the 7th Energy Research Programme. The network currently has over 600 members.

TECHNOLOGY TRANSFER

Technology transfer (TT) refers to the technical utilisation and exploitation of scientific R&D results by industry. With regard to biomass usage for energy and integrated material production, the aim is to maintain and expand the technological leadership of Germany and Europe. At the DBFZ, TT is carried out both through joint R&D&I projects (third-party funded projects) with industrial partners, industry-funded contract research and, at times, through employee spin-offs.
To support all employees in these processes, the DBFZ innovation strategy provides basic guidance for this exploitation. In the strategy, the DBFZ defines the innovation process as the targeted development of an idea which is accompanied through the phase of applied research and development (including method development) until it becomes a marketable product, process or service. These phases overlap, are collectively referred to as the RDI process and, if successful, result in products established on the market. The aim to transfer scientific results to industry or enable their use in other practical or scientific applications is part of the entire RDI process at the DBFZ, right from the planning pahse of publicly funded projects. The use of potential intellectual property rights is regulated in cooperation agreements with project partners. The aim is to enable the value-adding use of such rights by industry partners, with adequate compensation for the DBFZ and its inventors.

The Innovation Centre for Bioenergy is also utilised in the management and coordination of specific innovation processes and for establishing and expanding national and international networks.

The above-mentioned goals and processes are primarily implemented in two ways: firstly, by evaluating bioenergy technologies with respect to technical, economic and environmental aspects, and secondly by developing new and optimising existing concepts and processes.

In addition to assessing the technical, economic and environmental parameters of bioenergy plants, these analyses provide a suitable basis for optimising processes and concepts. Examples of technical analyses include:

- Mass and energy balances
- Technical feasibility
- Technology screening and learning curves
- Parameter-based evaluations (e. g. specific efficiencies, availabilities, quality levels, classification according to technical development status)

The economic analysis includes:

- 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, bio-based products)
- Analysis of value chains using life cycle cost analyses (LCC, social life cycle assessment) and an assessment of the contribution of the biomass use concepts to regional added value

Examples of environmental analyses include:

- (Environmental) life cycle assessments (LCA) on greenhouse gas emissions and other environmental impacts (including water balance and soil parameters) as well as primary energy consumption
- Competing land uses

As part of the development and optimisation of concepts and processes, primary tools include pilot plants and computer models with which material and energy flows can be calculated (process balancing). These can be used for entire biorefineries or individual components such as combustion, gasification and synthesis plants. Experiments can thus be complemented and rounded off by numerical investigations. Depending on the object under investigation, flowsheet simulations or CFD models are used to precisely understand processes and improve the prediction accuracy of models.

The interaction of different process steps can be investigated using flowsheet simulations. By analysing the mass and energy balances of complete, or parts of, biorefineries, efficiency can be increased early on. This forms an essential basis for economic and environmental analyses and is suitable for simulating the effects of adaptations to existing plants. CFD simulations enable any size of plant to be depicted three-

dimensionally in order to examine the physical and chemical processes occurring within them. Special attention is paid to the investigation of flow processes, taking into account the chemical reactions that are taking place. By varying different parameters, processes can be controlled and optimisation potential can be identified, for example, the reduction of emissions from combustion plants or the increase in efficiency of synthesis plants.

The DBFZ also conducts kinetic measurements for catalysts, developing plant control concepts and, last but not least, specialises in transferring processes from laboratory to pilot, demonstration or industrial scale.

