Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ

Annual Report 2022

Directions

By train: to Leipzig main station. Take tram line 3/3 E (towards Taucha/Sommerfeld) as far as the Bautzner Strasse stop. Cross the street, leave the car park on the right and use the main entrance of the DBFZ (House 1, Torgauer Str. 116). Please check in at the front office.

By car: on the A 14 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 3/3 E towards Taucha/Sommerfeld; Bautzner Strasse stop (see “By train” for further directions).

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DBFZ

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1 Editorial

Dear readers,

The third year of the Covid-19 pandemic, combined with the effects of Russia's brutal war of aggression against Ukraine, was also associated with special challenges for the DBFZ. We are very pleased that we were able to master these well with our very committed DBFZ team and continue to drive forward the positive development of the DBFZ. Special thanks go to all our partners (Supervisory Board, Research Advisory Council, project management organisations and project partners) for their tireless input, many valuable suggestions and constructive cooperation!

Fig. 1: The General Management of the DBFZ

There was already a major motivational boost at the end of January 2022 when the German Science Council (WR) published the final evaluation report and certified that the DBFZ had "further developed into a renowned institution in the field of biomass research since the previous evaluation in 2014. Not only the quality of the scientific achievements, but also the very good national and international networking of the DBFZ with industry and the scientific community should be emphasised".

According to its current research, development and innovation concept, the DBFZ's activities focus on the energetic and integrated material utilisation of renewable raw materials, especially biogenic waste and residues. A central research and demonstration project is the "Pilot SBG – Bioresources and hydrogen to methane as fuel – conceptual design and realisation of a pilot-scale plant", which is being implemented on behalf of the BMDV. In addition, scientific issues relating to the entire bioeconomy are increasingly being addressed in order to make a contribution on the path to a climate-neutral society. Against this background, activities in the area of policy advice were also strengthened in 2022, as well as international activities.

On this basis, we can now look back on another labour-intensive research year with exciting projects and developments. In this Annual Report 2022, you will find a great deal of interesting information. On behalf of the entire DBFZ team, we hope you enjoy reading this report and wish you all the best.

Prof. Dr. Michael Nelles
Scientific Managing Director

Dr. Christoph Krukenkamp
Administrative Managing Director

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Overview of the DBFZ

“The object of the company is application-oriented research and development in the field of energetic and integrated material use of renewable raw materials in the bioeconomy with special consideration of innovative techniques, economic effects and environmental concerns.”

(Excerpt from the shareholder agreement)

Fig. 2: The main building of the DBFZ, located in Leipzig

Fig. 3: Bioenergy in the context of the Sustainable Development Goals

Mission

In order to be able to permanently establish the use of biomass for energy in the existing energy system, the DBFZ is developing concepts for the economically viable, ecologically safe and socially acceptable use of biomass for energy. The aim is to analyse potential areas of conflict between the various goals pursued with the expansion of bioenergy at an early stage and to develop design approaches with foresight. Questions to be addressed in this context include integration into a changing energy system, improving energy efficiency, avoiding competing uses or avoiding emissions into the soil, water and especially the air. The DBFZ's work is intended to expand knowledge about the possibilities and limits of using biomass for energy overall and to secure Germany's outstanding position as an industrial location in this sector.

Target groups

The target groups for the results of the R&D work are the professional public and here in particular the energy sector, agriculture and forestry, the economy in the biomass/bioenergy/bioeconomy sector and ultimately the end consumer, who has a great interest in an environmentally and climate-compatible, economically feasible and socially acceptable bioenergy supply. In addition to the Federal Ministry of Food and Agriculture, other target groups include federal and state ministries with an energy focus as well as governmental and non-governmental organisations at national and international level.

Key figures 2022

48
Newly launched projects (market and third party funded projects)

59
Completed projects

222
Processed projects

224.517 €
Average project volume of the projects launched in 2022

263
Employees as of: 31/12/2022

39
Internal & external events (online/hybrid/in person)

58
Peer reviewed publications (including 49 open access articles)

The Smart Bioenergy approach of the DBFZ

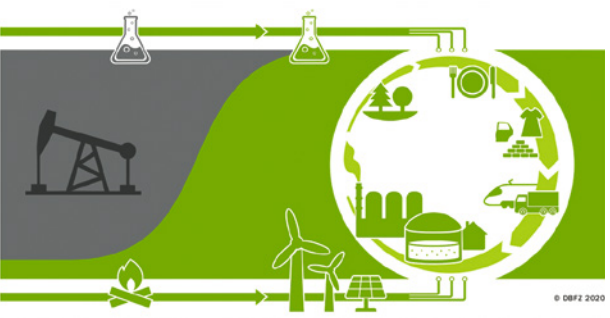

Fig. 4: Development stages towards “smart” bioenergy use

Future biomass use must combine numerous objectives. These include food security, security of supply in the energy mix, but also innovative products and markets within the framework of the bioeconomy as well as climate and environmental protection and, last but not least, the development of rural areas. This represents a major challenge. Together with the fact that the potential of biomass is limited, conflicts of objectives and limits to biomass use inevitably arise. Accordingly, raw material strategies should follow the prioritisation “food first” and focus on sustainable innovative use paths in key technologies. However, technological innovations are not sufficient in a complex system. Rather, innovations are also needed at the societal level that enable technical progress, but also allow the relevant sectors in the system to interlock wisely. The urgent demand to increase energy efficiency and reduce energy demand for a successful energy transition makes this all too clear.

The proposal of the smart bioenergy approach takes up these ideas. Smart bioenergy thus encompasses the further development of modern biomass utilisation systems into integrated systems consisting of optimised interaction with various renewable energy sources on the one hand and coupled material/energy utilisation within the framework of the bioeconomy on the other. The approach consists of the components:

_ Use of sustainable raw materials,
_ further development of smart technologies and
_ integration into future concepts of the bioeconomy.

However, it also presupposes changing patterns of consumption, energy saving and an increasing demand for sustainability with changing target values. The concept thus makes a significant contribution to future sustainable energy supply. However, in order to be able to provide concrete support for the energy transition together with its political course-setting, the “Smart Bioenergy” approach must be further developed and questions about its implementability in the energy transition process must also be asked holistically. The step-by-step implementation of the approach supports the energy transition in Germany as well as the further development of bioenergy provision in site-adapted energy strategies.

→ **Further information:**
www.smart-bioenergy.com

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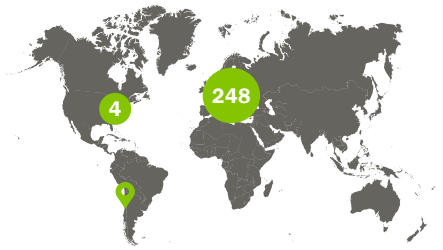
Key figures and scientific highlights

Project cooperation

Close research cooperation with numerous partners from science, industry and society enabled the DBFZ to further expand its position as a leading national research institution in the field of the energetic and integrated material use of biomass in the past year. In total, more than 116 research projects were carried out in 2022 in cooperation with scientific institutions and industry partners. You can find a project overview in this annual report from page 137 onwards.

As part of 28 EU project collaborations with over 250 partners or as an active member and national team leader in leading international research networks, e. g. the IEA Energy Technology Collaboration Programme, the European Energy Research Alliance (EERA) or the European Technology and Innovation Platform Bioenergy (ETIP Bioenergy), the DBFZ is active in the field of committee work and is continuously expanding its scientific networks at national and international level. An overview of the extensive committee and network activities can be found in this annual report starting on page 116.

Main partners in EU cooperation
(Number per country/region)

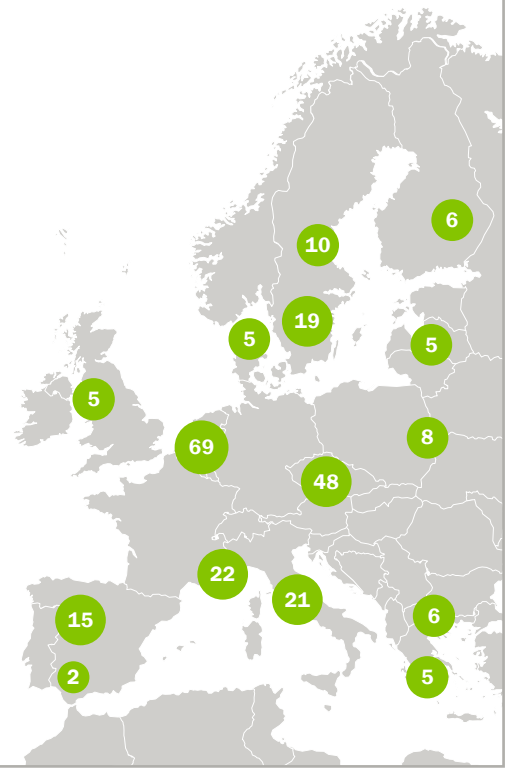


KEY DATA

28 EU projects (FP7/Horizon2020/HEU)

254 partners:
39 % Private-for-profit organisations (Industry, SME)
20 % Research institutions
19 % Colleges and universities
18 % Others (Associations, Agencies, Networks)
4 % Institutions under public law (public administration)

Funding for DBFZ:
9.1 Mio EUR



Source: © EU, Funding & tender opportunities (Status: February 2023)

Fig. 5: International cooperation at EU level

Publication output 2022

In 2022, scientific project results and findings were published together with co-authors from 70 institutions in almost 60 peer-reviewed publications and numerous popular science journals. The more than 140 publications per year with DBFZ participation in 2022 also included an increased number of statements and position papers to inform interested practitioners and users as well as policy-makers. With more than 200 presentations at scientific congresses and conferences, DBFZ employees also presented the latest results and findings in bioenergy research and actively networked with the scientific community and interested members of the public.

With a total of 308 publications, a new record was set in 2022. A detailed overview of the DBFZ's publications can be found in the appendix from page 141 onwards.

→ **Further information:**
www.dbfz.de/en/press-media-library/publications-directory

Tab. 1: Publication overview for the period from 2018–2022

Publications	2018	2019	2020	2021	2022
Book publications/ Editorships	12	9	12	15	13[1]
Book articles	16	5	37	14	23
Journal articles (reviewed)	57	57	70	62	58[2]
Journal articles	14	10	11	11	17
Contributions to conference proceedings	35	44	27	31	33
Presentations	142	156	132	165	217
Research data	3	1	3	4	5
Total	**279**	**282**	**292**	**302**	**308**

[1] of which: 3 monographs, 4 editorships of collective works, 6 editorships of conference proceedings/readers
[2] of which: 49 open access articles

Biomass to energy

BMWK funding area "Biomass to Energy"

The scientific support project of the BMWK funding programme "Energetic use of biogenic residues and waste" (in short "Biomass to Energy"), which has been based at the DBFZ since 2008, is a long-lasting example of the successful scientific monitoring and networking of R&D projects.

The task of the scientific support project is to create added value from the research programme that goes beyond individual project results. This includes the ongoing transfer of knowledge to various sectors of society, for example through products such as the video series "Bioenergy Heads", topic-related focus booklets or recommendations for the future regulatory framework. In order to form a network among actors from the different projects, the scientific support project also organises regular workshops and a biennial status conference. In 2022, the "Bioenergy" research network listed over 800 members.

Green hydrogen, sewage sludge utilisation or process heat from bioenergy: in 2022, 16 new projects started their work in the funding programme "Energetic use of biogenic residues and waste". The DBFZ is represented with three new projects. The projects coordinated by the DBFZ deal, among other things, with the potential analysis of residues from the hemp processing industry for energy use and with the optimisation of the fermentation of wheat pulp.

→ **Further information:**
www.energetische-biomassenutzung.de
www.forschungsnetzwerke-energie.de

Publications 2022

Contact
Prof. Dr. Daniela Thrän
Project Management
Phone: +49 (0)341 2434-435
E-mail: daniela.thraen@dbfz.de

Tina Händler
Project Coordination
Phone: +49 (0)341 2434-554
E-mail: tina.haendler@dbfz.de

Anna Flora Schade
Communication/Knowlegde transfer
Phone: +49 (0)341 2434-597
E-mail: Anna.Flora.Schade@dbfz.de

Scientific highlights

1st Central German Bioeconomy Congress in Altenburg

A highlight of the event, which was extensively co-organised by the DBFZ, was the 1st Central German Bioeconomy Congress, which took place on 2 May 2022 in Altenburg, Thuringia. The event, jointly organised by the Metropolregion Mitteldeutschland Management GmbH, the DBFZ and with the support of the BioEconomy e. V., presented the diverse bioeconomy activities in Saxony, Saxony-Anhalt and Thuringia. Around 300 personalities from business, science, politics and administration took part in the event in person and virtually. The highlight was the signing of a declaration of intent for a joint bioeconomy region of Central Germany, in which representatives of 23 regional companies, research institutions, universities, bioeconomy networks and business promoters expressed their will to "develop Central Germany into a bioeconomy region in which efficient biobased processes and innovative products are researched, produced and marketed".

→ **Further information:**
www.mitteldeutschland.com/de/biooekonomie

Fig. 6: Representatives of the DBFZ and the BMEL at the 1st Central German Bioeconomy Congress in Altenburg

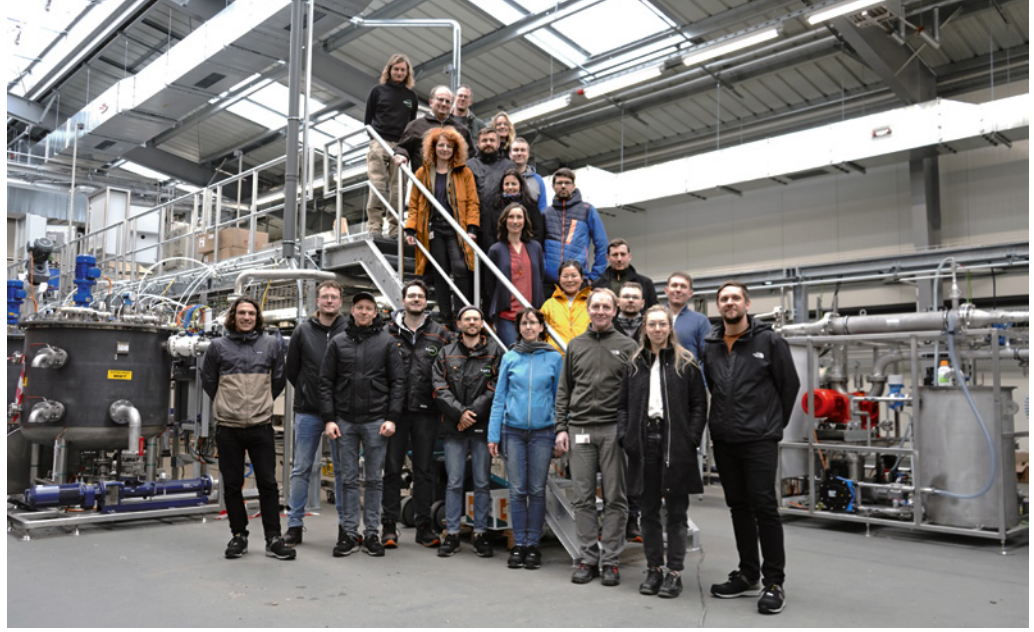


Fig. 7: The pilot SBG project team (March 2023)

Bioresources and hydrogen to methane as fuel – implementation of a pilot-scale plant

The research and demonstration project "Pilot-SBG" commissioned by the Federal Ministry for Digital and Transport (BMDV) pursues the provision of renewable methane as an energy carrier for transport sectors that are difficult to electrify. The concept combines both established and innovative technologies and processes biogenic residues, by-products and waste as well as green hydrogen for the provision of renewable methane as the main product and valuable by-products.

After a two-year planning phase, the go-ahead was given in May 2022 for the construction of the pilot plant on the DBFZ site. Various modules for hydrothermal substrate pre-treatment, anaerobic fermentation, catalytic methanation and digestate processing will be installed on an area of around 800 square metres. Accompanying the technical implementation, feasibility analyses and concept developments are being continued to serve as a basis for transfer to commercial scale. Following the Pilot-SBG project, the pilot plant is to be used as part of an R&D technology platform for further research and development projects with partners from industry and science.

→ **Further information:**
www.dbfz.de/en/projektwebseiten/pilot-sbg/

Position paper: the role of biogas for a secure gas supply

The 2022 parliamentary summer recess did not apply to the DBFZ's policy advice. Especially against the backdrop of the Russian war of aggression on Ukraine and the resulting gas shortage, there was a high demand for advice from the DBFZ. The possible contributions of biogas and biomethane to overcoming the gas shortage situation were summarised in the much-cited position paper

Fig. 8: Position paper “The role of biogas for a secure gas supply in Germany”

“The role of biogas for a secure gas supply in Germany”, which can be downloaded free of charge from the DBFZ website under the heading “Statements & Studies”. The position paper shows that an export stop of Russian natural gas can only be compensated to a very limited extent by biogas. In order to secure the existing contributions, the authors advocate, among other things, a rapid conversion of biogas production to agricultural by-products, biogenic waste and cultivated biomass without additional land requirements.

→ **Download:**
www.dbfz.de/statements

Fig. 9: New research project measures ultra-fine dust particles at chimney outlets

Project to measure ultrafine particles from small combustion plants

In the project “Measurement of ultrafine particles from small combustion plants (UFPMess)”, commissioned by the Federal Environment Agency (UBA) and launched in August 2022, particle measurements are being systematically carried out for the first time at the chimney outlets of log furnaces, both in the laboratory and in the field. In both environments, very complex particle number measurement methods, classical test bed measuring instruments and more cost-effective field-capable sensors are used. The data from the different measurement methods and from the laboratory and field are compared with each other. The findings are to be used to develop a concept that will make it possible to measure ultra-fine dust particles (particle diameter smaller than 100 nm) at domestic biomass combustion plants. It can be deduced from the current results that it is necessary to reduce the emission of ultrafine particles from small combustion plants very significantly through technology and training of the users. The DBFZ’s project partners are the Technology and Support Centre (TFZ) at the Competence Centre for Renewable Resources (Straubing) and the Leibniz Institute for Tropospheric Research (TROPOS) in Leipzig.

ISWA world congress in Singapur

After a two-year break from Corona, the International Solid Waste Association (ISWA) in Singapore was able to present a very good new start with over 1,000 participants from 51 nations. Germany was very well represented at the conference, especially with the members of the RETech-DGAW working group ISWA Germany under the leadership of Prof. Dr. Michael Nelles. The ISWA General Assembly took place on 20 September 2022. After a five-year “time-out”, Germany was able to set the tone again as a fully-fledged national member and to contribute intensively to the technical discussions at the meetings of the ISWA Working Groups and the WM&R Editorial Board. Top-class presentations by ALBA, Black Forrest Solution, HTP, Naue, N3, Sutco, University of Rostock & Wehrle, among others, impressively demonstrated the broad competences of the circular economy in Germany. Networking was not neglected either; it is becoming apparent that the Asian region is already an important market for RETech members and is to be further expanded in the future.

→ **Further information:**
www.iswa-germany.de

ISWA 2022
WORLD CONGRESS
21 - 23 SEPTEMBER, SINGAPORE

Fig. 10: Members of ISWA Germany at the ISWA World Congress in September 2022 in Singapore

Prices and awards

Fig. 11: Doctoral student Simon Hellmann (right) at the 5th Doctoral Colloquium BIOENERGY 2022

Doctoral student Simon Hellmann receives best poster award

DBFZ scientist and doctoral student Simon Hellmann (Biochemical Conversion Department) was a double winner of the “Best Poster Award” at various conferences in 2022. After successfully participating in the 17th IWA World Conference on Anaerobic Digestion in Ann Arbor, Michigan/USA, the young scientist was also able to convince the jury of the 5th Doctoral Colloquium BIOENERGY and once again received the prize for the best scientific poster. Both poster contributions dealt with the topic “Monitoring and control of agricultural biogas plants: Observability and identifiability analysis of simplified ADM1models”.

Dr. Matthias Jordan receives the Leipzig Energy and Environment Foundation Award

To promote young scientists and to deepen cooperation with scientific training and research institutions in the city and region of Leipzig, the Leipzig Energy and Environment Foundation awards an annual prize for the promotion of young scientists for outstanding student theses and innovative scientific project work. In 2022, scientist Dr. Matthias Jordan received the € 1,000 award for his doctoral thesis on “The future role of bioenergy in the German heat sector: Insights from an energy system analysis” in the Energy and Environment class. The dissertation was supervised by Prof. Dr. Daniela Thrän (UFZ/DBFZ) and supported by funded by the DBFZ-led project “BioPlanW”.

Fig. 12: Prize winner of the Leipzig Energy and Environment Foundation: Dr. Matthias Jordan

Fig. 13: Award winner Dr. Özge Mutlu

Top cited article / top downloaded article

DBFZ scientist Dr. Özge Mutlu (Thermochemical Conversion Department) was awarded a prize in mid-2022 for her reviewed paper “Challenges and Opportunities of Modelling Biomass Gasification in Aspen Plus: A Review” in the categories “Top Cited Article 2020–2021” and “Top Downloaded Article 2020–2021” by the online publisher WILEY. The scientific paper deals with recent developments and studies on biomass gasification modelling in the Aspen Plus process simulation tool, including important aspects such as tar formation and model validation. The publication is Open Access and is available free of charge at the following link: **https://doi.org/10.1002/ceat.202000068**

Climate challenge at the DBFZ – who saves the most CO_2 in everyday life?

How large is the ecological footprint of each individual and how can the most CO_2 emissions be saved in everyday life? With this in mind, the DBFZ launched an in-house “Climate Challenge” in May 2022. Over a period of four weeks, a total of 12 teams, and thus more than 55 DBFZ employees, took part in determining their own “carbon footprint” and competing with their colleagues. At the end of the competition, the individual prize-winning teams from different categories planted their prize – four redcurrant bushes – on the DBFZ premises and took on tree sponsorships for four Kaiser lime trees along Torgauer Straße.

Fig. 14: Winning teams of the DBFZ “Climate Challenge” (above) / plaque for tree sponsorship

4 Interview: International Research

Since its foundation in 2008, the DBFZ has left its mark on every continent. Although most of the projects have been realised in Germany and Europe, the DBFZ has now carried out studies and projects in various countries around the world. Over the years, the DBFZ has built strong networks in some countries to establish close research collaborations and promote exchanges of PhD students and scientists (including Brazil, China, Japan). In other countries, short-term studies were carried out on biomass potentials, the use of various raw materials for bioenergy production or pre-feasibility studies for bioenergy pilot plants (e. g. Caribbean, Mexico, Vietnam). In addition to active project work outside Europe, the DBFZ is an active member of a large number of international bodies and committees.

Fig. 15: International project collaborations with the DBFZ

Interview with Dr. Sven Schaller

Dr. Schaller: You work as a coordinator for international knowledge and technology transfer at the DBFZ, what are you doing at the moment?

SVEN SCHALLER: At the moment, we are working on further project development in our target regions. In particular, this is related to West, East and South Africa. Brazil (after Lula da Silva's election victory), Colombia and Argentina may also become more prominent in our activities abroad. Vietnam could be established as a new anchor country in East Asia. The Indonesian and Pakistan embassies are asking for DBFZ expertise in sustainable biomass use. In addition, there is a constant need to maintain the international network and keep track of the individual DBFZ projects abroad. It never gets boring. Sometimes it's like country hopping. And at the end of the day I realise that I had been only at my desk in Leipzig after all.