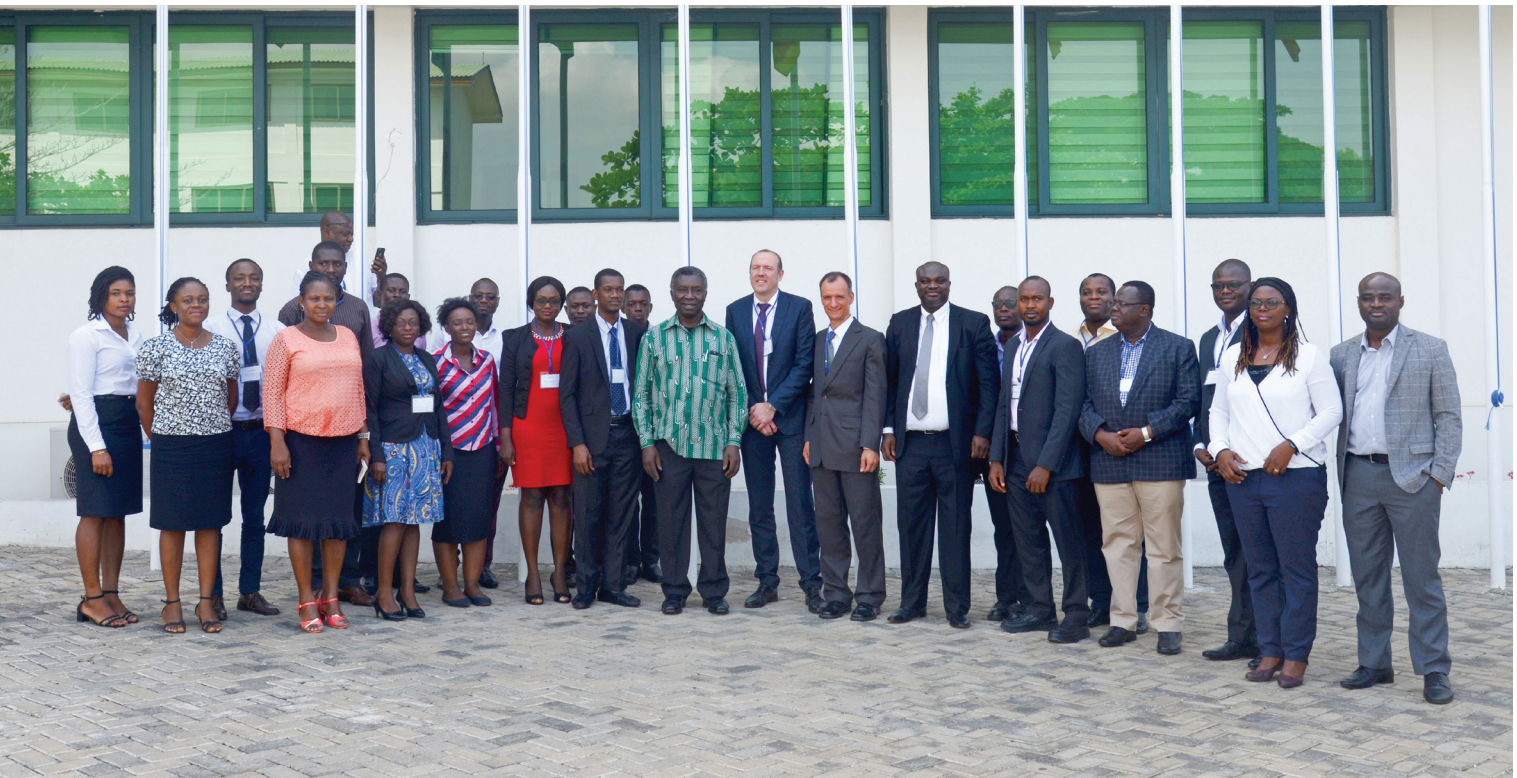
Internationalisation

The DBFZ has already gained a solid international reputation and would like to further increase its international visibility in the future, especially outside Europe. This includes the transfer of knowledge as part of application-oriented projects. At the same time, cooperation with foreign universities and non-university research institutions is to be intensified, with heavy emphasis on excellence and impact within the respective country. The aim is not only to attract talented young researchers to the DBFZ, but also to intensify cooperation with experts in order to achieve a leading position in the field of bioenergy research on an international level.