The challenges in many countries are extensive. Where can international transfer performance in the field of research most usefully start?

SVEN SCHALLER: The challenges are indeed manifold. In rural regions there are clearly different problems than in big cities, apart from the country-specific characteristics and different biomass potentials. Small villages, for example in remote African regions, often have a problem with eroded soils, which in turn endangers food security. In big cities, the issue of waste and waste treatment, in particular organic waste, is paramount. These are essentially the starting points for our projects. In general, it is a matter of transferring established technologies and knowledge to the various countries and anchoring them

"There is no single 'remedy' for all regions of the world"

permanently. All in all, there are enormous tasks at the various levels. The great challenge of my work at DBFZ is to work in this environment in a meaningful, targeted and effective way. And it is clear that there is no single "remedy" for all regions of the world.

Africa is a core region of your activities. What topics/projects are you working on locally?

SVEN SCHALLER: In our "Waste-to-Energy" project, we are building a combined waste sorting, biogas and pyrolysis plant together with partners in Ghana. The household waste generated in the community of Atwima (Ashanti Region) will no longer end up in the local landfill or scattered across the landscape, but will be processed into new products and energy. For this purpose, a solar PV system on the roofs supplies electricity that is fed directly into the power grid. This realised concept of the "circular economy" is a showcase project for the whole of Ghana, so that training and further education measures are also regularly carried out for other communities. The significance of the project is made clear not least by the fact that the plant was officially opened in April 2022 by the Ghanaian Minister of Environment, Science, Technology and Innovation, Dr. Kwaku Afriyie.

Another DBFZ project is being implemented in the neighbouring country of Togo?

SVEN SCHALLER: That's right. In the Togolese capital of Lomé, we are building up a biogas laboratory that will eventually provide trainings for technicians and scientists in the field of anaerobic conversion of biomass. We are not only transferring the latest laboratory technology here, but are also ensuring that the scientists involved can later operate and manage the laboratory independently. The laboratory is thus intended to become a hub for training new Master's students from all over West Africa, for example, without our further involvement.

However, a large part of the African population lives in relatively simple conditions and in rural regions. How can these groups be reached?

SVEN SCHALLER: From my point of view, it is specifically a matter of meeting people in their reality and supporting them accordingly through simple and practicable solutions. And to do so at eye level. The rural population, for example, cooks on simple stoves and mainly with wood that comes from deforestation, which in turn leads to successive erosion of the soil. A sub-package of the project in Togo therefore deals with the development of low-emission pyrolysis cookers made of clay that work with various organic residues beyond wood. These robust, low-cost cooking facilities are to be manufactured by local partners and marketed in the country as a follow-up to the project. Therefore, one focus of the project has been on reducing production costs, which are only about one fifth of the costs of previous steel-based pyrolysis cook-stoves. If these cook-stoves succeed in replacing the "three-stone" fireplaces throughout the country, it would be a big step ahead to reduce deforestation and at the same time fundamentally and sustainably improve the health conditions of women and girls. Accordingly, we are training this group of people in the use of the cook-stoves.

PROFILE

Dr. Sven Schaller has worked as the Coordinator for International Knowledge and Technology Transfer at the DBFZ since 2013. In his role, he is responsible for coordinating the DBFZ's international (non European) projects, activities and networks. After studying political science, economics and law with a focus on international relations, development theories and international political economy, Dr. Schaller spent four years abroad and completed his doctorate in Peru. In addition to teaching at the University of Leipzig, he was also the coordinator of a project on climate adaptation in Santiago de Chile at the Helmholtz Centre for Environmental Research (UFZ) in Leipzig.

Education and training is also an essential part of the “ETH Soil” project in Ethiopia. What is this about?

SVEN SCHALLER: From a formal point of view, the ETH Soil project is by far the DBFZ’s largest project abroad. At the same time, it is the first project to be commissioned directly by the Federal Ministry for Economic Cooperation and Development (BMZ). The preparatory work had correspondingly been a long-term process. In terms of content, there are several new approaches that the DBFZ could pursue in the future. In addition to training national agricultural advisors, we also want to train farmers on how to improve the quality of their soils through the use of biofertilisers and biochar and thus increase their food production. In other words, the focus of the project is no longer on the optimisation of bioenergy technologies, as has often been the case in recent years, but on the use of their products. Particularly in view of the looming global fertiliser crisis as a result of the Russia-Ukraine war, the project provides the Ethiopian population with the tools to improve food security in a self-determined and sustainable way in the future.

Keyword sustainability: how can it be ensured that Western technologies and knowledge are not only accepted but also further developed on site in the long term?

SVEN SCHALLER: A very important focus is on local education and training. In development cooperation, this approach runs under the catchy motto: “Train the trainer”. At the same time, we try to promote the active exchange of guest researchers. Due to the very high standard of our own research infrastructure at the DBFZ, we are able to regularly train scientists from other countries on new technologies and processes in a very practical way, which can then be passed on in the respective countries. In this regard, we rely on long-term cooperation with universities and research institutions, so that the knowledge can ideally find its way into practice, e. g. through newly established university curricula. Of course, we as DBFZ can only benefit from good international networking and the constant transfer of knowledge across national borders.

Can you give us a concrete example of such research cooperation?

SVEN SCHALLER: For example, we have been engaged in an intensive scientific exchange with the Forestry and Forest Products Research Institute (FFPRI) in Ibaraki, Japan, for several years. The institute has a lot of scientific expertise in wood products research, such as lignin printed circuit boards. The cooperation offers us good opportunities to develop ideas for our own research. Conversely, the scientists from Japan also use the findings from DBFZ research, especially on torrefied/pyrolysed biomasses, to make progress in the field.

“Of course, we as the DBFZ can only benefit from good international networking and the constant transfer of knowledge across national borders.”

Fig. 16: Technical development of a cooker in the DBFZ’s technical centre

Where do you see the greater challenges in terms of international knowledge and technology transfer – in highly industrialised countries or rural regions?

SVEN SCHALLER: IIn the countries where we run projects, the challenges are fundamentally different. In some African countries, for example, it is a question of developing technologies such as cook-stoves which work with local residual and waste materials, are easy to use and support the local people in their daily lives. For East Africa, we have developed a guide for the treatment of organic waste in cities and rural areas. (Read more about the WasteGui project on page 40).

In Asian countries such as China, the challenges are of a completely different nature. Here, biogas plants, solar and wind farms are being built on a scale that is beyond the imagination in Germany. The hunger for energy is enormous. Most governments are aware that the consumption of fossil fuels such as coal, natural gas and crude oil cannot continue as it has used to be. The use of renewable energies has so far focused on solar and

wind energy. Bioenergy was too complex and expensive. Now, however, more and more countries are realising that biomass is the only sustainable source of carbon.

From your perspective, what is the state of climate protection in the international context?

SVEN SCHALLER: With the UN climate summit in Paris in 2015, the global community set itself ambitious goals. In my opinion, the basic problem in highly industrialised countries is that it is difficult to reconcile economic growth with effective climate protection. And every individual should ask himself how he can reduce his personal carbon footprint. Always looking at others is not very effective.

With a view to the faltering energy transition in Germany: what can we learn from other countries?

SVEN SCHALLER: Unlike Africa, where most people walk, Germany is a country of car drivers. Completely new traffic concepts have to be thought out and implemented here. In my opinion, it's not about switching to electric cars or hydrogen power, but about significantly fewer cars, more public transport, more walking and cycling. It is about a lower consumption of resources and a reduction of land sealing in favour of nature. In the second field, the heat transition, we are also facing huge challenges. But this does not only concern Germany. All countries beyond the tropics and subtropics must quickly develop solutions.

Fig. 17: Training on the use of geographic information systems (GIS) in Togo

"The use of renewable energies has so far focused on solar and wind energy. Bioenergy was too complex and expensive. Now, however, more and more countries are realising that biomass is the only sustainable source of carbon."

Finally, what were your personal highlights in 2022?

SVEN SCHALLER: Personally, I was very happy to finally meet face to face the Ethiopian partners of the ETH Soil project, with whom we have been in exchange for three years during the Covid-19 pandemic, in Jimma and Addis Ababa – and to eat injera and drink Ethiopian coffee together with them. These live meetings, the immersion into a new culture, were something fundamentally different from the video conferences on the screen.

Thank you very much for the interview.

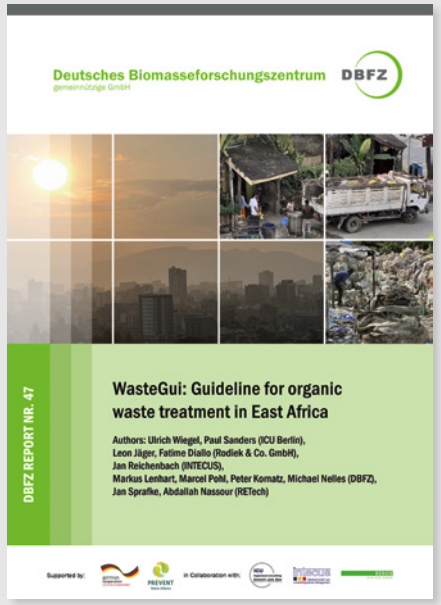


Fig. 18: Guideline for the treatment of organic waste (DBFZ Report No. 47)

→ **Further information:**
www.dbfz.de/en/international

5 Research Focus Areas: Reference Projects

A large number of different research projects in the field of energetic and integrated material biomass use were successfully completed in 2022. Key research topics are implemented at the DBFZ in five research focus areas. They ensure that important aspects of bioenergy and bioeconomy can be covered in the depth necessary for excellent research. The DBFZ's research focus areas are oriented towards current and future research policy challenges and framework conditions (e. g. the National Bioeconomy Strategy, the Mobility and Fuel Strategy, the EU Green Deal and the future National Biomass Strategy). Important cornerstones for the scientific orientation of the research priorities are also the funding policy framework conditions, the unique selling points in the research landscape and the very good research infrastructure of the DBFZ.

→ **Further information:**
www.dbfz.de/en/research/research-focus-areas

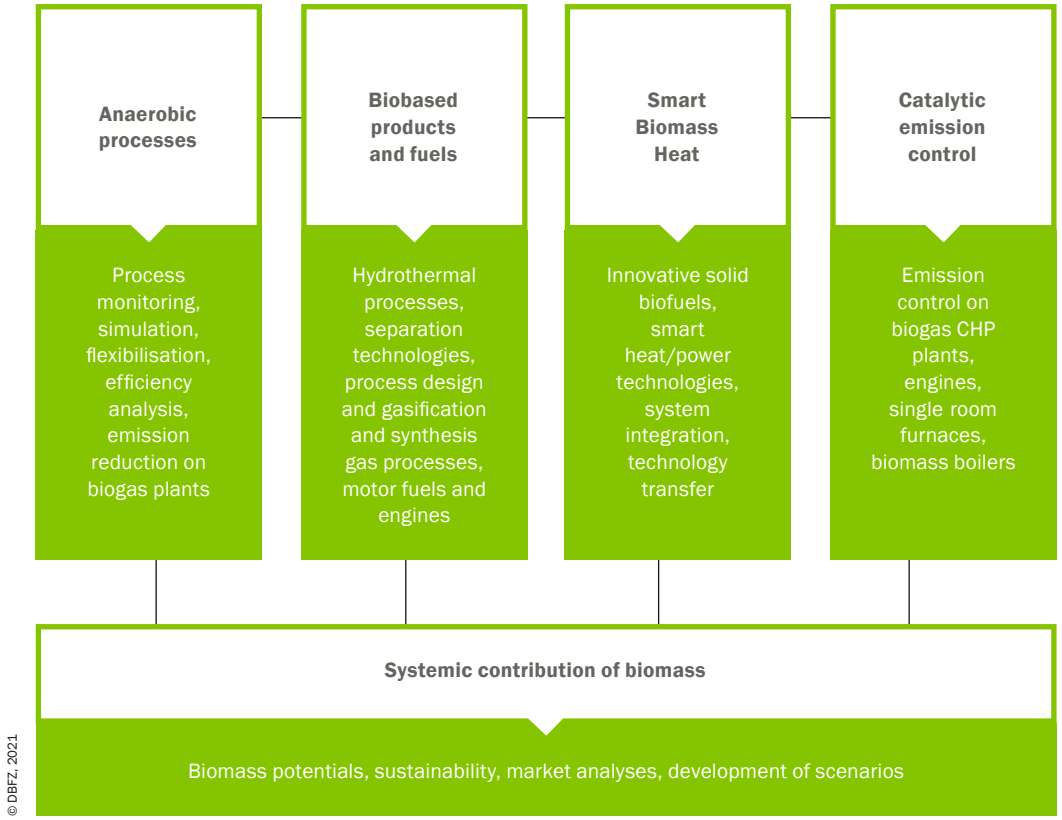


Fig. 19: The five research focus areas of the DBFZ

5.1 Research project “REGATRACE”

“With the REGATRACE project, we have laid the foundations for European trade in biomethane and other renewable gases. In addition, major barriers to market access, the issuing of guarantees of origin and problems in sustainability certification have been solved.”

Stefan Majer
Project Manager

REGATRACE – development of a european registry for renewable gases

While the production of renewable gases (especially biogas and biomethane, and increasingly hydrogen) is increasing in many European countries, their use has so far been predominantly regional or national. In recent years, many member states of the European Union have defined ambitious targets for the further expansion of the use of renewable gases. However, the starting conditions and potentials for their production differ considerably in some cases. International trade in renewable gases can help to balance out these differences between the European partners.

KEYWORDS

Renewable gases
Biogas
Biomethane
Sustainability certification
Resources
Gas Register
Trade
GHG balances

The EU has an extensive gas network of around 2.2 million kilometres and is therefore in principle well placed for European trade in renewable gases. In practice, however, a number of essential elements to support this trade are missing. The EU H2020 project BIOSURF already dealt intensively with the existing obstacles in practice and identified necessary steps to reduce practical barriers [1]. One of the main conclusions of the BIOSURF project was the urgent need for an EU-wide system to organise proofs of origin and sustainability, to trace the renewable origin of the energy sources used and the carbon used to produce the gases.

The Horizon2020 research project REGATRACE (Renewable Gas Trade Centre in Europe) addresses these issues and developed a European platform for cross-border and cross-sectoral trade of renewable gases. The development of this platform started with the already existing national registers (such as the biogas register in Germany). REGATRACE also supported the development of registries in seven target countries (Belgium, Ireland, Italy, Lithuania, Poland, Romania and Spain).

In addition to the work on registers and trading platforms, REGATRACE has been working intensively on problems related to the practical implementation of the requirements of the Renewable Energy Directive (RED II). Among other things, this directive includes sustainability requirements for the production of biogas and biomethane, which are verified in practice through certification systems. The DBFZ led a work package (WP5) in the REGATRACE project to analyse and solve these challenges. Three main topics were investigated:

1. key figures on costs and greenhouse gas emissions and general differences between various renewable gas production technologies,
2. identification of regional hot-spots for future renewable gas production in the REGATRACE partner countries,
3. analysis of existing challenges and barriers to sustainability certification of renewable gases in the EU.

REGATRACE involves 16 partners from 11 different European countries. The project started in June 2019 and the final conference was held in Brussels in November 2022. REGATRACE was funded by the EU Commission’s Horizon 2020 research and innovation programme.

Project structure and main contents

REGATRACE was worked on by the project consortium in a total of eight work packages. The core points and main contents of the project were:

_ The development of a detection system for the origin of renewable gases: WP2, coordinated by ERGaR
_ The support of the establishment of national detection registers in seven target countries: WP3, coordinated by dena
_ The integration of different guarantees of origin in a common system: WP4, coordinated by AIB
_ An integrated assessment of the ecological and economic indicators of different technologies for the production of renewable gases: WP5, coordinated by DBFZ
_ Supporting the future market development of biomethane, coordinated by EBA
_ Policy recommendations, coordinated by ISINNOVA

The work in the project was accompanied by a close exchange with practice partners and regional stakeholders. In the course of

the project, a total of 52 workshops were held with participants from 13 countries. Interim results of the project were discussed and continuous input into the project was ensured.

Main project results

REGATRACE produced extensive results in three years. In addition to technical specifications for guarantees of origin, the European gas registry ERGaR (The European Renewable Gas Registry, www.ergar.org) and national registries were further developed and harmonised. The entire results of the project are available at: **www.regatrace.eu/work-packages**.

The DBFZ is working on three thematic areas. These include:

The evaluation of technologies for the production of renewable gases
A key factor for the future competitiveness of renewable gases is their greenhouse gas abatement costs compared to potential alternatives in different industrial sectors. Report 5.1 [2] of the project compares the costs and GHG emissions of technologies for the production of biogas and biomethane via biochemical conversion of biomass with concepts for biomass gasification, the production of hydrogen and the production of synthetic gases, for example via electrolysis.

The results of this assessment showed significant differences in terms of short-term availability as well as market maturity and current competitiveness of the technologies studied. While the production of biogas and biomethane from biogas upgrading is an established technology that is widely used in various EU

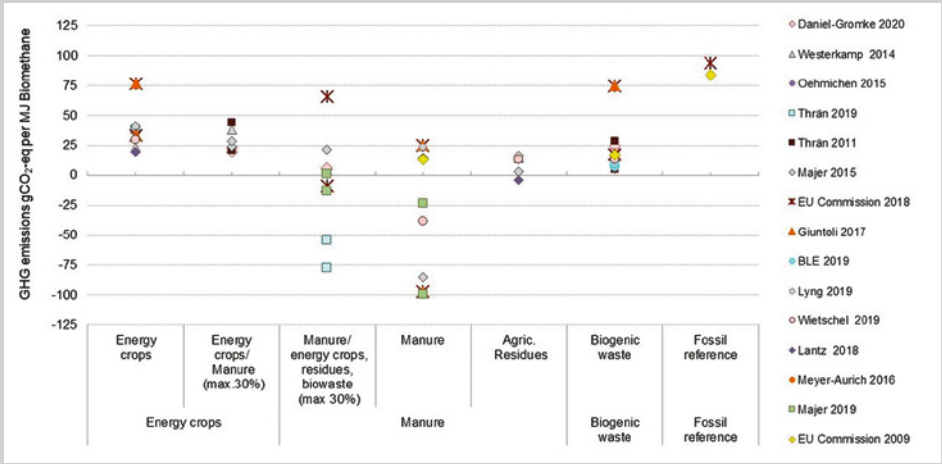


Fig. 20: GHG emissions from biomethane production from different publications

Member States, concepts for the production of (bio-) synthetic natural gas (i.e. from biomass gasification), power-to-gas or hydrogen from renewable electricity are currently not available on the market in significant quantities. This is partly due to the comparatively higher production costs of these gases.

The results further revealed key drivers and influencing factors. In the production of biomethane, the type of feedstock used is of great importance for the overall result. The local availability and cost of feedstocks can vary significantly, leading to large location differences within the EU in terms of GHG abatement costs. In general, the production of biomethane from wastes and residues showed relative advantages in the GHG balance compared to the use of energy crops (comparison Figure 20).

In the production of hydrogen, especially upstream emissions and the type of energy carriers used (currently) lead to significant differences in the GHG balance and costs. Depending on the future development of the energy sector and the decarbonisation of electricity and gas production, the GHG abatement costs of e. g. hydrogen from electrolysis could be significantly reduced.

Future hot spots for renewable gas production
Based on these results, the prerequisites for the future production of renewable gases in the partner countries of the project were investigated. Current capacities for biogas and biomethane as well as for the production of biogenic CO_2 and renewable energies were analysed as starting points. As a result, a profile was created for each REGATRACE partner country with the main preconditions

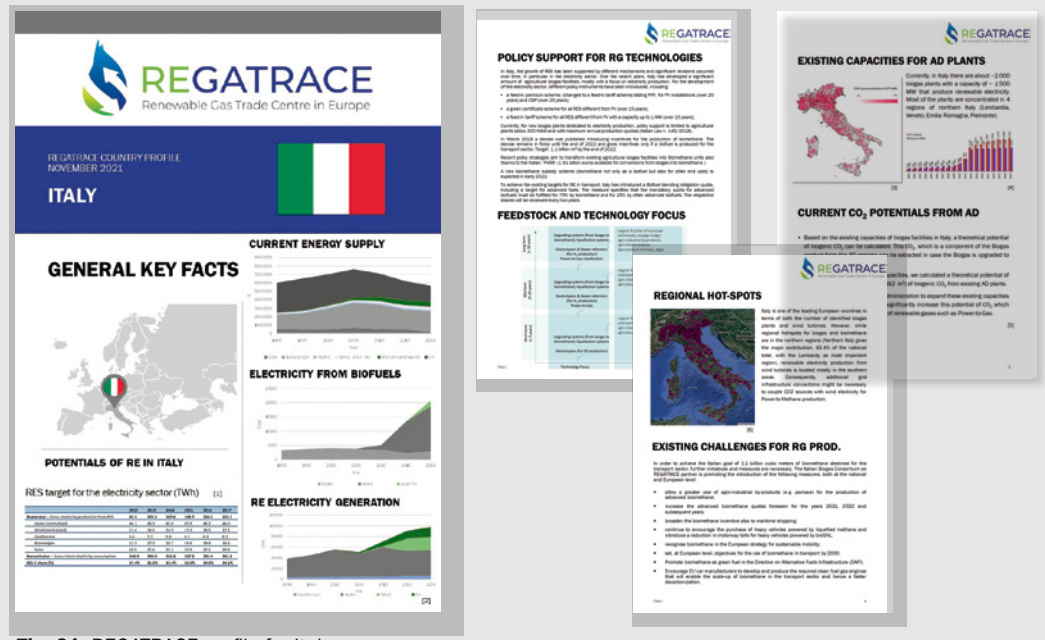


Fig. 21: REGATRACE profile for Italy

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and potential barriers for the expansion of renewable gases. Figure 21 shows an example of the country profile for Italy. The results of this step are presented in Report 5.2 [3].

Supporting the sustainability certification of renewable gases

The last part of the REGATRACE project dealt with questions on the implementation of requirements from RED II for renewable gases. In stakeholder workshops and discussions with project partners, open questions and existing obstacles were identified and solutions were proposed. The comprehensive results are presented in Report 5.3 [4]. The recommendations for action developed address the following points:

_ Measures to reduce the complexity of GHG accounting for renewable gases,
_ Harmonisation of certification approaches,
_ Development of additional tools and handouts for practical use
_ Development of additional standard values and solutions for group certification of agricultural producers
_ Clear specifications for the use of renewable electricity for the production of renewable fuels of non-biogenic origin
_ Traceability of sustainability information along the entire value chain for the production of renewable gases and taking into account different mass balance systems.

The project report with this content contains further tools, such as an overview of available GHG accounting tools and sample calculations for market actors.

Perspectives

The REGATRACE project came to an end in November 2022 after three years. The extensive project results were presented at a final conference with over 100 participants in Brussels in November 2022.

In addition to numerous project reports, methods and data, the contributions to the establishment and improvement of numerous national gas registers, especially in Belgium, Ireland, Italy, Lithuania, Poland, Romania and Spain, as well as the operational European gas register ERGaR remain as practical achievements after three years of the project. These systems can be continuously developed over the next few years in order to significantly support the market ramp-up and trade in renewable gases in the EU. The intensive exchange and the network created among the REGATRACE partners also made it possible to learn from each other's experiences in setting up national gas registers and thus reduce the existing differences in the starting conditions of the various European partners.

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PROJECT PROFILE

Duration:
1/11/2019–30/11/2022

Scientific contact:
Stefan Majer

Funding bodies:
EU/Horizon2020

Project number:
GA 857796

Project partner:
ISINNOVA, EBA, ERGaR, ARBIO, CIB, RGFI, UPEBI, FLUXYS, Amber, Nedgia, Elering, AIB, AGCS, dena, DBFZ

REGATRACE
Renewable Gas Trade Centre in Europe

→ **Further information:**
www.regatrace.eu

The Research Focus Area “Systemic Contribution of Biomass”

The research focus area contributes to the development of sustainable bioenergy strategies at a national and international level. Here, regionally and globally available biomass potentials are determined and various biomass utilisation concepts are considered and evaluated. The overarching goal is to solve methodological and system engineering issues surrounding the efficiency and sustainability of biomass use from an economic, ecological and technical perspective, taking into account both the land resources used and the energy carrier-specific processing and conversion technologies. The combination of these aspects provides the basis for deriving strategies and recommended courses of action for policymakers and corporate decision-makers.

Important reference projects and publications :

Project: BEniVer – Joint project: Begleitforschung Energiewende im Verkehr – Subproject: Ermittlung von Rohstoffpotentialen strombasierter Biokrafstoffoptionen und ökologische Bewertung von biokraftstoffbasierten Referenzszenarien, Federal Ministry for Economic Affairs and Climate Action, 01/06/2018–31/03/2023 (FKZ: 03EIV116C)

Project: BioNET – Biomasse-basierte Negativ-Emissions-Technologien, Federal Ministry of Education and Research, 01/01/2022–31/12/2024 (FKZ: 01LS2107B)

Project: CAFIPLA (Carboxylic Acid & FIbre PLAtform) – Pretreatment of organic waste for application of the carboxylic acid and fiber platform, European Commission, 01/06/2020–31/05/2023 (GA 887115)

Project: KIDA – Umsetzung der Maßnahme “KI- und Daten-Akzelerator”, Federal Ministry of Food and Agriculture, 01/03/2022–31/12/2025

Project: SUSTRACK – Supporting the identification of policy priorities and recommendations for designing a sustainable track towards circular bio-based systems, European Commission, 01/11/2022–31/10/2025 (GA 101081823)

Publication: Borchers, M.; Thrän, D.; Chi, Y.; Dahmen, N.; Dittmeyer, R.; Dolch, T.; Dold, C.; Förster, J.; Herbst, M.; Heß, D.; Kalhori, A.; Koop-Jakobsen, K.; Li, Z.; Mengis, N.; Reusch, T. B. H.; Rhoden, I.; Sachs, T.; Schmidt-Hattenberger, C.; Stevenson, A.; Thoni, T.; Wu, J.; Yeates, C. (2022). “Scoping carbon dioxide removal options for Germany: What is their potential contribution to Net-Zero CO_2?”. *Frontiers in Climate* (ISSN: 2624-9553), Vol. 4. DOI: 10.3389/fclim.2022.810343.

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Publication: Thrän, D.; Moesenfechtel, U. (Hrsg.) (2022). *The bioeconomy system*. [s.l.]: Springer. XVIII, 379 p. ISBN: 978-3-662-64414-0. DOI: 10.1007/978-3-662-64415-7.

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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 Research project “WasteGui”

“In East Africa, organic waste represents a huge untapped potential for recycling nutrients, humus and energy into the circular economy and at the same time an enormous risk for the environment and people. Many local communities and enterprises lack clear information and recommendations for action in the areas of technical, regulatory and economic implementation. The project “Guideline for organic waste treatment in East Africa” tries to fill this gap and to provide municipalities and planners with a sound starting point for a practice-oriented implementation.”

Markus Lenhart
Project manager

WasteGui: guideline for organic waste treatment in East Africa

Due to population and wealth growth as well as increasing consumption, the amount of waste produced and to be disposed of is growing at the same time. One of the problematic side effects is that proper waste logistics and treatment are not growing at the same pace. Still, only very few and only certain types of waste are treated in a cycle-oriented manner through appropriate recycling systems. In the area of municipal waste management, particular attention needs to be paid to emerging economies: Countries moving towards higher income levels will experience a sharp increase in per capita waste generation and an exacerbation of management problems due to growing affluence and the shift to urban centres [1].

KEYWORDS

Organic waste
Ethiopia
Guideline
Treatment
Logistics

Fig. 22: Organic waste in Ethiopia offers great, as yet untapped potential for further recycling

The share of organic waste in East African cities (as well as in rural areas) is very dominant, ranging from 55 % to even 80 %. The organic fraction therefore offers great untapped potential and at the same time represents the greatest lever for reducing the volume of municipal waste. The waste composition not only requires special attention, but also offers a number of possible management and treatment solutions. If not managed and treated separately, organics are responsible for numerous negative environmental, health and social impacts, not least almost all methane emissions in the waste sector. Common practices such as landfilling or incineration lead to the loss of the organic fraction as a valuable material in the form of nutrients, humus or even energy. Improvement concepts can be relatively simple, affordable, low-tech and effective.

Many municipalities are looking for affordable solutions and best practices for both collection and treatment to not only minimise the amount of waste going to landfills, but also to increase the recycling of valuable resources step by step. The most effective but challenging approach, with numerous positive side effects, is the separate treatment of biodegradable waste components through natural decomposition – such as anaerobic digestion or composting.

As part of the “Call for Solutions” of the PREVENT Waste Alliance, the pilot project “Guideline for organic waste treatment in East Africa” (WasteGui) was initiated under the leadership of the DBFZ. The aim of the project is to develop a technical, regulatory and economic guideline for organic waste treatment as a basic strategy for politics, ad-

ministration, research and the private sector for East African countries, taking Ethiopia as an example.

The guide is intended to provide a sound basis for decision-makers to identify a range of efficient and best practices in organic waste management and to give planners and developers a good starting point for future planning. The focus of the project is on the organic fraction of domestic waste, but relevant agricultural, industrial and other organic residues are also considered.

All recommendations for action are adapted to local conditions in East Africa. Different settlement structures in metropolises, urban and rural areas are also taken into account. The aim is not only to help decision-makers, planners and the private sector by providing information on the various concepts for treating organic waste, but also to provide concrete approaches for implementing and establishing waste management concepts.

Methods/measures

The WasteGui project has four main objectives:

_ to assemble a working group of actors from all sectors of waste management and to network with local actors in Ethiopia,
_ to evaluate the status quo of organic waste management in East African countries,
_ the development of appropriate solutions,
_ the transfer of knowledge to decision-makers and target groups in the form of a guide and workshops.

The crucial first step to support Ethiopia in building a circular economy is to provide and disseminate basic information on locally adapted waste management solutions based on evaluated data. This will enable local decision-makers to select appropriate solutions for their individual needs, which can even be transferred beyond Ethiopia's borders to other East African countries with comparable local conditions.

When developing the different treatment options, it is important to develop concepts that are adapted to different settlement structures in Ethiopia and their individual infrastructural challenges. The concepts are developed for the following structures:

_ Metropolitan areas (> 500,000 inhabitants)
_ Semi-urban to urban areas (20,000 to 500,000 inhabitants)
_ Rural areas (< 20,000 inhabitants)

The status quo of organic waste management in East African countries is surveyed on the basis of secondary data and expert interviews. Individual countries are compared with each other on the basis of their potential, waste characteristics and regulatory framework. For Ethiopia, a detailed analysis is made on the basis of municipal secondary data and expert interviews.

The guideline for establishing organic waste management combines the findings from the development of biowaste management in Germany with contributions from the German biowaste recycling industry and international experts on the basis of the previously surveyed status quo. The focus on the presentation of tried and tested and robust technologies for logistics and treatment. In addition, cost forecasts and cost projections and long-term financing concepts as well as regulatory recommendations will be presented. The design is to be as practice-oriented as possible. The results have so far been presented in several workshops and in two DBFZ reports (45 & 47).

Milestones/challenges

In line with the main objectives of the project, various actors from the German and Ethiopian waste management sectors were recruited for joint cooperation within a working group. With the German RETech Partnership e. V., an established network of the German waste industry could be linked to the project. Cifa Onlus, as the Ethiopian actor, ensured the networking and dissemination of the project results within Ethiopia. Experts from ICU-Berlin, Rodiek & Co. GmbH and INTECUS GmbH were found for the development of technical concepts and their translation into a guideline. In addition, with the help of interviews and regular exchanges, the expertise of other Ethiopian and international actors in organic waste management was also incorporated into the recording of the status quo and the drafting of a guideline.

The results of the evaluation of the status quo were published in DBFZ Report No. 45 [2]. In addition to quantitative and qualitative characteristics of East African countries in comparison, the report also highlights explicit case studies of different settlement structures within Ethiopia. In particular, the increasing challenges due to the increase in total waste generation could be presented. Due to growing populations, increasing prosperity and a rising rate of urbanisation, large cities in particular are facing enormous challenges. A tripling of waste generation is expected in a business-as-usual scenario in East Africa by 2050 (see Figure 23).

Based on the status quo, a comprehensive guideline for the management of organic waste was developed in cooperation with practical experts and published as DBFZ Report No. 47 [4]. The technical concepts devel-

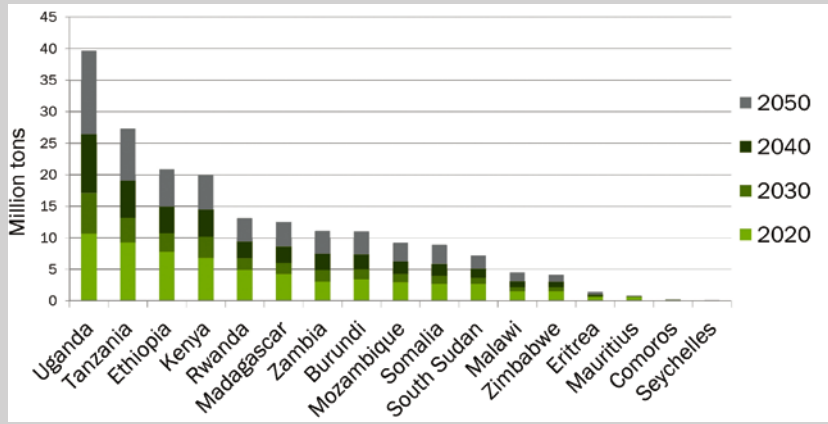

Fig. 23: Projection of waste generation in East African countries in millions of tonnes by 2050 [1–3].

oped were designed taking local conditions into account. The guide contains a systemic classification as well as detailed technical concepts for logistics and treatment, taking into account costs and urban conditions. In addition, concrete recommendations are given for set-up, implementation and the legal framework. Besides composting, anaerobic digestion, mechanical-biological treatment and incineration, other technologies such as black soldier fly treatment and worm composting (see also worm composting (see Figure 24) are represented.

All project results were made accessible in various formats to a wide range of actors from administration, politics, science and the private sector. In addition to the annual RE-Tech Conference 2021 and the Circular Solutions Festival of the PREVENT Waste Alliance in 2022, a half-day workshop with Ethiopian stakeholders was also held in Addis Ababa in 2022. In addition to lively discussions and exchange of project results, participants particularly pointed out the problems they face in their daily work, but also problems in initiating projects to create new treatment and logistics capacities. These include:

_ a high dependence on imported technologies and locally available skilled personnel – combined with difficulties in process management
_ a lack of reliability of the legal framework and the desire for more political support
_ the establishment of a market for the sale of composts and biofertilisers as well as further financing possibilities in general
_ creation of uniform quality criteria for better comparability of products
_ networking of actors in the biowaste sector in Ethiopia to observe current trends and create synergies

Perspectives

Organic waste is currently an environmental and public health problem in East Africa. The quantities generated are inadequately

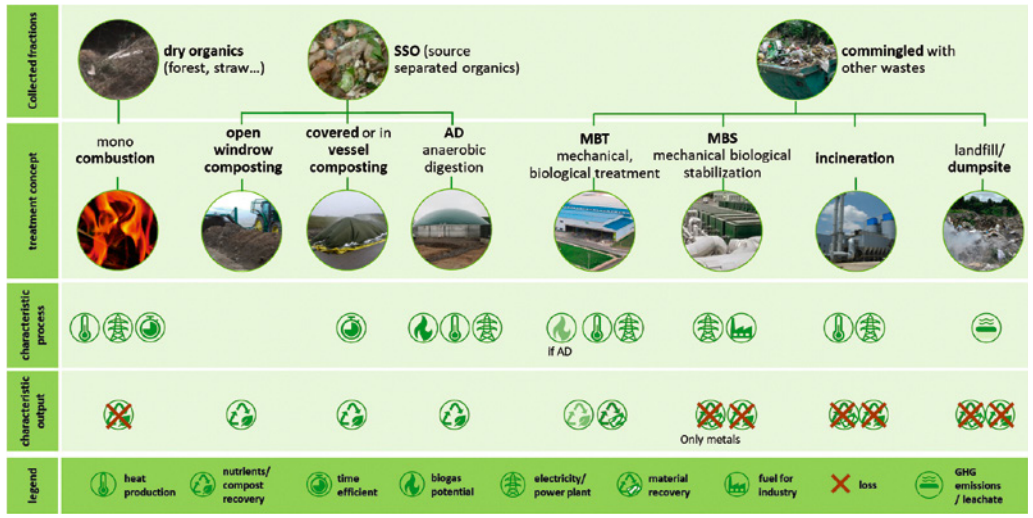

Fig. 24: Overview, characteristics and suitability of the different treatment technologies for organic waste (ICU) [4]

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managed: The solid waste management system in East Africa is characterised by a low collection rate, an inadequate transport system and unsafe final disposal. On the other hand, the current situation can also be seen as an opportunity to establish a waste management system that considers organic waste as a valuable resource that can be converted into valuable products such as biogas, compost or solid fuels. Initial efforts on the part of Ethiopian municipalities and local companies include the increasing establishment of composting plants within the country and the progressive expansion of the Ethiopian National Biogas Programme in the form of micro biogas plants.

The guideline complements these previous efforts by encouraging long-term strategy development in the field of organic waste management. In order to counteract emissions and other negative consequences of the predominant landfilling in East African countries, the following long-term goals therefore apply:

_ Complete regular collection of all waste for controlled disposal.
_ Separate collection of organic waste – this can reduce the remaining waste and produce usable compost with almost no impurities
_ Treatment of the remaining waste to remove biological reactivity before it goes to landfill.

For successful establishment, a phased approach with focus on small successes, while not losing sight of long-term goals must not be lost sight of. An important building block here is the further dissemination of the knowledge generated and transfer to easily accessible tools, which tools that enable decision-makers to establish treatment and logistics capacities in a targeted manner.

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Further information:

DBFZ Report Nr. 45
Status-Quo of organic waste collection, transport and treatment in East Africa and Ethiopia

DBFZ Report Nr. 47
WasteGui: Guideline for organic waste treatment in East Africa

PROJECT SUMMARY

Duration:
01/12/2020–30/09/2022

Project partners:
German RETech Partnership e. V.,
Cifa Onlus, ICU –
Partner Ingenieure Berlin,
Rodiek & Co. GmbH,
INTECUS GmbH – Waste management and environmentally integrated management

Scientific contact:
Markus Lenhart

Project number:
16.2156.4-001.00

Funding bodies:
Deutsche Gesellschaft für internationale Zusammenarbeit (GiZ) GmbH,
PREVENT Waste Alliance

The Research Focus Area “Anaerobic Processes”

Processes that use microorganisms to convert biomass under anaerobic conditions are the basis of a large number of biotechnological processes for producing energy carriers and materials. The research focus area “Anaerobic Processes” is developing efficient and flexible processes, primarily for biogas production, that can meet the requirements of the future energy system.

Higher added value is achieved by coupling these with material utilisation processes. To this end, the research focus area is developing tools to monitor and control processes, concepts for flexible, low-emission plants and operating regimes, methods to evaluate and optimise efficiency, and processes to maximise material conversion, especially for difficult substrates.

Important reference projects and publications

Project: KlimaBioHum – Klimaschutzorientierte Bioabfallverwertung in der Landwirtschaft, Federal Ministry of Food and Agriculture, 01/10/2018–31/12/2022 (FKZ: 281B303316)

Project: LabTogo – Aufbau von Forschungskapazitäten und Demonstration von Technologien zur Nutzung der Biomassepotenziale in Togo, Federal Ministry of Education and Research, 02/01/2020–31/12/2023

Project: MEMO – Methanemissionsmodell für offene Gärprodukt-/Güllelager, Federal Ministry of Food and Agriculture, 01/11/2021–31/10/2024 (FKZ: 2220WD003X)

Project: PaplGas2 – Biomethan & Torfersatzstoff aus Pappelholz – 2nd Phase, Federal Ministry of Food and Agriculture, 01/12/2021–30/11/2023 (FKZ: 2221MT017A)

Project: RestFlex – Eignung landwirtschaftlicher Reststoffe zur Flexibilisierung des Biogasprozesses, Federal Ministry of Food and Agriculture, 01/07/2019–30/06/2022 (FKZ: 22041818)

Publication: Koók, L.; Rosa, L. F. M.; Harnisch, F.; Žitka, J.; Otmar, M.; Nemestóthy, N.; Bakonyi, P.; Kretzschmar, J. (2022). “Functional stability of novel homogeneous and heterogeneous cation exchange membranes for abiotic and microbial electrochemical technologies”. *Journal of Membrane Science* (ISSN: 0376-7388), Nr. 658. DOI: 10.1016/j.memsci.2022.120705.

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Head of the Research Focus Area
Dr. agr. Peter Kornatz
Phone: +49 (0)341 2434-716
E-mail: peter.kornatz@dbfz.de

5.3 Monitoring renewable energies in transport

"Avoiding, shifting and improving transport are the three key words for achieving the climate targets in the transport sector. An essential aspect of this will be the provision of renewable energy sources for the various vehicle drive systems. However, the availability of both renewable electricity and renewable fuels is limited. The project shows the status quo and the perspective of renewable energies in transport and clearly presents the resulting findings."

Jörg Schröder
Project manager

Monitoring Renewable Energies In Transport

The transport sector, including shipping and aviation originating in Germany, generates up to 25 % of the total greenhouse gases (GHG) produced in Germany each year. The targets of the Federal Climate Protection Act were not met even in the year 2021, which was strongly influenced by Covid-19. A trend reversal is not expected in the upcoming years. Measures to avoid and shift traffic will not be implemented to the necessary extent. At the same time, the stock of currently 60 million vehicles will continue to increase or remain at this high level until the end of the decade. Volumes of transport will rise sharply again after the Covid-19 years, especially in the energy-intensive segments such as freight transport and aviation. The expansion of the urgently needed electromobility as well as its infrastructure is taking place far too slowly and is not yet fully accepted in many parts of the society. Therefore, renewable energy sources such as fuels from cultivated biomass and waste and residual materials play a decisive role in reducing greenhouse gas emissions in transport. In 2021, 139 PJ of 2,352 PJ were substituted by renewable fuels in transport, saving 11.1 million tons of CO_2 equivalents [1, 2]. Perspectively, renewable electricity and electricity-based fuels will have to complement these available options to enable climate-neutral transport by 2045.

KEYWORDS

greenhouse gas
transport sector
renewable energy
fuels
monitoring

In a global context, these challenges are assessed as being much greater, because volumes of transport and energy demand will increase much more strongly worldwide compared to Germany.

Over the past two years, the project "Monitoring Renewable Energies in Transport" has intensively dealt with the role of renewable electricity as well as biomass- and electricity-based fuels in the transport sector. In the process, all major topics, as listed below, have been addressed:

_ Political and regulatory framework
_ Transport and its infrastructure
_ Production technologies for supplying renewable fuels
_ Resources and their mobilisation
_ Market overview
_ Use of renewable energy in transport-Environmental aspects of sustainability-Economic aspects of sustainability

Based on this, condensed technology profiles as well as two overviews of suitable energy sources for the different vehicle classes were developed for the years 2030 and 2045. In addition to road transport, the work focused on shipping and aviation with a German, European and global perspective. The results of the project provide general information on renewable energies in transport and show their opportunities, risks and requirements. Accordingly, the project results were published as DBFZ Report No. 44 in German [3] and English [4] as well as on the Internet at the address **www.dbfz.de/en/monitoring-renewables-transport**

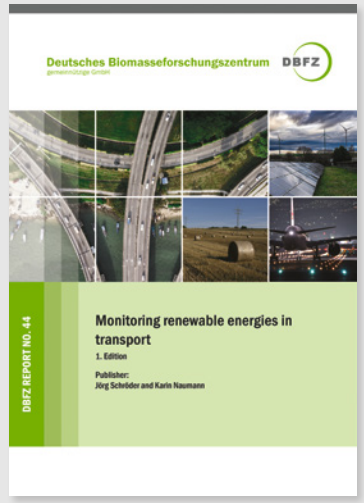

Fig. 25: DBFZ Report No. 44 – Monitoring renewable energies in transport

Renewable energies and their resources

The provision of resources is the first step in the value chain for the production of renewable energies. The biogenic resources, which are suitable for biofuel production, can be categorised according to various criteria. Regulations primarily divide these into biogenic products (primarily cultivated or crop plants), biogenic by-products, and wastes and residues. The main feedstocks for e-fuels are renewable electricity and water for the provi-

sion of green hydrogen, as well as a carbon source (mostly CO_2) for further processing into carbon-containing fuels. Above all, the non-biogenic resources of electricity, water and carbon as well as biogenic residues such as straw, manure, slurry or bio-waste from households and industry will be in the focus of the competition.

Global renewable fuel production volumes have increased to approximately 4,000 PJ (95 Mtoe) by 2019 [5]. This represents only 3 % of the global transport energy demand [5]. With the beginning of the Covid-19 pandemic in 2020, a stagnation in renewable fuel production was observed . However, this should be quickly overcome in the upcoming years. Today, the main established energy sources are

- bioethanol from the alcoholic fermentation of biomasses containing sugar and starch,
- biodiesel (FAME) and HVO/HEFA fuels from the esterification/transesterification or hydrotreatment of oil- and fat-containing biomasses or residual and waste materials; and
- biomethane from the anaerobic fermentation of cultivated biomass, waste and residues, and animal excrements, all to a lesser extent.