International knowledge and technology transfer at the DBFZ relies on third-party funding, which sets certain limits for a broad strategic orientation. Nevertheless, the DBFZ strives to offer concrete solutions in all regions of the world, albeit not in all countries. The focus is mainly on the following key regions: East Asia (China, Japan), North America (Canada), Latin America (Mexico, Brazil, Chile), West Africa (Ghana, Togo), East Africa (Ethiopia, Kenya) and South Africa.

The majority of the DBFZ's international projects have been carried out in these regions. The contacts that have been established are to be maintained in the future and, in the spirit of excellence research, continuously expanded upon. The DBFZ may become involved outside the above-mentioned regions if this creates new impetus for research and development at the DBFZ or if this increases the DBFZ's level of international recognition. Current initiatives for intensified cooperation concern Canada and India.

Participation in international bodies is an essential element to increasing international visibility. In this context, the International Energy Agency TCP Bioenergy (www.ieabioenergy.com) should be mentioned, where DBFZ employees are national team leaders for Germany in various areas of bioenergy. Membership to the International Organization for Standardization (ISO) gives the DBFZ the opportunity to play an active role in international standardisation. DBFZ employees have also been appointed to expert committees and have assumed guest professorships (China). The international activities will continue along this pathway.



1

North America

Bioenergy from agricultural and forestry residues is important in Canada and the USA.

2

Latin America

DBFZ activities in Latin America focus on biogas from sugar cane residues and liquid manure.

3

West Africa

Knowledge transfer and research capacity building on potential, biogas and pyrolysis are in focus.

4

South Africa

The focus is on building biogas research capacity and scientific cooperation.

5

East Asia

There is long-standing cooperation on waste, biogas and solid biomass in China and Japan.

6

South Asia

The topic of waste, especially the organic fraction in household waste, determines the activities in South Asia.

Press and Public Relations

Press and public relations work is intended to reach the following target groups and to inform them about relevant research topics and current developments at the DBFZ. The target groups include all stakeholders from research, the industry and politics connected to bioenergy and bioeconomy. Among these are relevant scientific institutions (universities, non-university research institutions and research networks), the BMEL and other federal and state ministries as well as other national and international governmental and non-governmental organisations, especially from the agricultural, forestry and energy sectors. This also includes, in particular, downstream industries or economic sectors directly or indirectly affected by the production of energy from biomass and the material use of biomass. Our own research results are also communicated to members of the public deeply interested in a supply of bioenergy that is environmentally and climate-friendly, economically feasible and socially acceptable.

The overall aim of the DBFZ's press and public relations work is to create a broad impact (spatially across all target persons including management and specialists) and a deep impact (expertise, market penetration by assuming market leadership in bioenergy research with respect to technology and expertise) as well as to increase the level of awareness of the DBFZ as a research institution in the scientific world and for potential employees. To this end, the department makes use of a variety of common PR instruments such as press and media relations, event and visitor management, publications and social media. In addition to external communication, the press and public relations department is also responsible for internal communication via the intranet, newsletter and internal information transfer. The department also provides support in the area of quality management. As a controlling and management tool, we use measurement variables such as the number of participants at an event, monthly media and press reviews, visitor numbers to our website, and general feedback on PR activities.

We have continued to develop the activities and measures established in recent years as part of our press and public relations work. In addition to organising our own national and international expert events (e. g. IBC - International Biomass Conference (2009-2013), the DBFZ Annual Conference (since 2014), the Doctoral Colloquium BIOENERGY (since 2018), expert talks, workshops with a consulting nature etc. we have co-organised regional, national and international specialist conferences and expanded on our publication series "DBFZ Reports" as well as the "DBFZ Conference Readers". Intensified press and media relations, specialist newsletters, statements and studies on current issues surrounding biomass use, the DBFZ annual report in German and English, a completely revamped DBFZ website, a revised corporate design and the ongoing introduction of a Customer-Relationship-Management-System (CRM) all contribute to optimising internal processes within the department, professionalising the DBFZ's public image and increasing its visibility.