Other technologies, such as the fermentation of lignocellulosic biomass into bioethanol, already reach a high technology readiness level and are partially integrated into the market on a regional basis. However, they have not yet been able to fully establish themselves in the market. Current developments focus on

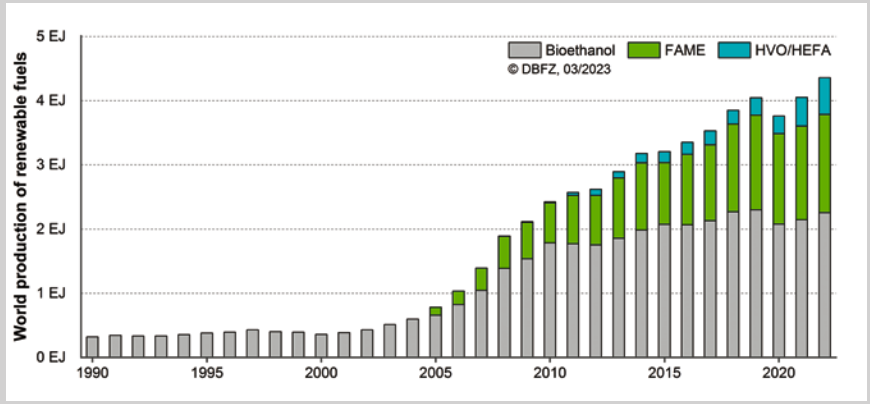

Fig. 26: Global production of renewable fuels

purely electricity-based technologies for e-fuels as well as electricity- and biomass-based hybrid technologies. Which of these options will be realised in the market depends largely on their economic feasibility, regional conditions such as resource availability and regulatory framework conditions such as minimum ecological requirements or minimum quotas.

Trade in renewable fuels is characterised by strong global as well as regional regulatory dependency. The introduction of anti-dumping duties, greenhouse gas reduction or fuel quotas as well as bans on individual resources can stop established trade routes in the short term and create new ones at the same time. With the German ban on palm oil as a resource for renewable fuels eligible for quotas, the next drastic change is done in 2023. Similar to the currently discussed phasing out of biofuels from cultivated biomass, the quantities of palm oil-based fuels, that will then be available, will be sold in other regions of the world. In this case, Germany will use the economically next alternative according to the merit order principle and, if necessary, offer a market to technologies, that are not yet established. In the future, the different technologies will compete much more than they do today for the same, usually limited resources. For example, with increasing production capacities of HVO/HEFA fuels, the pressure on FAME plants will grow.

Economic and environmental aspects of sustainability

The fuel industry and the transport sector are subject to strong regulatory constraints. First of all, the Renewable Energy Directive (RED II) at the European level and the Federal Immission Control Act at the national level define minimum ecological requirements. Accordingly, renewable fuels require a sustainability certification in order to be counted towards the national greenhouse gas reduction quota and the minimum share of renewable energies required by the EU. Further sustainability requirements are primarily intended to minimise the risk of negative impacts on biodiversity and on other ecosystem functions when using biomass. This sustainability principle is designed for road transport and is oriented on the fuel value chain. Currently, specifications for shipping (EU Fuel Maritime) and aviation (ReFuelEU Aviation) are being developed or are only based on the voluntary target agreements of the international organisations IMO and ICAO.

Fuel production plants commissioned after 2020 must demonstrate at least 65 % GHG reduction for biofuels and 70 % for electricity-based fuels compared to the fossil reference of 94.1 g CO_2 eq./MJ in order to count against the GHG reduction quota. Due to the implementation of the RED II in Germany, the specific greenhouse gas avoidance became a clear competitive criterion for renewable fuels. Therefore, the specific GHG emissions of the volumes used in Germany also decreased from an average of 25.0 g CO_2 eq./MJ in 2015 to 14.8 g CO_2 eq./MJ in 2021. In the same period, consumption of renewable fuels increased from 114 PJ to 139 PJ.

In addition to the ecological assessment, the economic assessment of, in particular, new technologies is also of interest in order to be able to classify their economic advantage over other technologies. Therefore, comparable system boundaries are necessary. For already established fuels, wholesale prices of individual trading markets can be used, e. g. for bioethanol from cultivated biomass between 24 and 38 EUR/GJ or for biodiesel (FAME) between 15 and 23 EUR/GJ in 2020.

For fuel options that are not yet available on the market or are handled directly in business-to-business transactions, only the

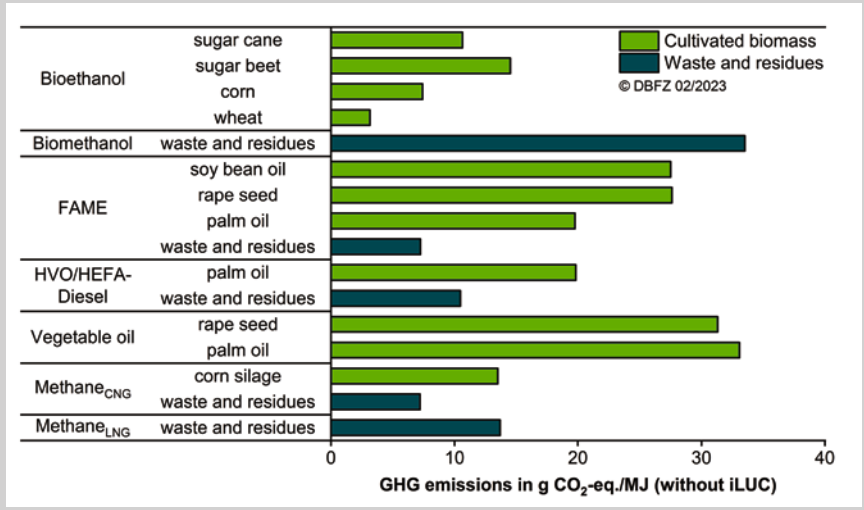

Fig. 27: Average greenhouse gas emissions of renewable fuels used in transport in 2020

prime costs can be evaluated on the basis of comparable studies. This leads to a much broader picture – the costs are mostly higher than the prices of established fuel options, e.g. bioethanol from lignocellulosic waste and residues between 18 and 43 EUR/GJ or electricity-based diesel between 18 and 88 EUR/GJ.

Outlook

The monitoring of renewable energies for transport has shown that quantifying the economically available biomass potential and, in particular, the implementation potential for renewable fuels at the international level is subject to considerable uncertainties. These uncertainties lead to wide ranges in the contextualisation for the transport sector. However, the availability of resources for biofuels can be estimated as rather low and that for electricity-based fuels as rather high. Research and development is needed to significantly improve this knowledge of the status quo, the likely development of renewable resources and the uncertainties in their availability. This is necessary in order to be able to better assess the contribution of renewable energy sources to sustainable development in the transport sector. The exchange with parallel research projects such as the DBFZ-internal project “Scenarios of optimal energetic biomass use until 2030 and 2050” (SoBio) should be continued in this sense. In addition to the availability of resources, further work must focus even more on transport sectors that are difficult to electrify, such as shipping and aviation, and international assessment.

DBFZ Report No. 44 significantly expands the existing monitoring activities of the DBFZ in the field of renewable energies for transport [3, 6] and summarises their complexity. It is important to make the results even more accessible to the general public (online) and to present the interrelationships and perspectives for climate-neutral transport in a generally understandable way.

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PROJECT PROFILE

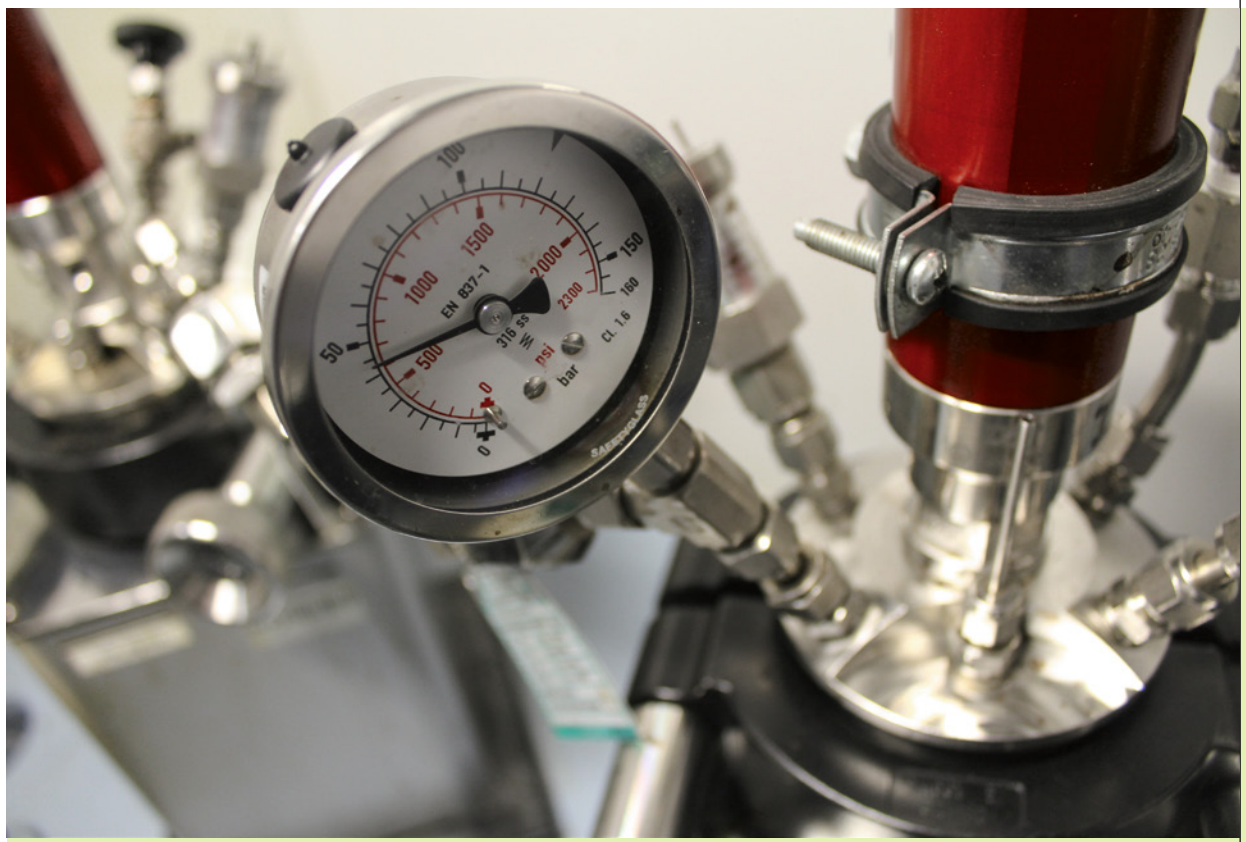
Duration:
01/01/2021–28/02/2023

Project partners:
Technology and Support Centre (TFZ) at the Competence Centre for Renewable Resources (Straubing); Hamburg University of Technology (TUHH) – Institute of Environmental Technology and Energy; Paul Scherrer Institute (PSI)

Scientific contact:
Jörg Schröder,
Karin Naumann

→ Further information:

www.dbfz.de/en/monitoring-renewables-transport/
www.dbfz.de/en/press-media-library/publication-series/dbfz-reports



The Research Focus Area “Biobased Products and Fuels”

The overarching research goal of the research focus area “Biobased Products and Fuels” is to contribute to biorefinery concepts as part of a sustainable bioeconomy through the use of innovative technological approaches. Here, the process engineering equipment of the biorefineries technical centre is used and comprehensive methods for the multi-criteria technology assessment of individual processes and overall concepts for biorefineries are applied. A wide range of process engineering equipment and processes are used to map the complexity of the biorefineries. It is only through the meaningful combination of these process steps that biorefinery concepts emerge in which marketable products can be manufactured. For this reason, the technical equipment of the biorefineries technical centre is designed to be inter-compatible so that a wide range of processing chains for biogenic raw materials can be investigated. In addition, the focus is increasingly on the automated acquisition of measurement data and automated plant operation. Work is naturally done in accordance with high scientific standards using statistical experimental design and evaluation methods as well as process simulation, databases and software tools to evaluate the technology.

Important reference projects and publications

Project: BIO2HY – Wasserstoff aus Biomasse, Federal Ministry of Food and Agriculture, 01/04/2021–31/03/2022 (FKZ: 2221NR010A)

Project: BIOFIT – Bioenergy retrofits for Europe’s industry, European Commission, 01/10/2018–31/03/2022 (GA 817999)

Project: HTKkChem – Umwandlung von wasser- und kohlenhydratreichen Reststoffen der Biomasseverarbeitung in Chemikalien und Kraftstoffkomponenten durch hydrothermale Prozesse, Federal Ministry of Education and Research, 01/11/2018–31/12/2022 (FKZ: 031B0674A)

Project: NormAKraft – Normung alternativer Kraftstoffe, Federal Ministry for Economic Affairs and Climate Action, 01/01/2020–31/12/2022 (FKZ: 03EIV241C)

Project: Wachstumskern abonoCARE – TP 2.V – Entwicklung der säure- und membranbasierten Phosphorabscheidung während der HTC sowie der energieeffizienten Trocknung von HTC-Kohle im Labormaßstab, Federal Ministry of Education and Research, 01/04/2019–31/12/2022 (FKZ: 03WKDI2E)

Publication: Dögnitz, N.; Hauschild, S.; Cyffka, K.-F.; Meisel, K.; Dietrich, S.; Müller-Langer, F.; Majer, S.; Kretzschmar, J.; Schmidt, C.; Reinholz, T.; Gramann, J. (2022). *Wasserstoff aus Biomasse: Kurzstudie im Auftrag des Bundesministeriums für Ernährung und Landwirtschaft*. (DBFZ Report, 46). Leipzig: DBFZ. III, 4-147 p. ISBN: 978-3-946629-88-7. DOI: 10.48480/b4wn-c154

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Head of the Research Focus Area
Dr.-Ing. Franziska Müller-Langer
Phone: +49 (0)341 2434-423
E-mail: franziska.mueller-langer@dbfz.de

5.4 Research project “SmartBioGrid”

“The focus of the ‘SmartBioGrid’ project is the development of a software tool available free of charge to support the identification of optimal transformation processes to ensure the long-term, cost-efficient and resource-saving operation of heating grids.”

Heike Gebhardt
Project manager

Dr. Peter Stange
Co-Author

SmartBioGrid – options for the use of solid biomass in decarbonised heat networks

In order to achieve the climate protection targets by 2030 and 2050, not only the electricity sector but also the heat supply sector will have to make the transition from fossil fuels to renewable energy sources. In addition to decentralised supply systems, this also affects local and district heating networks, as these account for about one tenth of the final energy consumed for heating purposes in Germany [1]. District heating networks are installed in about 3,000 German cities and municipalities [2], supplying a total of about 5 million households with heat [3]. Currently, 94 % of the heat for district heating networks throughout Germany is still provided using fossil fuels and waste [4]. In this context, heat grids can make a significant contribution to reducing emissions, as there is the possibility of both the spatial separation of heat source and heat sinks and the temporal balancing of heat supply and heat demand, thus facilitating the use of volatile, renewable heat sources [5]. Furthermore, the transformation of heat grids offers the option of increasing efficiency, reducing heat losses and decentralised feed-in, for example by customers, as well as potentially reducing costs [6]. However, the possible options and the economic viability of different variants are highly dependent on the respective network and customer structure as well as the availability of land and different heat sources. Therefore, there are no universally applicable concepts for the transformation of existing heat grids.

KEYWORDS

Heat grids
bioenergy
transformation concepts
multivalent energy systems

Against this background, the aim of the cooperation project with the Technical University of Dresden and the Biomass Institute Ansbach was to identify options for the transformation of fossil heating networks by creating a software-supported procedure, as well as to work out the role of bioenergy in future heat supply structures.

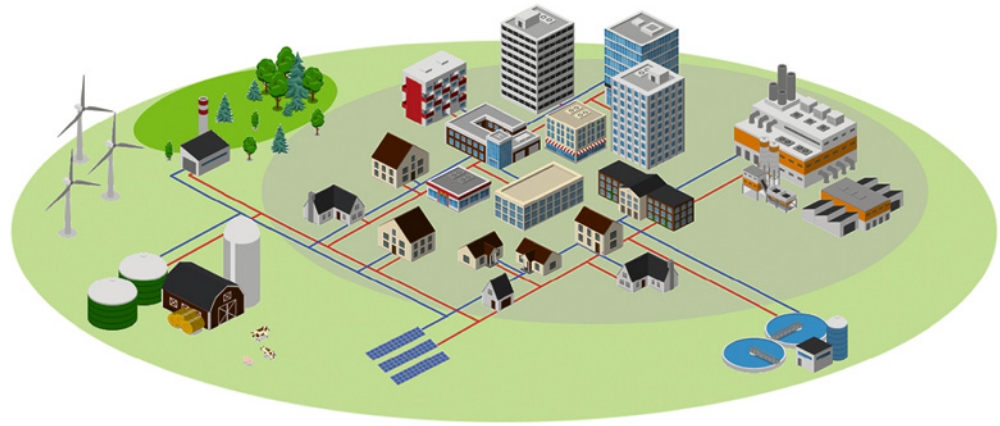

Fig. 28: Schematic representation of a district heating supply

To support the evaluation and selection of suitable transformation strategies, a free optimisation tool was developed that determines the optimal generator dimensioning and the best possible operating strategy for selected time periods based on the user specifications. The result of the mathematical optimisation can take into account the investment costs, the operating costs or the GHG emissions, depending on the specified priority, and shows parameters such as power classes and modulation levels of the generators and storage charging stations. The pre- and post-processing necessary for the use of the software was also defined in order to provide the user with detailed assistance, in addition to the description of the handling of the tool itself, both for the preparatory analyses of the possible technical and legal adjustments and for the final evaluation of the results. The developed procedure of pre-processing and the optimisation through the developed tool were tested on a real existing network. Here, the applicable legal situation regarding the options for retrofitting the heating network was determined, the technical feasibility of measures on the network was examined by means of detailed

thermohydraulic simulation and their effects on the optimisation results were determined.

Methods/measures

The creation of the software-supported procedure was divided into three interlocking thematic sub-blocks. The combined technological and legal preliminary considerations provide the basis for the pre-processing.

Technological framework
In order to describe the procedure for creating concepts for network transformation in preparation for software use in a way that is as universally applicable as possible for each existing heating network, extensive research was first carried out. This included the acquisition of data and the compilation of information on the characteristics of German heating networks including their consumer structures and typical load profiles, the possible adaptations to the heating network and the consumers, the technical possibilities and limits of heat supply plants and heat storage facilities, as well as the heating network transformations that have already been implemented. In addition, the technical challenges of converting existing heating networks, e. g. through network expansion or the reduction of network flow temperatures, were investigated. For this purpose, detailed network simulations were used to evaluate the various measures for adapting the heating network in terms of thermohydraulic feasibility and the resulting change in load profiles.

Due to the inherent characteristics of renewable energies, such as fluctuations in availability and the need to use different sources or storage facilities to ensure security of supply, the conversion of heating networks can have not only technical but also legal consequences for the various actors in the heating network.

Applicable legal situation
In addition to the collection of the essential legal characteristics of the selected heat supply and storage technologies, the focus was on the possible use of prosumers and decentralised feed-in concepts for heat grids. In this respect, the legal design was carried out for scenarios in which:

1. the connectee itself is allowed to feed heat into the grid,
2. the connected objects are considered as passive storage,
3. consumption data with a high temporal resolution is recorded, or
4. the network operator has further access to the connected heating systems.

In order to classify the aforementioned topics, a basic analysis of the existing legal framework for district heating supply in Germany was first carried out, which was then used to determine the legal prerequisites and obstacles for the implementation of the transformation strategies investigated in the project.

Software development
Based on the already existing “FreeOpt” of the TU Dresden, a new, functionally extended optimisation tool was developed for the independent determination of the optimal generator structure and operating strategy for heating networks. In addition, a user-friendly input interface and results display were developed for the online version of the tool.

Milestones/challenges

Within the framework of the project, the software tool “flixOpt” was developed to support decision-making for the optimal dimensioning of generators and storage units in energy systems. The core of the tool is based on classical model approaches of mixed integer linear optimisation. With their help, the optimal

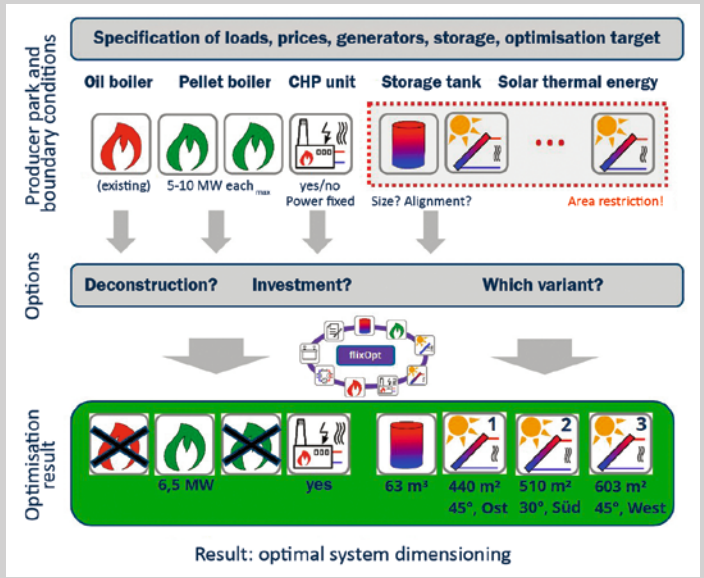

Fig. 29: Schematic representation of the possible uses of flixOpt

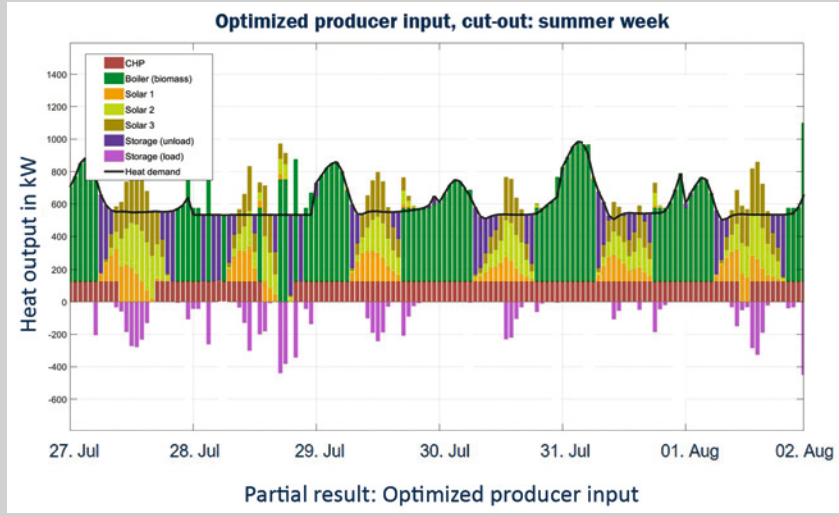

Fig. 30: Exemplary representation of the optimal producer input within a summer week

operation of a given energy system and, in combination, the optimal design of the plants are calculated. FlixOpt thus enables the analysis and planning of energy supply concepts and provides support for investment decisions, for example for the transformation of heating networks and within municipal heating planning. A schematic representation of the possible applications of flixOpt is given in Figure 29. In this example, the transformation of the supply from a currently used oil boiler to environmentally friendly alternatives is to take place. In addition to the question of the optimal nominal output of the new systems to be purchased, the best possible use of an area available for solar generation is also included in the optimisation.

In flixOpt, the focus was on a largely generic implementation. In addition to the consideration of sector coupling, energy storage, conventional and renewable generators, the user is enabled to adapt to the individual application case. The optimisation can be carried out for periods of any length and temporal resolution. For this purpose, a theoretically optimal result within the scope of the model accuracy is calculated on the basis of the relevant, time-dependent data. This includes the best possible operational management corresponding to the user specifications, cf. Figure 30, as well as the optimal dimensioning of the generator park. The latter is done on the basis of minimising annualised investment and annual operating costs.

In general, however, the calculation of an exact, time-step-accurate operation management plays a subordinate role in the investment consideration. This allows the use of an optional, automatic time series aggregation to reduce the optimisation problem size. This allows the annual operating costs, which are typically critical in terms of computing time, to be calculated in a very good approximation, i. e. within a shorter time.

Moreover, the optimisation objective is not limited to the primary minimisation of operating costs. Alternative criteria can be, for example, the minimisation of CO_2 emissions or primary energy demand. A combined consideration of several target variables can also be implemented through the optional internalisation into the primary target.

FlixOpt was developed as open-source software in Python and published on GitHub. The modular programme structure allows for user-specific extensions as well as the individual connection of various optimisation solvers.

Perspectives

In addition to the already available, script-based version of flixOpt, a version with a reduced range of functions is published in the form of a web application that can be operated via a graphical user interface. It has no special hardware or software requirements, can be used without programming knowledge and offers direct explanations of the individual components and their input or default parameters via mouseover or dropdown displays. A manual with a step-by-step description of the procedure, the use of the software and the evaluation of the results is provided. Thus, flixOpt not only offers scientific starting points, but also enables a wide range of municipal actors and interested parties to compare different system combinations to cover their own heat demand. The individual determination of suitable system dimensions and the visualisation of the optimal operation of each component in multivalent systems can serve as an initial decision-making aid in the context of municipal heating planning and as illustrative material for citizen participation. Through the identification and parameterisation of the relevant technologies, the simulation-based analysis for the implementation of grid measures and the resulting changes in the load profile, as well as the accompanying consideration of the applicable law, a software tool was created in the SmartBioGrid project as a freely available instrument for the municipal heat transition.

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→ Further information:
https://github.com/flixOpt/flixOpt

PROJECT PROFILE

Duration:
01/09/2019–31/12/2022

Project partner:
Technical University of Dresden,
Institute for Energy Technology;
Biomass Institute,
Ansbach University

Scientific Contact:
Heike Gebhardt

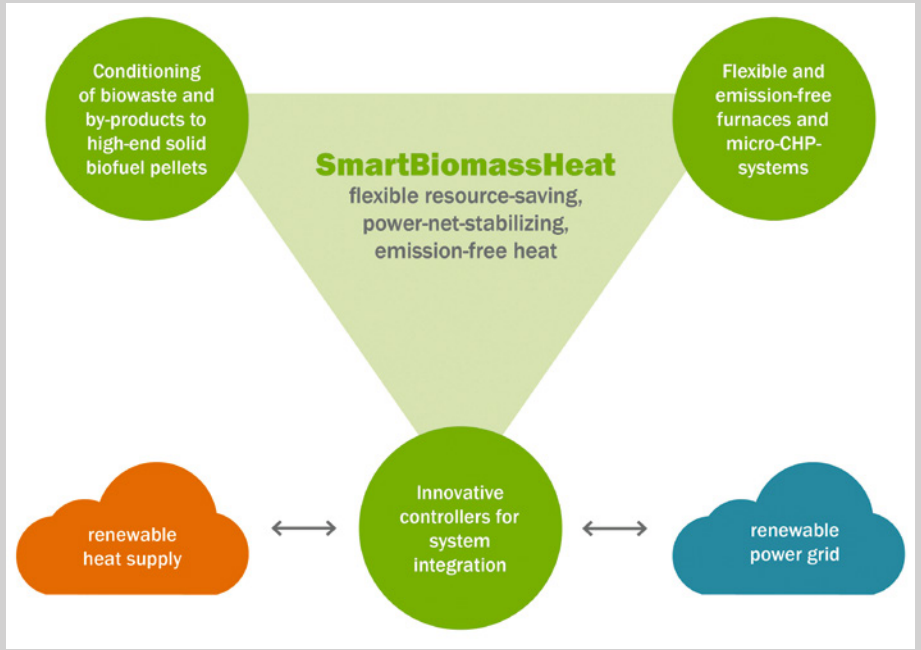
Project number:
03KB159

Funding bodies:
Federal Ministry for Economic Affairs and Climate Action/
Project Management Jülich

TECHNISCHE UNIVERSITÄT DRESDEN

BIOMASSE INSTITUT

Supported by:
Federal Ministry for Economic Affairs and Climate Action
on the basis of a decision by the German Bundestag



The Research Focus Area “SmartBiomassHeat”

The research focus area concentrates on the small-scale, renewable supply of heat to buildings and building complexes up to villages and neighbourhoods using alternative renewable energy sources and smart heating technology networks that are based on biomass, primarily from residues, by-products and waste. The overarching goal is to make the best technological and economic use of all renewable heat sources through the flexible demand-oriented use of biomass-based heating technologies. The entire chain must be mapped, investigated (both on an individual basis and as a whole), simulated and optimised – from the refinement of biomass fuels via new conversion plants, to the integration of biomass heating systems in the heating and power grid. These biomass heating systems are also designed as future heat-power-cooling systems. By developing the necessary technical components and combining these with the development of control systems, these systems can be optimised for flexible operation (including for micro and small CHPs) as well as for efficient (smart) operation that is environmentally friendly, economic, safe, demand-oriented, flexible and sustainable.

Important reference projects and publications:

Project: AbfallE – Abfall-Ende-Eigenschaft unbehandelter holzartiger Reststoffe durch Aufbereitungsverfahren und Qualitätssicherung, Federal Ministry for Economic Affairs and Climate Action, 01/11/2019–31/12/2022 (FKZ: 03KB160A)

Project: IdDiaPro – Identifikation von Methoden zur Diagnose, Prognose und Behebung von nicht-nominalen Betriebszuständen in biomassebasierten Versorgungsystemen, Federal Ministry for Economic Affairs and Climate Action, 01/03/2021–31/08/2022 (FKZ: 03EI5425A)

Project: Mini-WS – Emissionsarme kleinskalige Wirbelschichtfeuerungen zur Verbrennung von biogenen Reststoffen, Federal Ministry of Food and Agriculture, 01/06/2019–31/12/2022 (FKZ: 2219NR010)

Project: OBEN – ÖI-Ersatz Biomasse Heizung, Federal Ministry for Economic Affairs and Climate Action, 01/09/2019–31/08/2023 (FKZ: 03KB156)

Project: VergaFlex – Flexibilisierung der Biomassevergasung durch Nutzung des Vergaserkokses als Biomaterial für die stoffliche Verwertung und als Brennstoff für Kleinstvergaser, Federal Ministry for Economic Affairs and Climate Action, 01/10/2019–31/12/2022 (FKZ: 03KB157A)

Publication: Beidaghy Dizaji, H.; Zeng, T.; Enke, D. (2022). “New fuel indexes to predict ash behavior for biogenic silica production”. *Fuel* (ISSN: 0016-2361), Nr. 310, Part B. DOI: 10.1016/j.fuel.2021.122345.

Publication: Beidaghy Dizaji, H.; Zeng, T.; Hölzig, H.; Bauer, J.; Klöß, G.; Enke, D. (2022). “Ash transformation mechanism during combustion of rice husk and rice straw”. *Fuel* (ISSN: 0016-2361), Nr. 307. DOI: 10.1016/j.fuel.2021.121768.

Publication: Mutlu, Ö.; Jordan, M.; Zeng, T.; Lenz, V. “Competitive Options for Bio-Syngas in High-Temperature Heat Demand Sectors: Projections until 2050”. *Chemical Engineering & Technology*. DOI: 10.1002/ceat.202200217

Publication: Mutlu, Ö. Ç.; Roy, P.; Zeng, T. (2022). “Downstream Torrefaction of Wood Pellets in a Rotary Kiln Reactor: Impact on Solid Biofuel Properties and Torr-Gas Quality”. *Processes* (ISSN: 2227-9717), Vol. 10, Nr. 10. DOI: 10.3390/pr10101912.

Publication: Schrägle, R.; Adam, R.; Schmidmeier, T.; Hofherr, S.; Trumpa, M. (2022). “Energiegewinnung aus Altholz massiv gefährdet: Rechtsunsicherheit für Holzenergieanlagen nimmt weiter zu. Möglichkeiten einer sachgemäßen Auslegung der 44. BImSchV”. *Holz-Zentralblatt* (ISSN: 0018-3792), Vol. 148, Nr. 46. p. 804–80

→ Further information:
www.smartbiomassheat.com

Head of the Research Focus Area
Dr.-Ing. Volker Lenz
Phone: +49 (0)341 2434-450
E-mail: volker.lenz@dbfz.de

5.5 Research project “A+BiOx”

“The project investigates the efficient use of silicon rich agricultural residues from Africa for bioenergy and material applications. The focus is on the chemical pre-treatment of biomass residues from food production and their conversion properties in energy production. The comprehensive and innovative approach addresses aspects of climate change, efficiency and sustainability of agricultural production, soil degradation and new transformation processes of agricultural production.”

Clement Owusu Prempeh
Doctoral candidate

A+BiOx – 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

KEYWORDS

Biogenic silica
Fuels from African biomass
Thermochemical conversion
Catalyst support
Methane combustion

Increasing population and economic growth, rising demand for food, improved standards of living and the rural-urban shift have contributed significantly to the increasing production of agricultural residues and biomass waste in Africa [1]. In view of the increasing demand for energy from renewable resources as well as the growing environmental problems (especially greenhouse gas emissions), biomass has gained attention as an alternative source of energy and raw materials. Compared to current conventional feedstocks, biogenic residues are considered a clean and renewable source [1–2].

In South Africa, biogenic residues have the greatest potential for increased use of biomass for energy production. Currently, these materials are mostly disposed of by burning with minimal or no energy recovery, or they rot, which also poses a fire hazard [3]. This is especially true for forestry residues and residues from sugarcane harvesting, as well as some of the residues from maize cultivation. In 2010, biomass accounted for only about 10 % of South Africa’s total energy supply, behind coal and oil [4]. According to the Intergovernmental Panel on Climate Change, agricultural residues have enormous prospects in future energy systems [5].

The thermochemical conversion (combustion, gasification) of agricultural biomass residues into energy is of great interest [2, 6]. The combustion of agricultural biomass waste produces ash as the main product. The ash contains a large amount of silicon, carbon and other trace elements [2]. Amorphous silica from biogenic origin (so-called biosilica) can be used in industrial and scientific fields such as catalysis, glass production, ceramics, pharmaceuticals and for the production of plastics and refractory materials [2].

The results obtained in this project will contribute to the understanding of the mechanisms of silica synthesis during the combustion of agricultural residues from Africa. Furthermore, the new results will help to generate added value from the thermochemical conversion processes, which is crucial for a resource-efficient bio-based economy and waste reduction strategies. The knowledge gained about the energetic and material use of sugar cane bagasse, maize cobs or cassava peels could be a stepping stone for new market opportunities and create jobs for both German and African companies.

Methods/measures

Within the framework of the project, an integrated approach is being developed in which biogenic residues such as corn cobs, sugar cane bagasse or cassava peels are used as SiO_2-rich biogenic residues to generate energy via thermochemical conversion routes. At the same time, processes are being developed for the production of high-quality products (adsorbents, catalyst carriers, ceramics) from biogenic silica, which accumulates during the thermochemical conversion processes.

In addition, the principle of residue utilisation is being pursued, which includes as far as possible all residues arising from the pre-treatment of agricultural residues (corn cobs, sugar cane bagasse or cassava husks). For example, the wastewater used to treat agricultural residues can be used as liquid fertiliser to increase biomass yields, enable safer food production and balance nutrient availability in the soil.

Many previous studies have mainly focused on exploring the described concept for applicability at laboratory scale. The fundamental investigation of the feasibility under practical conditions in thermochemical conversion processes and the effects of the conversion conditions as well as the variation of the quality of the biosilica depending on the properties of the feedstock, are currently a knowledge gap. Therefore, the investigation of the practical process parameters is essential for the market application of the process to produce the desired mesoporous biosilica.

Milestones/challenges

Figure 31 shows the SiO_2-rich ashes of the investigated biomass residues sweet potato peelings, cassava peelings, coconut, maize cob shank and maize straw.

The procurement of the majority of agricultural biomass residues from Africa took place in 2021. Bagasse, residue from sugar cane from sugar production, as well as maize cob spindle and maize straw can be considered as biomass residues with no competition for use and high recycling interest. In the laboratory, the biomass residues were analysed according to a defined analysis protocol and an analysis of the corresponding proportion of biogenic silica was prepared. Based on these results, the selection and provision of suitable biomass material was carried out with presentation of the utilisation potential.

Cooperation with LIKAT Rostock (Leibnitz Institute for Catalysis) was started with several guest visits to the laboratory with its own workstation. Here the DBFZ followed up

Fig. 31: Image overview of various thermochemically produced ashes from untreated and acid-leached African biomass residues at 600 °C. From left to right: biomass and ash from cassava peels, yam shells, coconut shells, maize cob spindle and maize straw. First row from top: untreated biomass fuels; second row: ash of untreated biomass fuels; third row: ash of biomass fuels with 1 ma.% acid wash; last row: ash of biomass fuels with 5 ma.% acid wash.

on earlier collaborations on the production of catalysts with a focus on methane total oxidation [7]. Maize residue ash was selected for the production of the catalyst support based on the conclusions from the currently available analysis data. The corn residue ash had a silica content of 92 %, a surface area of 97 m^2/g and a pore volume of 0.226 m^3/g. The catalyst was synthesised as described above. A synthesised catalyst was prepared as shown in Figure 32.

In the current phase of the project, the catalyst is being synthesised and tested in the total oxidation of methane. The initial results and comparisons with a commercially available SiO_2-supported catalyst are promising. Successfully produced catalyst material with biogenic silica as support material from African agricultural residues will be further optimised. The process protocol for catalyst production is being further developed accordingly.

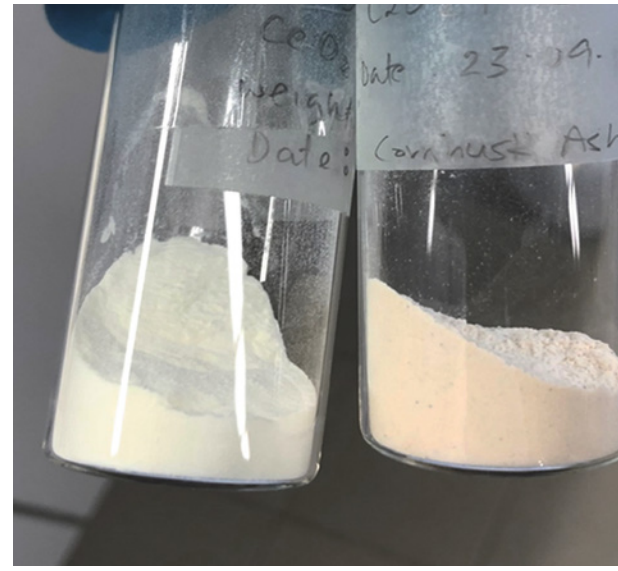


Fig. 32: Catalyst support material made from commercially available silica (left) and silica from corn husk ash (right)

The catalyst from the laboratory synthesis is to be produced in further investigations in practical manufacturing processes and its application properties tested.

Prospects

The selection of SiO_2-rich African agricultural residues for the extraction of amorphous biogenic silica and the production of a catalyst support material were successful. The production of catalysts for methane total oxidation on a laboratory scale was promising. Currently, the usability of the produced catalyst is being investigated. The first results have been published in a scientific journal and the results are continuously presented at conferences.

Two scientific papers have already been published as part of the project. Publication 1 [8] deals with the extraction and characterisation of biogenic SiO_2 from selected agricultural waste in Africa. Publication 2 [9] contains innovative findings on the production of biogenic SiO_2 from corn husks using a sol-gel polymer process.

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[1] Mohlala, L. M.; Bodunrin, M. O.; Awosusi, A. A.; Daramola; M. O.; Cele, N. P.; Olubambi, P. A. (2016). “Beneficiation of corncob and sugarcane bagasse for energy generation and materials development in Nigeria and South Africa : A short overview”. *Alexandria Engineering Journal* (ISSN: 1110-0168). Vol. 55, Nr. 3. DOI: 10.1016/j.aej.2016.05.014

[2] Pode, R. (2016). “Potential applications of rice husk ash waste from rice husk biomass power plant”. *Renewable and Sustainable Energy Reviews* (ISSN: 1364-0321). Nr. 53. p. 1468–1485. DOI: 10.1016/j.rser.2015.09.051.

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[7] 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.

[8] Prempeh, C. O.; Formann, S.; Schliermann, T.; Beidaghy Dizaji, H.; Nelles, M. (2021). “Extraction and Characterization of Biogenic Silica Obtained from Selected Agro-Waste in Africa”. *Applied Sciences*, Vol. 11, Nr. 21. DOI: 10.3390/app112110363.

[9] Prempeh, C. O.; Formann, S.; Hartmann, I.; Nelles, M. (2022) “An improved method for the production of biogenic silica from cornhusk using sol–gel polymeric route”. *Biomass Conversion and Biorefinery* (ISSN: 2190-6815) DOI: 10.1007/s13399-022-03615-6

PROJECT PROFILE

Duration:
01/10/2019–31/05/2023

Scientific contact:
Clement Owusu Prempeh,
Dr. Steffi Formann

Project number:
2819D0KA05

Funding bodies:
Federal Ministry
of Food and Agriculture/
Federal Office for
Agriculture and Food

With support from

Federal Ministry
of Food
and Agriculture

by decision of the
German Bundestag

The Research Focus Area “Catalytic Emission Control”

The vision of a climate-neutral and sustainable bioeconomy – and the premises associated with this – place very high demands on the research focus area “Catalytic Emission Control” at pollutant-free bioenergy. In particular, increased use in the future of biogenic residues and waste materials in increasingly varying qualities represents a challenge for emission-free bioenergy. The focus here is on controlling the emissions of the combustion processes of bioenergy carriers through the use of and in combination with solid-state catalysts. An extensive abatement in the greenhouse gas methane (CH_4) and toxic volatile organic compounds (VOC), semi-volatile as well as low-volatile hydrocarbons, such as polycyclic aromatic hydrocarbons (PAH) and polychlorinated dioxins and furans (PCDD/PCDF), soot particles (carbon black), and nitrogen oxides (NO_x) is required. The objective of the research focus area is to investigate recyclable and cost-effective catalysts which are stable over a long time on stream and at high temperatures. These catalysts should contain no or a significantly lower amount of precious metals. In particular, combining catalysts with additional emission abatement processes needs to be investigated in detail.

Important reference projects and publications

Project: BioFeuSe – Neue Sensorik für die Prozessoptimierung von SCR-Verfahren und Partikelabscheidung an Biomasseverbrennungsanlagen, Federal Ministry for Economic Affairs and Climate Action, 01/07/2021–30/06/2024 (FKZ: 03EI54346A)

Project: FNRUVV – Entwicklung und Praxisdemonstration der nächsten Generation an Biomasseverbrennungsanlagen: Emissionsminderungsstrategien zur umweltverträglichen Verbrennung (UVV) auf Basis von aktuellen Forschungsergebnissen “UVV – Umweltverträgliche Verbrennung“, Federal Ministry of Food and Agriculture, 01/04/2019–31/03/2022 (FKZ: 22038418)

Project: KaRo – Katalytischer Rohrbündelreaktor für die Totaloxidation von Brenngasen aus der thermischen Umsetzung von festen Biobrennstoffen zur emissionsarmen regenerativen Wärmeerzeugung, Sächsische Aufbaubank – Förderbank, 01/10/2019–30/06/2022 (FKZ: 100332481)

Project: PaCoSil – Verbrennung regionaler Reststoffe zur energetischen Nutzung von Biomasse mit gekoppelter Erzeugung von biogenem Silika für Feinstaubfilter-Prozesse, Federal Ministry for Economic Affairs and Climate Action, 01/07/2021–30/06/2024 (FKZ: 03EI5436A)

Project: UFP-MESS – Messung ultrafeiner Partikel aus Kleinfeuerungsanlagen, Market project, 27/07/2022–30/11/2025 (FKZ: 3721522050)

Publication: Hartmann, I. (2022). *Wood Combustion Agenda 2030: Development Pathways for a Low Emission Future*. Lecture held: 5th Wood Heater Design Challenge, [online], 11.–12.01.2022.

Publication: Hartmann, I.; Formann, S.; Schliermann, T.; Hoferecht, F. (2022). *Application of biogenic silica for particulate matter precipitation processes out of regenerative heat generation from biogenic residues*. Lecture held: 9th International Symposium on Energy from Biomass and Waste, Venice (Italy), 21.–23.11.2022.

Publication: Müller, M.; Hartmann, I. (2022). “Catalyst Activity Characterization and Proper Integration in Small-Scale Biomass Combustion Systems”. *Chemical Engineering & Technology*, Vol. 45, Nr. 10. p. 1894–1902. DOI: 10.1002/ceat.202100464.

Publication: Prempeh, C. O.; Formann, S.; Hartmann, I.; Nelles, M. (2022) “An improved method for the production of biogenic silica from cornhusk using sol–gel polymeric route”. *Biomass Conversion and Biorefinery* (ISSN: 2190-6815) DOI: 10.1007/s13399-022-03615-6

Publication: Yan, S.; Yin, D.; He, F.; Cai, J.; Schliermann, T.; Behrendt, F. (2022). “Characteristics of Smoldering on Moist Rice Husk for Silica Production”. *Sustainability* (ISSN: 2071-1050), Vol. 14, Nr. 1. DOI: 10.3390/su14010317.

Head of the Research Focus Area
Prof. Dr. rer. nat. Ingo Hartmann
Phone: +49 (0)341 2434-541
E-mail: ingo.hartmann@dbfz.de

6 Doctoral programme

The DBFZ's doctoral programme, which has been in existence since 2013, offers doctoral students a variety of opportunities to delve deeper into a topic in the field of bioenergy/bioeconomics and to apply the knowledge they have acquired in applied research. For practical work on their research topics, doctoral students will find state-of-the-art technology in the DBFZ's well-equipped laboratories, pilot plants and offices. The expert supervision provided by experienced DBFZ scientists is an additional guarantee of high-quality doctoral supervision and research. Academic supervision is generally provided by renowned universities in Germany with which the DBFZ maintains research partnerships. The doctoral students take an active part in the research life of the DBFZ right from the start and are integrated into ongoing projects. Regular participation in high-level scientific events (e. g. Doctoral Colloquium BIOENERGY and DBFZ Annual Conference) introduces them to the scientific community at an early stage. In addition, they are given the opportunity to consolidate their experience through committee work.