The Fachagentur Nachwachsende Rohstoffe e. V. (FNR) has the general responsibility to provide information on the subject of bioenergy and renewable energies and this is therefore not part of the press and public relations work of the DBFZ. Instead it is tasked with providing the FNR with scientific support.


Deutsches Biomasseforschungszentrum
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DBFZ
MART BIOENERGY –
NOVATIONEN FÜR EINE
ACHHALTIGE ZUKUNFT
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Summary and Outlook

The present research, development and innovation concept (Part I: RDI concept) represents the scientific strategic planning of the DBFZ for the period 2021-2026. The concept shows the planned research goals of the individual RFAs in connection with the national and international research policy framework.

The RFAs at the DBFZ, which are already established in the national research landscape, and the state-of-the-art research infrastructure currently available at our site provide a solid basis for implementing this concept. The current investment of around € 60 million by the BMEL in the new technical centre, as recommended by the German Science Council, will be specifically used to strengthen our top position in bioenergy research nationally and further increase the international standing of the DBFZ.

The concrete implementation of the RDI concept is set out in a roadmap (Part II), which illustrates how it fits into the research landscape and lists the defined short-term (1 year) and medium-term goals (3 years) for each RFA.

Both documents were developed in close cooperation with our employees as part of information days, surveys and seminars, and were coordinated with the strategically relevant committees (BMEL Department 524, the Supervisory Board and the Research Advisory Council).

List of Abbreviations

BECCS	Bioenergy with carbon capture and storage
BEN	Bioenergy Department UFZ
BImSchG	Federal Immission Control Act
BImSchV	Federal Emission Control Ordinance
Biokraft-NachV	Biofuels Sustainability Ordinance
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMVI	Federal Ministry of Transport and Digital Infrastructure
BMWi	Federal Ministry for Economic Affairs and Energy
CEN	European Committee for Standardization
CFD	Computational fluid dynamics
CH_4	Methane
CHP	Combined heat and power plant
CRM	Customer relationship management
DBFZ	Deutsches Biomasseforschungszentrum gemeinnützige GmbH
DIN	Deutsches Institut für Normung e. V.
EEG	Renewable Energy Sources Act
EERA	European Energy Research Alliance
EEWärmeG	Renewable Energies Heat Act
ETIP Bioenergy	European Technology and Innovation Platform
FNR	Fachagentur Nachwachsende Rohstoffe e.V. (Agency of Renewable Resources)
FTE	Full-time equivalent
GHG	Greenhouse gases
GIS	Geographic information system
HCl	Hydrochloric acid
HiL	Hardware-in-the-loop simulation
HTP	Hydrothermal processes
IBC	International Biomass Conference
ICP-OES	Inductively coupled plasma optical emission spectrometry
IEA	International Energy Agency
ISO	International Organization for Standardization
LCA	Life cycle analysis
LCC	Life cycle cost analysis
NGO	Non-governmental organisation
NOX	Nitrogen oxide
PAH	Polycyclic aromatic hydrocarbons
PCDD/PCDF	Polychlorinated dibenzo-p-dioxins and dibenzofurans
POF4	Programme-oriented funding (Helmholtz Association)
RDI / R&D&I	Research, development and innovation
RED II	Renewable Energy Directive
RFA	Research focus area
SDG	Sustainable development goals
SET Plan	European Strategic Energy Technology Plan
SME	Small and medium enterprise
SMEKUL	Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture
SO_2	Sulphur dioxide
SynBioPTx	Synergies (Syn) from biomass (Bio) and electricity-based processes (PTx, Power-to-x)
TRL	Technological maturity
TRNSYS	Transient systems simulation
TT	Technology transfer
UFZ	Helmholtz-Zentrum für Umweltforschung GmbH - UFZ (Helmholtz Centre for Environmental Research GmbH – UFZ)
UN	United Nations
VOC	Volatile organic compounds

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