Tab. 2: Doctorate figures at a glance (as of 1 February 2023)

Number of doctoral projects in 2022	**57**
of which supervised at the DBFZ	36
of which supervised at the Universities of Leipzig, Rostock or UFZ	21
of which successfully completed	1
Cooperation with national and international universities and universities of applied sciences	12

5th Doctoral Colloquium BIOENERGY

With more than 70 participants from 22 countries (Austria, Belgium, Denmark, France, Italy, Norway, Spain and many more), the 5th Doctoral Colloquium BIOENERGY took place at the DBFZ in Leipzig on 13/14 September 2022. In over 40 lectures and poster presentations, the latest results of bioenergy research were presented and new contacts were made during interactive group activities such as the scientific talk show on the topic of “Not in My Backyard Phenomenon” or the “Get in Touch” session. The prize for the best scientific poster on the topic of “Monitoring and control of agricultural biogas plants: Observability analyses of a simplified ADM1” was awarded to PhD student Simon Hellmann from the DBFZ’s Biochemical Conversion Department. The 6th edition of the event will take place on 18/19 September 2023 in Göttingen and will be hosted in terms of content and organisation by the University of Applied Sciences and Arts Hildesheim/Holzminden/Göttingen.

→ **Further information:**
www.doc-bioenergy.de

Fig. 33: Participants of the 5th Doctoral Colloquium BIOENERGY

Promotion example by Daniel Dzofou Ngoumelah

Fig. 34: Doctoral student Daniel Dzfou Ngoumehlah

Electrochemical activity and stability of Geobacter spp. dominated biofilm anodes in anaerobic digestion

One of the greatest challenges facing mankind is the mitigation of climate change. For this, renewable energy supply systems need to be further developed. The transition from unsustainable energy systems based on fossil fuels to sustainable energy production based on renewable energy sources, such as solar, wind and biomass, seems to be the most effective way to ensure environmental security as well as energy and food supply worldwide. Several technologies can be used to meet these needs, including anaerobic digestion (AD) and microbial electrochemical technologies (MET).

AD is a key technology for stabilising organic waste streams and producing energy in the form of biogas. To achieve high biogas production, the AD process needs to be monitored, as a high substrate feed or a disturbance of the process parameters (e. g. a high pH fluctuation) can disrupt the underlying biological processes. MET are technologies or applications that take advantage of the electrochemical interaction of microbes and electrodes. AD performance can be supported and enhanced by MET in a variety of hybrid technologies. The strength of combining both technologies lies in their complementary nature, e. g. application areas, substrates (e. g. wastewater) or process conditions (e. g. neutral pH and mesophilic temperature range). Potential benefits of the AD-MET combination include: 1.) process monitoring, control and stabilisation, 2.) nutrient recovery, 3.) wastewater treatment and 4.) biogas upgrading. These applications can be achieved by using electroactive bacteria of the genus Geobacter spp. that form a biofilm on solid electrodes (e. g. graphite rods) as receptors for microbial electrochemical sensors (MESe). However, the combination of AD and MET not only enables a new ecological niche between microorganisms, but also leads to different interactions between biofilm electrodes and AD components. So far, most studies combining both technologies have reported inhibition of biofilm anodes dominated by Geobacter spp. It is suggested that the observed biofilm inhibition may be caused by certain components of the AD fermenter contents acting as alternative terminal electron acceptors (TEA) (Fig. 35).

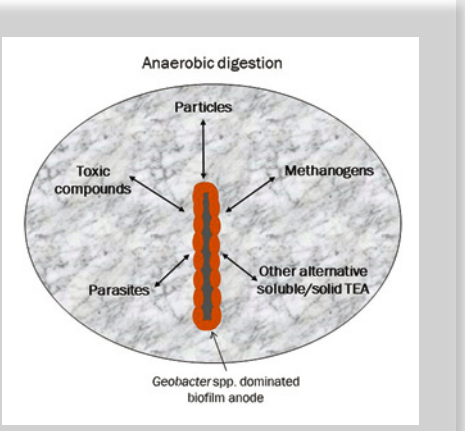

Fig. 35: Potential inhibitors of Geobacter spp. dominated biofilm anodes in anaerobic digestion. Double line arrows represent possible interactions.

The aim of the work was to elucidate and address the main cause of the inhibition of Geobacter spp. dominated biofilm anodes previously observed in AD environments. The results indicated that the combination of AD and MET requires constant activity and stability of electroactive biofilms such as Geobacter spp. dominated biofilm anodes under AD conditions. Parameters such as the age of the biofilm, the composition of the methanogenic community in the AD effluents and the applied anode potential were found to be crucial in this combination. However, identifying other potential triggers of biofilm inhibition dominated by Geobacter spp. (e.g. other detrimental AD components to EAM in biofilms) and strategies to overcome them could represent an unprecedented breakthrough in AD-MET combinations. For this, further improvements and a better overview of AD-MET combinations need to be achieved, e.g. by: 1.) analysing and comparing the chemical, physical and biological composition of AD plants with different feedstocks, 2.) monitoring biofilm activity and changes in the microbial community of Geobacter spp. dominated biofilm anodes in a wider range of AD effluents from different feedstocks, 3.) monitoring Geobacter spp. gene regulation (knock-out/down/in) under different AD environments, and 4.) investigating in depth all possible syntrophic reactions between Geobacter spp. dominated biofilms and the AD microbiome.

The results of this doctoral thesis have been published in several peer-reviewed articles:

Publications:

[1] Dzofou Ngoumelah, D.; Harnisch, F.; Kretzschmar, J. (2021). “Benefits of Age-Improved Resistance of Mature Electroactive Biofilm Anodes in Anaerobic Digestion”. *Environmental Science & Technology* (ISSN: 1520-5851), Vol. 55, Nr. 12. p. 8258–8266. DOI: 10.1021/acs.est.0c07320.

[2] Dzofou Ngoumelah, D.; Kuchenbuch, A.; Harnisch, F.; Kretzschmar, J. (2023). “Combining Geobacter spp. Dominated Biofilms and Anaerobic Digestion Effluents: The Effect of Effluent Composition and Electrode Potential on Biofilm Activity and Stability”. *Environmental Science & Technology* (ISSN: 1520-5851), Vol. 57, Nr. 6. p. 2584–2594. DOI: 10.1021/acs.est.2c07574.

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[4] Dzofou Ngoumelah, D.; Bjerkan Heggeset, T. M.; Haugen, T.; Sulheim, S.; Wentzel, A.; Harnisch, F.; Kretzschmar, J. Effect of model methanogens on the activity, stability, and microbial community structure of Geobacter spp. dominated biofilm anodes. *Environmental Science & Technology* (submitted)

DBFZ

List of current doctorates at the DBFZ

(as of 31 January 2023) /
* Successful completion in 2022

Ackermann, Konstantin
Farm optimisation using digital twins
Pending approval

Adam, Roman
Investigation of the compaction of biomass by means of DEM simulation
Technical University Berlin

Beidaghy Dizaji, Hossein*
Ash-related aspects during thermochemical conversion of silica-rich biomass assortments
University of Leipzig /
Iran University of Science and Technology (IUST)

Bindig, René
Method for the development of catalysts for emission reduction at combustion plants
Martin-Luther-University Halle-Wittenberg

Chang, Yingmu
Economic analysis and carbon emission reduction strategies of China’s agricultural biogas and biomethane and strategies with regard to Germany’s experience
University of Leipzig

Delory, Felix
Model-based monitoring of anaerobic digestion plants
Pending approval

Dernbecher, Andrea
Numerical investigation of emissions from small-scale biomass combustion plants
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 residue utilisation
Martin-Luther-University Halle-Wittenberg

Dotzauer, Martin
Economic evaluation of policy instruments to achieve the expansion targets of bioenergy plants in the electricity sector with the help of object-oriented programming
University of Leipzig

d'Espiney, Ana Careirra
Bioenergy production optimization through complementary effluents management
University of Lisbon

Gallegos, Daniela
Optimization of ensiling fermentation of Elodea genus for biogas production
University of Rostock

Gebhardt, Heike
Heat grids 4.0 – options for the use of solid biomass in decarbonised heat grids
Technical University Dresden

Hahn, Alena
The role of smart bioenergy in combination with CO_2 removal in decarbonisation scenarios
University of Leipzig

Hellmann, Simon
Process monitoring and advanced control of agricultural biogas plants
Technical University Chemnitz

Hirschler, Olivier
Potential of renewable resources to replace peat as a substrate feedstock in German horticulture
University of Leipzig

Karras, Tom
Biomass supply costs for biogenic residues
University of Leipzig

Kirstein, Niels
Future use of biogenic solid fuels against the background of the two-degree target
University of Leipzig

Klüpfel, Christan Paul
Hydrothermal liquefaction of residual biomasses
Technical University Berlin / Aarhus University, Denmark

Köchermann, Jakob
Hydrothermal production of furfural from biomass and biomass hydrolysatesn
Technical University Berlin

König, Mario
Investigations on the development and application of novel SCR catalysts for nitrogen oxide reduction of exhaust gases from the thermo-chemical conversion of biogenic solid fuels
Martin-Luther-University Halle-Wittenberg

Kurth, Matthis
Operating conditions and mass transport descriptions of water-separating membranes in biorefinery processes
Technical University Berlin

Meola, Alberto
Artificial Intelligence for process simulation of anaerobic digestion plants
University of Leipzig

Ngoumelah, Daniel Dzofou
Electrochemical activity and stability of Geobacter spp. dominated biofilm anodes in anaerobic digestion
University of Leipzig

Nieß, Selina
Methanation catalysts for direct biogas methanation of upgraded biogas
Technical University Berlin

Nitzsche, Roy
Demonstration and assessment of adsorption and membrane filtration for the separation and valorization of hemicellulose from Organosolv Beechwood Hydrolyzates
Technical University Berlin

Pouresmaeil, Shabnam
Bioelectrochemical Power-to-Gas using bed electrodes based on biochar
University of Leipzig

Prempeh, Clement Owusu
Generation of silicon dioxide from biogenic residues for advanced applications
University of Rostock / University of Stellenbosch, South Africa

Pujan, Robert
Systematic modelling of biorefinery processes
Norwegian University of Science and Technology

Reinelt, Torsten
Monitoring of spatially unknown and time-varying methane emissions at biogas plants
Technical University Dresden

Richter, Lukas
Optimised energy management in an energy cell
Pending approval

Richter, Sören
Bioeconomy scenarios for Germany until 2050
University of Leipzig

Röder, Lilli Sophia
Implementation of demand side management in biorefineries
Ruhr-University Bochum

Schliermann, Thomas
Synthesis and property optimisation of biogenic silica by thermochemical conversion on the basis of rice husks in conversion plants of different scales from laboratory to kg-scale
Pending approval

Siol, Christoph
Assessing new technologies for the circular bioeconomy with combined environmental and economic LCSA
University of Leipzig

Sumfleth, Beike
Integrated assessment framework for sustainability certification of low indirect land use change risk biomass
University of Leipzig

Thiel, Christian
Reduction of volatile organic compounds (VOCs), soot, polycyclic aromatic hydrocarbons (PAHs) and particulate matter in a single-room combustion system
Pending approval

Undiandeye, Jerome Anguel
Fermentation of agricultural residues for energetic and material utilization
University of Rostock

Weber, Svenja Nathalie
Degradation and sorption behaviour of veterinary antibiotics and metabolites during anaerobic digestion of dry chicken manure
Pending approval

Wedwitschka, Harald
Method development for feedstock characterisation for pit fermentation processes
University of Rostock

Zerback, Timo Rolf
Influence of hydrothermal (HT) pre-treatment on the anaerobic digestibility of lignocellulosic residual and waste materials
Pending approval

List of ongoing doctorates with the cooperation partner Helmholtz Centre for Environmental Research – UFZ

(as of 31 January 2023) /
** Successful completion in 2022

Baleeiro, Flávio César Freire
A biorefinery on sugarcane by-products based on the carboxylate and syngas platforms
Karlsruhe Institute of Technology

Chan, Katrina
Modelling biomass energy use in sustainable agriculture and food scenarios
University of Leipzig

Cheng, Zhe
Fate and effects of antibiotics in anaerobic digestion systems
Technical University Berlin

Grosch Schröder, Bruna
Development of a biogas production process inspired by the Pachnoda marginata larvae gut system
University of Leipzig

Kähl, Daniel
Reduction of the inhibitory effects of propionic and butyric acid in methanation by promoting direct interspecies electron transfer
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

Schäfer, Christina
Engineering microbial communities for the conversion of lignocellulose into medium-chain carboxylates
University of Leipzig

Strobel, Piradee
Sustainable bioethanol development for an approach to circular economy in Thailand – an evaluation by multi-criteria decision making
University of Leipzig

Tafarte, Philip**
Assessing the potential of immediate technical options for an optimized renewable energy supply – a case study for Germany
University of Leipzig

Zeug, Walter
A holistic life cycle sustainability assessment for bioeconomy regions – linking regional assessments, stakeholders and global goals
University of Leipzig

List of ongoing doctorates with the University of Rostock

(Status: 31 January 2023)

Afrakoma Armoo, Ekua
Closing the loop in a circular economy – sustainable compost product from fermentation residues
University of Rostock

Daldrup, Markus
Integration of a plant for the production of insect products into the material cycles at Gut Hülsenberg
University of Rostock

Darmey, James
Continuous process biogas production from municipal solid wastes from Ghana
University of Rostock

Ender, Tommy
A concept for the treatment and nutrient recovery of process waters from the hydrothermal carbonisation of wastes
University of Rostock

Fröhlich, Janina
Dynamic conversion of biogenic carbon dioxide with regeneratively produced hydrogen into a chemical energy carrier
University of Rostock

Gievers, Fabian
Comparative investigation and balancing of process chains for the production and use of vegetable coal
University of Rostock

Gökgöz, Fatih
Development and optimisation of grid-autonomous biogas upgrading plants with integrated filling station technology for local fuel supply with biomethane
University of Rostock

Sarquah, Khadija
Production of refuse derived fuels from municipal solid waste
University of Rostock

Shettigondahalli Ekanthalu, Vicky
Sewage sludge treatment and HTC
University of Rostock

Vincent, Lynn
Expansion of energy system modelling for Thuringia – survey of biomass potentials, expansion of bioenergy pathways, life cycle assessment
University of Rostock

Contact
Dr. Elena H. Angelova
Phone: +49 (0)341 2434-553
E-mail: elena.angelova@dbfz.de

7 Science Communication

In the area of science communication, the DBFZ was able to generate numerous media mentions in 2022 and further increase its visibility among the general public and the scientific community. Against the backdrop of the difficult national energy supply situation, DBFZ scientists and their expertise were increasingly in demand as independent scientific experts. In 2022, the DBFZ was mentioned in the following media (TV/print/online/audio): Welt, ZEIT, TopAgrar, Brandeins, Tagesschau, Spiegel Online, AgrarHeute, Handelsblatt, Deutsche Welle, Deutschlandfunk, WDR, SWR, MDR, ZDF, Holzzentralblatt, LVZ and Radio Mephisto (selection). DBFZ scientists also provided important input in various audio podcasts in 2022.

Fig. 36: DBFZ Managing Director Prof. Dr. Michael Nelles (right) in the first edition of the Zuckerpodcast

→ First edition of the “Sugar Podcast” on the topic of “Climate Neutrality“

→ E&M Energy Radio – the podcast for the energy industry with Prof. Dr. Daniela Thrän

DBFZ scientists in the media

Fig. 37: Head of the Biogas-Department, Dr. Peter Kornatz, in an interview for the science magazine “Odysso” (SWR)

Fig. 38: Dr. Claudia Kirsten in an interview with Deutsche Welle

Fig. 39: Biofuel expert Karin Naumann in an interview with the MDR

Social Media

Social networks have become increasingly important for the DBFZ as widely used media channels. A wide range of research topics and announcements (job vacancies, press releases and information about DBFZ events) were communicated via platforms such as Linkedin, Twitter, Xing and YouTube. In addition, various DBFZ research projects were accompanied with media attention via project-related accounts and topic-specific networks were established and expanded. Examples of this were projects such as the “Bioeconomy Model Region”, “TRANSBIO” and the “ETH Soil” project for soil improvement in Ethiopia. In 2022, a total of well over 4,500 followers followed the DBFZ’s diverse activities on social networks.

“Bioenergy Heads” video series launched

With the video series “Bioenergy Heads” of the scientific support project of the BMWK funding area “Energy to Biomass”, a new format of science communication was realised in 2022. The format pursues the goal of passing on results from the funded projects and creating constructive synergies between research and the market. Short videos report on current research and the people behind it. The pilot episode presented the research project “OBEN”. The project focuses on private households and aims to help shape the heat transition from within their own boiler room.

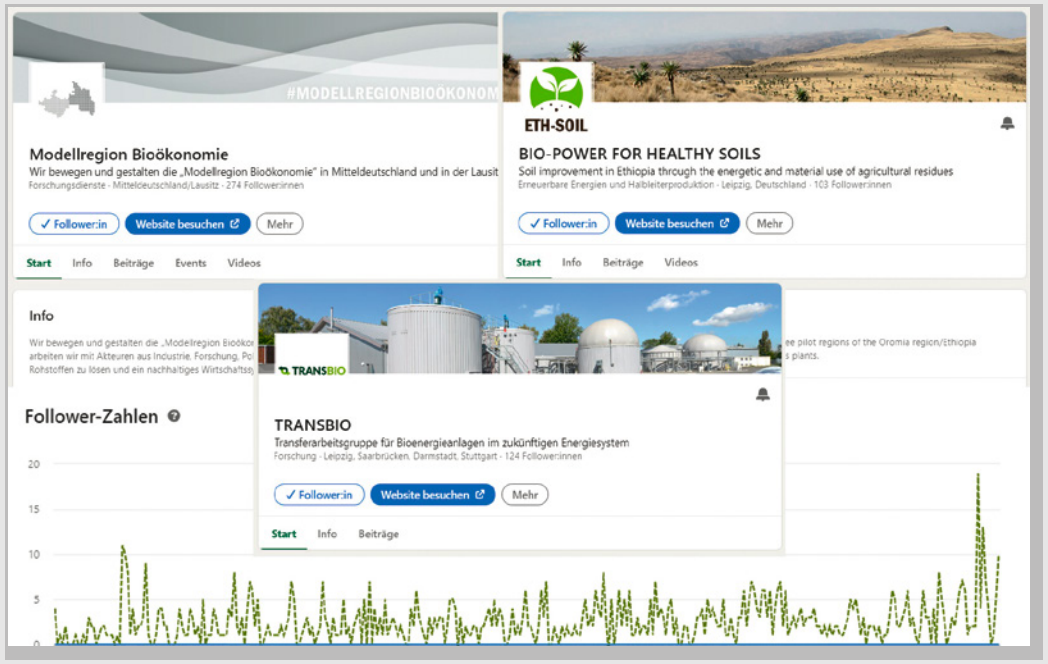


Fig. 40: Examples of project-related communication on social media (LinkedIn)

→ **Video:**
https://youtu.be/nypYfcoVaWU

New publications (DBFZ publication series)

The “DBFZ Report” publication series, which is available free of charge, has continued to grow in 2022. Four new issues deal with “Monitoring renewable energies in transport” (see page 50), “Hydrogen from biomass” and two aspects of the “WasteGui” research project (see page 40). All publications are available as a free download (PDF) on the DBFZ website.

Fig. 41: New issues in the scientific publication series “DBFZ Report”

→ **Further information and free downloads at:**
www.dbfz.de/en/reports
www.dbfz.de/en/brochures

Contact
Paul Trainer
Phone: +49 (0)341 2434-437
E-mail: paul.trainer@dbfz.de

Events hosted by and with the DBFZ

With a total of almost forty events (presence, online, hybrid), the DBFZ was able to start the 2022 event year actively after a two-year forced break from Corona. In addition to the DBFZ Annual Conference, which took place for the first time in spring and in a hybrid event format, the activities focused on the annual expert discussion on “Particle Separators in Domestic Combustion Systems” in cooperation with the Technology and Support Centre (TFZ), the 5th Doctoral Colloquium BIOENERGY and the Leipzig Expert Talk series on the topics of biofuels and biogas.

Fig. 42: After a two-year forced break from Corona, the 2022 annual conference was once again held as a (hybrid) attendance event at the DBFZ in Leipzig

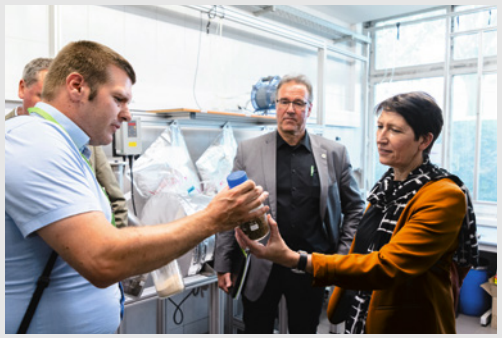
DBFZ annual conference: “Green Deal & beyond”

At the DBFZ’s annual conference from 21-23 June 2022, the challenges of the European “Green Deal” were discussed and current research topics in the field of bioenergy were presented. Almost 200 representatives from politics, industry and science used the conference to gain an overview of the status quo of bioenergy research, to establish personal networks and to discuss topics such as energy supply, climate protection, bioeconomy, circular economy and current research approaches. In her welcoming address, Silvia Bender, State Secretary of the Federal Ministry of Food and Agriculture, pointed out against the backdrop of the Russian war of aggression on Ukraine that the already urgent tasks have now become even more acute: “The bioeconomy is the central building block that must contribute to all the current challenges. It makes an indispensable contribution to our goal of making society climate-neutral by 2045”. In this context, research on biomass use as a sub-area of the bioeconomy has a very high priority. On the one hand, it shows the opportunities, but also the limits of the use of renewable raw materials, said Bender.

Within the framework of a total of five sessions, the three-day event was then dedicated to selected topics of bioenergy research. The focus was on aspects such as “sustainable mobility” and the role of renewable energies in reducing GHG emissions, secure and networked electricity and heat supply through integrated and smart bioenergy and, last but not least, the question of what role biomass can play in a sustainable circular economy. There was consensus among all participants on this point in particular: the potential is limited, so biogenic residues and waste materials represent an essential material flow for a sustainable circular economy and bioeconomy and should be used as a priority over fossil raw materials, according to Prof. Dr. Christina Dornack from the Expert Council on Environmental Issues at the Technical University of Dresden.

The next DBFZ Annual Conference will take place in spring 2024.

→ **Further information:**
www.bioenergiekonferenz.de



Visitor highlights 2022

What does applied biomass research look like in practice and what research approaches are being pursued today for the energy supply of tomorrow? These and many other questions were explored by a wide variety of visitor groups during more than twenty tours of the institute in 2022. In addition to guests from all over the world (including Senegal, India, Ghana, Brazil, Argentina & Canada), political representatives from various parliamentary groups also found their way to Leipzig. Highlights were the visit of Dr. Paula Piechotta, Member of the German Bundestag (Greens) on 9 March and the visit of Sören Pellmann, Member of the German Bundestag, from the Leipzig Left Party on 8 June 2022. Other political guests were Jens Lehmann, Member of the German Bundestag, and the EU parliamentarians Manfred Weber and Dr. Peter Jahr.

DBFZ Visitor Tour

On a visitor tour you can get to know the DBFZ with its main research areas and technical facilities. We will inform you about our organisation and our work mission. By choosing your topics, you have the opportunity to flesh out your visit to the DBFZ and thus contribute to an interesting discussion.

→ **Further information:**
www.dbfz.de/visit

Fig. 44: Visitor groups in 2022 (selection)

Successful specialist events on biogas & biofuels

In addition to numerous internal and external project meetings, conference participations and workshops, in the second half of 2022 the DBFZ's Biorefineries Department in particular was able to attract many interested parties from industry, science and politics to participate in three specialist events. With the 7th edition of the HTP specialist forum, the conference on "Hydrothermal Processes" has established itself as an important specialist event on the topic. This year's event took place on 27/28 September at the DBFZ and once again focused on the entire value chain of hydrothermal conversion with a wide range of presentations.

Another highlight of the departments events was the Biorefinery Day, which took place on 11 October and attracted a total of around 100 participants from science and industry to the DBFZ. The event was held in cooperation with Bioeconomy e. V. and focused on innovative technologies and approaches for processing biomass into biobased products and fuels as well as new solutions (processes, conversion or separation methods, etc.). As part of the "Leipzig Expert Talk" series of events, the event on biofuels entitled "Biofuels – outdated model or trailblazer?" was held at the DBFZ on 8 November. At the event, numerous experts and industry representatives discussed the challenges of the transport turnaround, the role biofuels play in it and the necessary steps to be taken by 2030. A total of over 110 participants followed the followed the exciting discussion.

Fig. 43: Panel discussion at the Biofuels Expert Talk (8 November 2022)

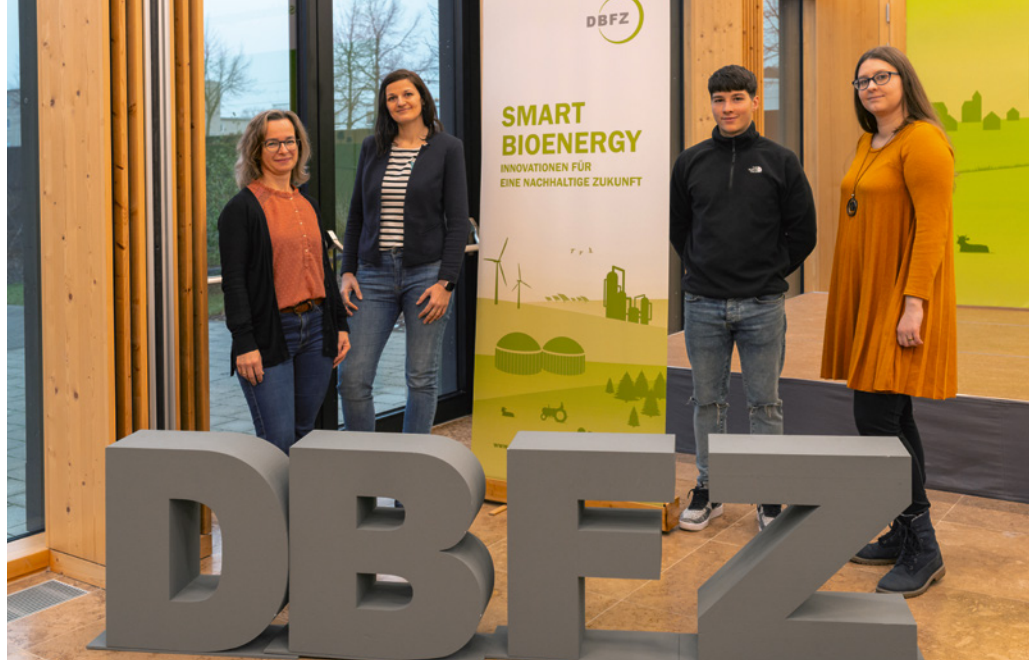


Fig. 45: The DBFZ events team in January 2023

The highlights of the 2023 event year (Selection)

VI. International Conference on Monitoring and Control of Anaerobic Digestion Processes
22/23 March 2023

World of Fireplaces
17–19 April 2023

31st European Biomass Conference & Exhibition
5–8 June 2023

11th International Bioeconomy Conference
14/15 June 2023

17. Rostock Bioenergy Forum
15/16 June 2023

Long Night of the Sciences 2023
23 Juni 2023

4th Biorefinery Day: Key technologies for bio-based products and fuels
12 September 2023

6th Doctoral Colloquium BIOENERGY
18/19 September 2023

Status Conference 2023
20–22 September 2023

Biogas Expert Talk
29 November 2023

→ **You can find a complete overview at:**
www.bioenergie-events.de

We are looking forward to see you!

Contact

Katja Lucke
Phone: +49 (0)341 2434-119

Dana Poitschke
Phone: +49 (0)341 2434-220

Nicole Wolf
Phone: +49 (0)341 2434-218

E-mail: veranstaltungen@dbfz.de

8 International Activities

Scientific project work in an international (non-European) context is one of the DBFZ's key objectives. The aim is to make scientific expertise available to foreign partners. In addition to the joint implementation of research projects, the exchange of doctoral students and guest scientists are also part of the international activities. Another goal is to establish cooperations with international universities and non-university research institutes and to consolidate and selectively expand non-European networks. This also includes initiating and arranging reciprocal visits and organising workshops and conferences.

The DBFZ at the Tropentag 2022 in Prague

Hands-on science – this was demonstrated by DBFZ scientists at the Tropentag (Tropics Day) in Prague from 13–16 September 2022.

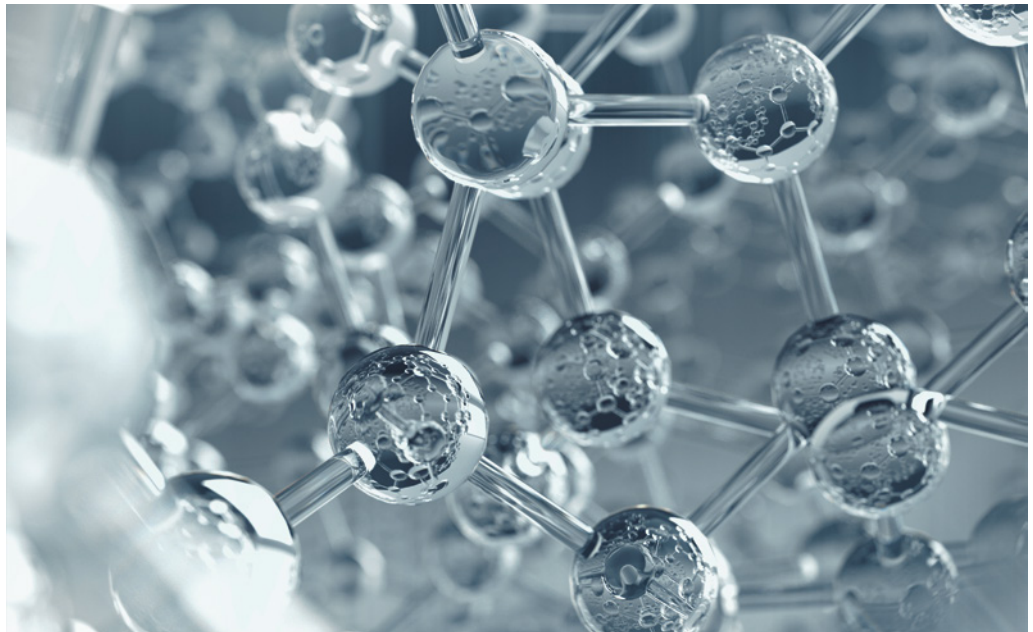
At the largest interdisciplinary conference on development policy issues in Europe, DBFZ scientists Dr. Annett Pollex, Dr. Mirjam Müller and Dr. Sven Schaller not only organised a workshop on improved cook-stoves in rural areas, but also gave a practical demonstration of how everyday cooking could be done in the future in a resource-conserving, health-promoting and low-emission way in Africa, Asia and Latin America. Unlike conventional steel cookers, this one can locally be made by people everywhere, at only a fraction of the cost compared to the metal version. During the workshop, Marius Biehrig (proLehm) and Katharina Prost (ClimEtSan) reported on their many years of experience in Ethiopia and the challenges required to adopt such new technologies. The demonstration with a smaller model of the NOAH pyrolysis cook-stove on the campus of the Czech University of Life Sciences could thus give new impetus to development cooperation in the field of basic energy supply for large parts of the world.

Fig. 46: Demonstration of a clay cooker at the TROPENTAG 2022 in Prague

Short study – hydrogen from biomass for GIZ in India

The potential uses of hydrogen are many and varied. Currently, hydrogen is mainly used in industry, but in the future it will also be used in sectors which are difficult to electrify or as a storage medium to balance fluctuating energy flows from renewable energies. In addition to the production of hydrogen from water and renewable electricity by means of electrolysis, there are other options for hydrogen production based on renewable energy sources, including biomass. Against this background, the aim of a short study prepared by the DBFZ – in close cooperation with the client – was to provide an overview of the topic of hydrogen from biomass and alternative biomass utilisation options in India. In this context, particular attention had to been paid to the biomasses available in India and their alternative utilisation pathways, with a special focus on the CO_2 balance. The aim of the study was to compare the land requirements for the production of hydrogen from biogenic residues and waste materials with the land requirements for the production of alternative renewable fuels and the production of electrolysis hydrogen using agri-photovoltaics.

Fig. 47: Commissioned study provides assessment of hydrogen from biomass in India



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ETH Soil – implementation in Oromia

Under the slogan “Bio-Power for Healthy Soils”, the DBFZ’s ETH Soil project aims to make smallholder agriculture in Ethiopia more climate-friendly and resilient. The project is part of the BMZ’s core thematic strategy “Life without Hunger – Transforming Agricultural and Food Systems” and is being implemented in close coordination with actors from german and international development cooperation. After corona-related travel restrictions and armed conflicts in Ethiopia had hindered the start of work on the ground, DBFZ staff were finally able to meet their partners in person in September 2022. Implementation planning at national level and in the Oromia region was coordinated with the Ethiopian partners and the goals and needs of the University of Jimma and the state agricultural research centre IQQO were recorded.

Fig. 48: The major Athiopia project ETH Soil is accompanied by a wide range of coordination measures

While the prices of mineral fertilisers on the world market are experiencing drastic fluctuations, the ETH Soil project is gaining widespread approval. Organic fertilisers made from fermentation residues and compost with the addition of plant carbon are not only the way to significant foreign exchange savings and fertiliser self-sufficiency. The production process will also use plant residues and invasive plants, which currently pose an environmental or disposal problem. The next goal is to ensure the ramp-up of infrastructural and plant capacities, to further develop competencies of the implementing partners and to test the right application recipes for smallholder agriculture. In Oromia, the project encounters an ancient culture in which the protection of natural resources – in accordance with a moral/ethical tradition (“Safuu”) – is part of the world view.

→ Further information:
www.eth-soil.com
www.dbfz.de/en/international

Contact
Dr. Sven Schaller
Phone: +49 (0)341 2434-551
E-mail: sven.schaller@dbfz.de

9 Knowledge and technology transfer

The DBFZ conducts applied research and development (R&D) in a variety of facilities, test beds and technical laboratories. The aim is to translate scientific findings from research projects into practical applications. Whether technological, in the form of an improved production process or a new product made from biowaste, or knowledge-based, for example by providing information on available raw material potentials or opinions on planned legislative changes: Research achieves impact when it reaches its respective target group.

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9.1 Knowlegde transfer

Online information portal Bioeconomy Atlas

The Bioeconomy Atlas information portal provides interested users with comprehensive data and information on the bioeconomy in the Central German and Lusatian regions. The website focusses on the transfer of knowledge to stakeholders in the Central German and Lusatian regions as well as to a specialist public interested in the topic of the “bio-based economy”. The portal offers extensive open data and statistics for further use. Dynamic figures show developments in the coalfields and can become a basis for decision-making and strategy processes of stakeholders within the transformation process of the coalfields. In addition to general information, news articles and publications on the bioeconomy, the atlas is structured into five main topics:

_ Bioeconomy & sectors: Strategies for the bioeconomy, monitoring, employment structures, potential sectors
_ Coal & structural change: Coal industry Europe, coal industry Germany, Opencast mining activities in the coalfields
_ Biomass base: areas, agricultural harvests, plant biomass base & Select-A-Plant, wood harvests, by-products, residual & waste materials
_ District structure: area & population, economy, labour market, transport and infrastructure
_ Knowledge & innovation: research landscape, academic training landscape, vocational training landscape

The Bioeconomy Atlas is integrated into the Open Data structure of the DFBZ. This ensures its long-term availability and use. The information portal was developed as part of the project “Bioeconomy Model Regions in the Central German Mining District and the Lusatian Mining District”.

→ **Further information:**
www.dbfz.de/biooekonomieatlas

Contact
Dr. Romy Brödner
E-mail: romy.broedner@dbfz.de

Fig. 49: Homepage of the Bioeconomy Atlas

© Hanffaser Uckermarck eG

Fig. 50: Harvesting hemp stalks

9.2 Technology transfer

Raw material hemp: added value for domestic businesses through the use of production residues

Hemp fibres have been used for clothing, cloth and ropes for several thousand years. After a niche existence in the second half of the last century, its importance is growing again today. As roof and wall insulation, as a mortar admixture and in dry construction, but also in cosmetics and other consumer products, hemp is used and serves as an environmentally favourable, sustainable substitute for petroleum-based materials. The transfer partner, Hanffaser Uckermarck eG, grows industrial hemp and processes it into building materials and technical fibres. The residues from fibre production have so far been used little or with little value. Changing this would increase the overall added value from the raw material.

As part of the “HempNRG” project funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK), scientists from the DBFZ’s three technical departments are working with Hanffaser Uckermarck eG to examine various options for using residues from hemp fibre processing to generate energy. The use of the residues as solid fuel, as raw material for biogas/biomethane plants, pyrolysis or gasification processes is being investigated. The waste heat from the thermal and biochemical processes is also to be used for the fibre production process. The aim is to make a regional, bio-based value chain more worthwhile and to give the company and the local raw material a market advantage.

Further information:
www.dbfz.de/en/hanfnrg

Contact
Harald Wedwitschka
Project manager
E-mail: harald.wedwitschka@dbfz.de

Fig. 51: Project video on the “PaplGas” project on Youtube (german)

PaplGas: Biomethane & peat substitute from poplar wood

Poplar wood can be used as an indigenous and fast-growing renewable raw material for the production of renewable energies, e. g. for decentralised heat supply. As a feedstock for biogas plants, however, the raw material is still uncommon. Wood fibres can only be degraded with difficulty by the microorganisms in the fermenters. Nevertheless, compared to maize, which has been by far the most important raw material up to now, there are clear advantages with regard to climate balance.

In the joint project “Biomethane & Peat Substitute from Poplar Wood (PaplGas1&2)”, the digestate from wood fibre fermentation is being tested for its suitability as a horticultural substrate. If successful, this by-product can replace peat and thus make a significant contribution to the protection of peatlands, which are important CO_2 reservoirs. DBFZ investigations to date have shown biogas yields from poplar wood fibres to be comparable to those from cattle dung. This means that, in addition to substituting peat in horticulture, poplar wood could also provide biomethane as a flexible energy source – a double benefit for climate protection and regional value creation.

By researching this innovative conversion concept for native hardwood to peat substitutes and at the same time to renewable energy (biogas/biomethane), the PaplGas projects are in line with the national bioeconomy strategy. The PaplGas projects will furthermore address the objective of the national biomass strategy (NABIS) to contribute to climate and biodiversity protection in the medium and long term through sustainable resource use.

Besides the DBFZ, the project partners of the PaplGas projects are Vattenfall Energy Solutions GmbH, Klasmann-Deilmann GmbH and the Helmholtz Centre for Environmental Research (UFZ). All projects were/are funded by the Federal Ministry of Food and Agriculture on the basis of a resolution of the German Bundestag through the FNR project management agency (Fachagentur Nachwachsende Rohstoffe e. V.), special fund “Energy and Climate Fund”.

→ **Further information:**
www.dbfz.de/en/paplgas

→ **Project video “Potting soil & biomethane from fermented wood fibres”**

Contact
Dr. Britt Schumacher
Project manager
E-mail: britt.schumacher@dbfz.de

9.3 Policy recommendations and advice

In the area of “policy recommendations and advice”, the DBFZ offers a wide range of advisory services for political decision-makers in ministries or parliaments as well as for the specialist public. The services take the form of statements, background or position papers or (short) studies on current political processes, as well as lectures and expert discussions. In addition to the scientific work of the DBFZ, the basis is also the continuous observation of the development of (bio-) energy markets, their political framework conditions at national and EU level, as well as the results of energy system scenarios for the medium and long-term use of biomass in the energy sectors.

Focal points of policy advice in 2022

Biomass use was also under the influence of the Ukraine war in 2022. With a view to the impact of the war on the food and energy sectors, the DBFZ published a background paper in May on possible contributions of biomass to the substitution of natural gas by 2030. The central recommendation was increased mobilisation of biogenic by-products and waste to ensure the sustainable contribution of biomass in the energy system. In July, an in-depth analysis of the future role of biogas and biomethane was published in the form of a short study. In addition, assessments were prepared for the responsible ministries on which immediate measures biogas can contribute to easing possible bottlenecks in the energy supply in the winter of 2022/23.

The DBFZ also contributed a discussion paper to the plans for capping electricity market revenues for renewable energies that were developed in the further course of the Ukraine war. This recommended a differentiated consideration of flexible producers and a consideration of the special cost situation of biomass plants in the Renewable Energy Sources Act (EEG).

Other focal points of the 2022 policy consultation included the German government’s so-called “Easter Package” for the further expansion of renewable energies. In this context, the DBFZ supported the responsible ministries with a large number of statements on the further development of the role of biomass in the EEG. Initial discussions on the stronger limitation of conventional biofuels in the greenhouse gas reduction quota (GHG quota) also received expert support. The importance of biomass for achieving the climate targets in the transport sector was explained in a comprehensive background paper, among other things.

Under the leadership of the DBFZ, a strategy paper on heating and cooling from biomass was prepared together with the scientific support project of the BMWK funding area “Biomass to Energy”. The paper presented the future research needs, also with regard to synergies with other renewable energies, as well as taking sustainability criteria and social aspects into account. The central statement is that bioenergy will continue to make an important contribution to heat supply. With regard to the European level, the Renewable Energy Directive (RED) was again the focus of the advisory activities. In particular, the

Fig. 52: Mention of the biogas study “The role of biogas for a climate-neutral, 100 % renewable electricity system in 2035” in the Tagesschau (3 August 2022)

consequences and challenges in connection with the implementation of RED II, but also the discussions about a further development as RED III were addressed.

In cooperation with the Wuppertal Institute, a short study on the role of biogas for a climate-neutral, 100 % renewable electricity system in 2035 was prepared in June 2022. In the study, which was also received by politicians, a thematic arc was drawn from the framework conditions for electricity generation from biogas to the status quo of various utilisation paths, the future role of biogas was derived and an assessment was made compared to biomethane and hydrogen.

Further knowledge transfer took place within the framework of events such as the Leipzig Biogas Expert Talk on or the Bad-Hersfeld Biomass Forum. Since January 2017, the DBFZ has also been advising the German government on an ongoing basis by sending staff directly to the Federal Ministry of Food and Agriculture (BMEL). The aim is to provide content-related support to Department 525 “Energy, Bioeconomy, Renewable Resources”.

Tab. 3: Selected activities and positions in 2022

Subject	Publication	Target groups
The role of biogas for a secure gas supply in Germany	05/2022	Politics, ministries, specialist public
Background paper: Greenhouse gas reduction quota for fuels	11/2022	Politics, ministries, specialist public
Discussion paper: Electricity price cap for biomass plants	11/2022	Politics, ministries, specialist public
Strategy paper on heating and cooling from biomass	12/2022	Politics, ministries, specialist public

Overview of the services

_ Scientific monitoring of legislative and administrative legislative procedures
_ Support of political strategy development in the field of bioenergy/bioeconomy
_ Monitoring and impact assessment
_ Analysis of climate, energy, environmental and research policy Framework conditions of the bioeconomy

→ **Further information:**
www.dbfz.de/en/services/policy-recommendations-and-advice
www.dbfz.de/en/press-media-library/more-publishments/statements-studies

Contact

Uta Schmieder
Phone: +49 (0)341 2434-556
E-mail: uta.schmieder@dbfz.de

Dr. Harry Schindler
Phone: +49 (0)341 2434-557
E-mail: harry.schindler@dbfz.de

9.4 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 as well as a wide range of science-based and technical services for this purpose. These go beyond the DBFZ's five main research focus areas and are aimed equally at politics and industry, associations, experts and committees. The content is processed in an interdisciplinary and cross-departmental manner so that the entire expertise of the DBFZ can be used comprehensively and efficiently for the following advisory and technical services.

Science based services

_ Market analyses and data provision
_ Technical, economic and ecological evaluation
_ Concept and process development and optimisation
_ Scientific support of R&D projects

→ **Further information:**
www.dbfz.de/en/services/science-based-services

Fig. 53: The preparation of studies, market analyses, assessments and background papers on the use of biomass, as well as policy advice, are key areas of the DBFZ's work

In addition, 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 the analytical laboratory. The technical-scientific services are aimed at plant and mechanical engineering, process-developing companies, plant operators and other R&D-driving companies and institutions.

Technical-scientific services

Biochemical Conversion Department:

_ Market analysis (based on the annual operator survey, among other things), forecasting and strategy consulting.
_ Scientific support for the development of plant components
_ Balancing and evaluation of processes with regard to efficiency, technical feasibility and economy
_ Test implementation (batch and continuous tests, microbial electrochemical tests)
_ Concept development for specific site conditions
_ Biogas process analysis
_ Determination of energy quantity (electricity, heat) and identification of optimisation potentials

Thermo-chemical Conversion Department:

_ Development, characterisation, pre-treatment and additivation of fuels
_ Combustion tests and comparative classification of combustion properties of furnaces and fuels
_ Separator measurement with regard to dust emissions
_ Investigation of catalyst technology
_ Catalyst investigations on the test bed and in practice with regard to efficiency and emissions
_ Catalyst screening in model and real gas
_ Catalyst characterisation by physisorption and chemisorption measurements
_ Catalyst synthesis
_ Innovative concept development for integrated renewable heat systems
_ Simulation of renewable heat solution options

Biorefineries Department:

Pilot plant trials to:
_ Hydrothermal carbonisation and liquefaction
_ Fixed bed and dust gasification
_ Synthesis gas process
_ Gas purification
_ Solid-liquid/liquid-liquid separation processes for biogenic recyclables from aqueous media

Analytical lab

In order to assess the potential uses of various biomasses, the DBFZ's analytical lab investigates the chemical composition and fuel properties of solid biofuels, biogas substrates, liquid fuels, by-products from agriculture and forestry and other biogenic residues and waste materials, as well as their conversion products, such as ashes, filter dusts, HTC coals and process waters. The analysis is carried out both according to the common standards and according to problem-oriented method development or adaptation.

Fig. 54: In the DBFZ laboratory, catalysts are produced to reduce emissions for biomass use

The following parameters can be determined with the available equipment: Pellet density, bulk density, particle size distribution, fines, abrasion resistance, calorific value, water content, volatile content, various carbon species, CHNS composition, ash content, element composition with regard to the 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. Fatty acid methyl esters (FAMEs) and phenols can be identified and quantified by means of GC analyses and the concentrations of sugars and furan derivatives can be determined by HPLC.

In the future, a method for the determination of volatile organic or polycyclic aromatic hydrocarbons (BTEX or PAH) by GC will be established. For this sample preparation, the use of an accelerated solvent extraction (ASE) is also planned, the methods of which are still under development.

→ **Further information:**
www.dbfz.de/en/services/technical-and-scientific-services

Fig. 55: Working in the DBFZ's Biorefineries Technical Centre

Research infrastructure

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

Department	Description	Contact person
Biochemical Conversion Department	Research Biogas Plant	Christian Krebs E-mail: christian.krebs@dbfz.de
	Biogas lab	Dr. Nils Engler E-mail: nils.engler@dbfz.de Katrin Strach E-mail: katrin.strach@dbfz.de
	Emission measurement	Lukas Knoll E-mail: lukas.knoll@dbfz.de
Thermo-chemical Conversion Department	Combustion lab	Michael Junold E-mail: michael.junold@dbfz.de
	Fuel conditioning lab	Dr. Claudia Kirsten E-mail: claudia.kirsten@dbfz.de
Biorefineries Department	Biorefineries Technical Centre	André Hermann E-mail: andre.herrmann@dbfz.de
Bioenergy Systems Department	Databases/Research data	Dr. Marco Selig E-mail: marco.selig@dbfz.de
	Assessment methods	Stefan Majer E-mail: stefan.majer@dbfz.de
	Potential analyses	Dr. Friederike Naegeli de Torres E-mail: friederike.naegeli@dbfz.de
All departments	Analytical lab	Dr. Jana Mühlenberg E-mail: jana.muehlenberg@dbfz.de Igor Adolf E-mail: igor.adolf@dbfz.de

Contact
Karen Deprie
Phone: +49 (0)341 2434-118
E-mail: karen.deprie@dbfz.de

10 Networks and research associations

The DBFZ is a member of numerous networks and research associations related to the topic of bioeconomy and bioenergy. Strong networking within the national and international research landscape and with industry is highly relevant in order to be able to solve the complex challenges of the energy and raw materials transition comprehensively and sustainably.

IEA Bioenergy

The IEA Bioenergy is an organisation founded in 1978 by the International Energy Agency (IEA) with the aim of improving international cooperation and the exchange of information on bioenergy research. Members of the IEA Bioenergy Working Groups (Tasks) are about 200 scientists from OECD and non-OECD countries who meet for three-year work programmes. The new triennium (2022–2024) of the IEA Bioenergy started at the beginning of the year and has already been successfully supported by DBFZ colleagues in 5 (of 11) working groups since 2009.

In June 2022, after a 4-year break, a (hybrid) meeting of the German participants of the IEA TCP Bioenergy (national team leaders of the 11 tasks and representatives of the FNR and BMEL) took place at the DBFZ. Another long-awaited physical meeting of Task 44 was held at the DBFZ at the end of September. Highlights of 2022 included a webinar with a presentation, two different open access articles in the journals *Energies* and *Renewable and Sustainable Energy Reviews*, three project reports and two workshops with DBFZ participation.

→ **Further information:**
www.dbfz.de/en/feature/iea-bioenergy

Fig. 56: Meeting of the German contributors to the IEA TCP Bioenergy at the DBFZ

EERA Bioenergy

Since the end of 2019, the DBFZ has been a full member of the European Energy Research Alliance (EERA), representing various aspects of bioenergy in five subgroups of the EERA Bioenergy programme. The overall objective of EERA Bioenergy is to develop into a robust research and development tool to assess the research challenges and priorities identified for bioenergy in the roadmap of the European Union's Strategic Energy Technology Plan (SET-Plan). By joining the European Energy Research Alliance, the DBFZ is even more closely involved in European bioenergy research. Among other things, the membership complements the EERA portfolio with the know-how of the "Smart Bioenergy" approach developed by the DBFZ.

Further activities take place in the following networks, clusters and associations, among others, predominantly with a focus on the exchange between science, industry and administration:

_ Renewable Energies Research Association – FVEE
_ BMWK Bioenergy Research Network/Scientific support project of the BMWK funding area "Biomass to Energy"
_ BioEconomy Cluster
_ Energy Cluster "Energy Saxony"
_ Leipzig Energy and Environment Network – NEU e. V.

Scientific cooperation with universities and research institutes

Scientific cooperation with universities and other research institutions is an essential component of the DBFZ's network activities. The focus is on implementing the defined research goals within the framework of applied research and development (R&D). For issues relating to the system assessment of bioenergy and the microbiological foundations of biochemical processes, there is a long-standing cooperation with the Helmholtz Centre for Environmental Research – UFZ. Here the DBFZ's Bioenergy Systems Department works closely with the UFZ's Bioenergy Department (head in both cases: Prof. Dr. Daniela Thrän). On the other hand, the Biochemical Conversion Department cooperates with the UFZ Department of Microbiology "MicAS". In the area of energy recovery from organic wastes and residues, there is a strategically oriented collaboration between the DBFZ research focus areas and the Rostock Chair of Waste and Material Flow Management (ASW), represented by the DBFZ's Scientific Managing Director, Prof. Dr. Michael Nelles. Together with the DBFZ, the University of Rostock has been hosting the Rostock Bioenergy Forum for several years.

The DBFZ's Deputy Scientific Managing Director, Prof. Dr. Daniela Thrän, has been closely associated with the University of Leipzig since the end of 2011 through the Bioenergy Systems Chair of the Faculty of Economics (IIRM – Institute for Infrastructure and Resource Management). In addition to the University of Leipzig, DBFZ scientists also teach at national universities such as TU Chemnitz, TU Dresden, Anhalt University of Applied Sciences, Merseburg University of Applied Sciences and HTWK Leipzig. Since the

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Fig. 57: Scientific exchange within the framework of the Rostock Bioenergy Forum 2022

2020/2021 winter semester, Prof. Dr. Ingo Hartmann (Head of the Catalytic Emission Control research focus area at the DBFZ) has also been representing the "Special Areas of Environmental Engineering III" module at the Leipzig University of Applied Sciences (HTWK) as an honorary professor of air pollution control technology. Scientific cooperation with non-European countries, especially China, has also been expanded in recent years. DBFZ scientists are active as visiting professors at Hefei University and other renowned universities in China.

11 Work in committees and boards

DBFZ scientists are represented as experts in a wide range of scientific bodies, advisory boards, working groups, networks and committees, and as (visiting) professors in Germany and abroad. The aim of the committee work is to achieve an intensive exchange with the scientific community.

Scientific committees/executive boards/ directorates (a selection)

Tab. 5: Selected committee activities of DBFZ staff (as of February 2023)

Committee	Function	Country	Since
Advisory Board of the Aviation Initiative for Renewable Energy in Germany e. V. (aireg)	Member of the Advisory Board	Germany	2011
Association for the Promotion of Exhaust After-treatment Technologies for Combustion Engines (FAD)	Member of the Advisory Board	Germany	2013
BioEconomy Cluster of BioEconomy e. V.	Member of the Board	Germany	2012
Bioeconomy Council – independent advisory body for the federal government	Co-Chair	Germany	2021
Biomass to Power and Heat	Member of the Programme Committee	Germany	2014
Chinese-German Biomass Research Centre (C-DBFZ) in cooperation with the Chinese Academy of Agricultural Engineering (CAAE), Beijing, and the C-DBFZ Anhui (University of Hefei)	Coordinator	China	2017
Circular Economy 4 Africa	Member of the Executive Board	Germany	2020
German Association for Waste Management e. V. (DGAW)	Member of the Executive Board	Germany	2014
Doctoral Colloquium BIOENERGY	Member of the Programme Advisory Board	Germany	2018
Doctoral Colloquium BIOENERGY	Member of the Scientific Advisory Boards	Germany	2018
Energy and Environment Foundation Leipzig	Member of the Board of Trustees	Germany	2013
Energy and Climate Protection Advisory Council of the Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture (SMEKUL)	Member	Germany	2021
European Biogas Association (EBA)	Member of the Scientific Advisory Board	Belgium	2019
Export initiative RETech “Recycling & Waste Management in Germany” of the German Federal Government (BMUV, BMWK, BMZ)	Member of the Board and Head of the China Working Group	Germany	2014
German Bioenergy Association (BBE)	Member of the Advisory Board	Germany	2012

Committee	Function	Country	Since
Helmholtz Centre for Environmental Research – UFZ	Member of the Scientific Advisory Board	Germany	2013
IEA Bioenergy, Task 37 “Energy from Biogas”	Member	International	2019
IEA Bioenergy, Task 39 “Biofuels to Decarbonize Transport”	German Management	International	2014
IEA Bioenergy, Task 40 “Deployment of biobased value chains”	Co-task leader, German Management	International	2019 2009
IEA Bioenergy, Task 44 “Flexible bioenergy and system integration”	Co-task leader, German Management	International	2019
IEA Bioenergy, Task 45 “Climate and sustainability effects of bioenergy within the broader bioeconomy”	German Management	International	2019
Institute for Non-Classical Chemistry e. V. at the University of Leipzig (INC)	Member of the Advisory Board	Germany	2013
International Solid Waste Association (ISWA)	Coordinator of Germany’s activities	Netherlands	2022
IUTA e. V. – Project Accompanying Committee: Multiphase anode materials for SOFC – Development of effective catalyst systems based on cerium oxide for the upgrading of biogas and biomethane (KatCe)	Member of the Advisory Board	Germany	2014
LaNDER3–Hochschule Zittau/Görlitz	Member of the Advisory Council	Germany	2017
Mecklenburg-Western Pomerania State Energy Council	Member and Head of the F&L Working Group	Germany	2012

DG AW RESSOURCEN NEU DENKEN.

Müll und Abfall Fachzeitschrift für Kreislauf- und Ressourcenwirtschaft

German RETech Partnership Recycling & Waste Management Made in Germany

Committee	Function	Country	Since
Mecklenburg-Western Pomerania Business and Science Strategy Council (including Board of Field of Action 1) “Hydrogen Technologies and Renewable Energies” of the RIS 2021-2026 of the State Government of Mecklenburg-Vorpommern	Member	Germany	2014
Ministry of Agriculture, Environment and Consumer Protection Mecklenburg-Western Pomerania	Member of the Scientific Advisory Board	Germany	2017
Renewable Energies Research Association (FVEE)	Member of the Board of Directors	Germany	2015
Renewable Energies Research Association (FVEE)	Expert on bioenergy (electricity, heat, fuels)	Germany	2016
Renewable Energies Research Association (FVEE) Annual Conference	Member of the scientific management	Germany	2022
Renewable Energies Research Association (FVEE) Annual Conference	Member of the Programme Committee	Germany	2016
Research Steering Committee of the Federal Ministry of Food and Agriculture (BMEL)	Member	Germany	2012
Scientific journal “Müll & Abfall”	Member of the Advisory Council	Germany	2007
Thuringian Ministry for the Environment, Energy and Nature Conservation	Member of the Scientific Advisory Board for Climate Protection and Climate Impact Adaptation	Germany	2019
verbio Biofuel and Technology “Straw in the Tank” Conferences	Member of the Scientific Advisory Board	Germany	2017

Professorships

Institution	Function	Land	Since
Faculty of Agricultural and Environmental Sciences, University of Rostock	Professorship	Germany	2006
Faculty of Energy and Environmental Science, Shenyang Aviation University	Visiting Professorship	China	2011
Faculty of Environmental and Biotechnology, Hefei University	Visiting Professorship	China	2002
Institute for Infrastructure and Resource Management, Chair of Bioenergy Systems, University of Leipzig	Professorship	Germany	2011
Institute for Renewable Energy, Petroleum University Beijing	Professorship	China	2014
Leipzig University of Applied Sciences (HTWK Leipzig)	Professorship	Germany	2020
National Centre of International Bioenergy Science and Technology Research (iBEST), Chinese Agricultural University (CAU)	Associate Professor	China	2018

Working groups

Committee	Function	Country	Since
Agru Interlaboratory Test, Board of Trustees for Technology and Building in Agriculture (KTBL)	Member	Germany	2018
Bioeconomy WG of the Structure-Related Commission on Technology Assessment and Design (Saxon Academy of Sciences in Leipzig)	Member	Germany	2020
BMDV Working Group 2 – Alternative Drives and Fuels for Sustainable Mobility	Member	Germany	2019
BMWK Bioenergy Research Network, WG ElectricityWG Heat	Member/Expert	Germany	2017
BMWK Bioenergy Research Network, Harmonisation of Methods	Management	Germany	2010
BMWK Bioenergy Research Network, Harmonisation of Methods	Member/Coordinator	Germany	2010
BMWK Dialogue Platform “Industrial Bioeconomy”, WG4 “Communication”	Member	Germany	2021
DECHEMA		Germany	
_ Expert Group “Industrial Use of Renewable Resources”	Member		2020
_ Expert Group “Measurement and Control in Biotechnology”	Member		2018
_ ProcessNet–Sustainable Production, Energy and Resources (SuPER), “Alternative Fuels and Combustibles”*	Member		2014
_ ProcessNet–Sustainable Production, Energy and Resources (SuPER), “Energy Process Engineering”*	Member		2015
EERA Bioenergy; Subprogramme		EU/Belgium	
1: Sustainable production of biomass	Member		2019
2: Thermochemical platform	Member		2019
3: Biochemical platform	Member		2019
4: Stationary bioenergy	Member		2019
5: Sustainability/Techno-economic analysis / Public acceptance	Member		2019
European Biofuels Technology Platform (ETIP Bioenergy)		EU/Belgium	2007
WG1 Biomass availability	Member		2008
WG4 Policy and Sustainability	Member		
German RETech Partnership “Recycling & Waste Management in Germany”	Member of the International Working Group (Emerging and Developing Countries)	Germany	2017
Project Group on Russia of the City of Leipzig	Member	Germany	2020
RHC–European Technology and Innovation Platform on Renewable Heating and Cooling		Belgium	
_ Horizontal Working Group: 100 % RE Individually Heated & Cooled Buildings	Member		2019
_ Horizontal Working Group: 100 % RE Cities	Member		2019
Taskforce Biomethane	Member	EU/Belgium	2022
WG Biogas of VGB PowerTech e. V.	Member	Germany	2019
WG Heat Market 2.0			
BMWK/PtJ Funding programme “Biomass to Energy”	Deputy WG Leader	Germany	2019
WG “Energy”, Board of Trustees for Technology and Building in Agriculture (KTBL)	Member	Germany	2019
WG on Substance-Specific Waste Treatment (ASA) e. V.	Member of the Advisory Board	Germany	2009
WG “Library concepts” of the BMEL departmental research institutions	Member	Germany	2016
WG “OpenAgrar” of the BMEL departmental research institutions	Member	Germany	2016
"WIR!” Innovation cluster Waste to Value	Member	Germany	2022

* ProcessNet is an initiative of Dechema and VDI-GVC

Fig. 58: Meeting of the IEA Task 44 “Flexible Bioenergy and System Integration” at the DBFZ (28 September 2022)

Networks/associations/platforms (a selection)

Committee	Function	Country	Since
BioEconomy e. V.	Member	Germany	2012
BioWEconomy of the European Commission	Member Core Group/Initiators	EU/Belgium	2020
BMDV National Platform “Future of Mobility”, WG2 – Alternative drives and fuels for sustainable mobility	Member	Germany	2019
Committee on the Sustainability of Biofuels and Bioliquids of the European Commission	Member	EU/Belgium	2017
DENA (German Energy Agency) Biogas partner – the platform for biogas feed-in	Member	Germany	2017
DFBEW German-French Office for the Energy Transition	Member	Germany/ France	2016
Energy Committee of the Leipzig Chamber of Industry and Commerce (IHK)	Member	Germany	2016
Energy Saxony e. V.	Member	Germany	2013
Förderverband Humus e. V. (FVH)	Member of the Scientific Advisory Board	Germany	2019
Network Energy and Environment e. V. (NEU e. V.) – Bioenergy Cluster	Member of the Advisory Board	Germany	2014
Network for Carbon Cycle Economy (NK2)	Member	Germany	2019
PREVENT Waste Alliance	Member	Germany	2020
Renewable Energies Research Association (FVEE), Hydrogen expert committee	Member	Germany	2020
Sustainable Development Solutions Network (SDSN) of the German Development Institute	Member of the Extended Steering Committee	Germany	2016

DIN/ISO – standard committees (a selection)

Committee	Function	Country	Since
Association of German Engineers e. V. (VDI)		Germany	
_ VDI 3670 “Flue gas cleaning – downstream dust abatement equipment for small combustion plants for solid fuels”	Chairman		2014
_ VDI 3670: Flue gas cleaning – downstream dust abatement equipment for small combustion plants for solid fuels”	Member		2014
_ VDI 4630 “Fermentation of organic substances – substrate characterisation, sampling, substance data collection, fermentation tests”	Member of the Policy Committee		2019
CEN–European Committee for Standardization TC 454 Algae and algae products	Chairman WG3 “Productivity”	Belgium	2015
German Institute for Standardisation e. V. (DIN)		Germany	
_ Working Committee “Requirements for liquid fuels” NA 062-06-32 AA	Member		2020
_ Working Committee “Liquefied gases, requirements and testing” NA 062-06-31 AA	Member		2021
_ Working Group “Dust separator testing” DIN 33999	Member		2012
_ Working Committee “Biogas” NA 032-03-08 AA	Member		2015
_ Working Committee “Pyrogenic carbon” NA 062-02-85 aa NA 062-02-85 AA	Chairman		2021
_ Working Committee “Biogenic solid fuels” NA 062-05-82 AA	Member		2019
International Organization for Standardization (ISO)		Switzerland	
_ ISO TC 238 Solid Biofuels WG1 “Terminology”	Convenor		2022
_ ISO TC 238 Solid Biofuels WG2 “Fuel specifications and classes”	Task leader		2020
_ ISO TC 238 Solid Biofuels WG7 “Safety of solid biofuels”	Member		2019
_ ISO/TC 238 Task Group 1 “Biochar”	Member		2021
_ ISO TC 255 Biogas WG1 “Terms, definitions and classification scheme for the production, conditioning and utilization of biogas”	Member		2015
VDI/DIN Commission on Air Pollution Control (KRdL)		Germany	
_ WG 3933 “Production of biomass carbonisates”	Member		2013
_ Committee for Basic Guidelines “Bioeconomy, biological transformation – terms, methods, definitions”	Contributor		2021
_ Guideline Preparation Committee VDI 3475 Sheet 8, “Emission Reduction; Digestate Treatment Plants”	Chair		2021
_ Guideline Preparation Committee VDI 3475 Sheet 9 “Emission Reduction; Manure Processing Plants”	Chair		2021

Contact
Dr. Elena H. Angelova
Phone: +49 (0)341 2434-553
E-mail: elena.angelova@dbfz.de

12 Structure and Organisation

An organisational structure of four research departments has been established at the DBFZ to handle the diverse research tasks. While the Departments of Biochemical Conversion, Thermo-Chemical Conversion and Biorefineries mainly work on applied research tasks in the field of bioenergy and bioeconomy, the Bioenergy Systems Department develops policy recommendations and advice, as well as potential analyses, acceptance studies, various scenarios for biomass use and database-based web applications. In cooperation with the Helmholtz Centre for Environmental Research (UFZ), two departments are also working on the topics of bioenergy (systems analysis) and microbiology of anaerobic systems (MicAS).

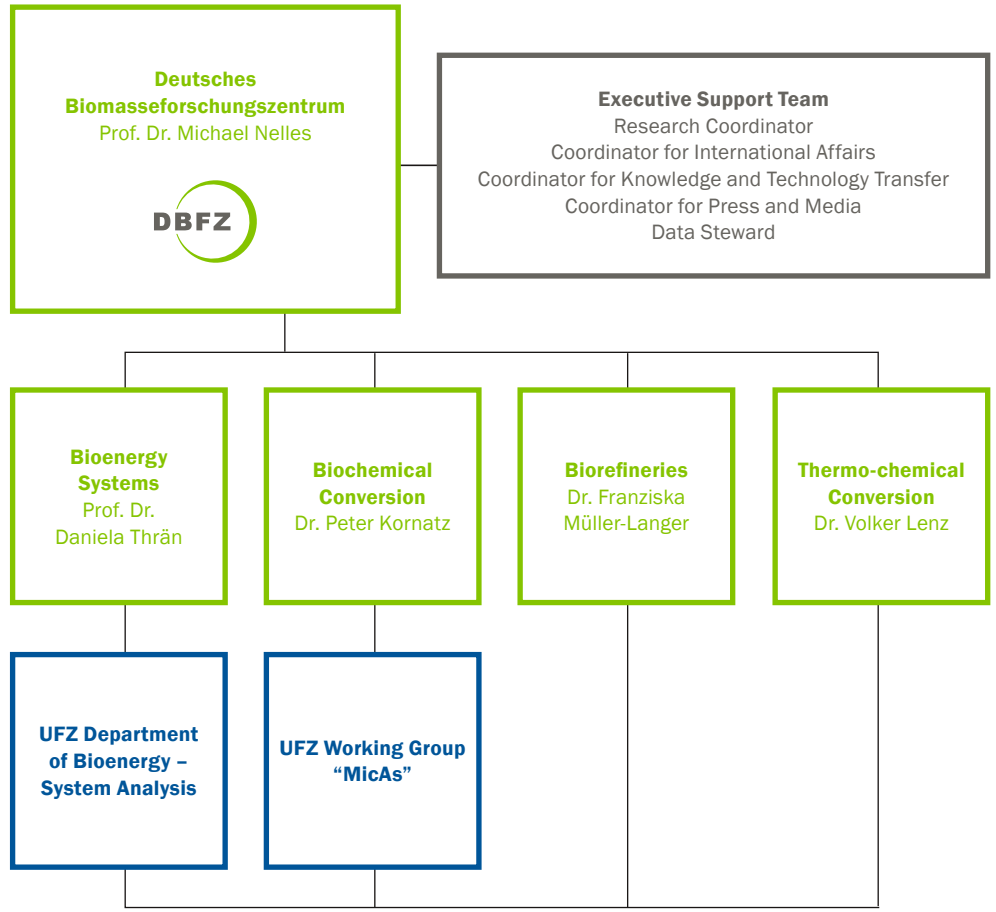

Fig. 59: The four research departments of the DBFZ, the executive support team and the two cooperation departments with the Helmholtz Centre for Environmental Research (UFZ)

12.1 Management, staff units and controlling bodies

Since its founding in 2008, the DBFZ has been managed equally by two managing directors, who have divided the tasks between the areas of research and administration. The DBFZ's most important scientific goals are defined in close cooperation with the heads of the five research focus areas and the executive support team, and are evaluated and further developed in regular strategy meetings together with the Supervisory Board and the Research Advisory Council.

The General Management

Scientific Management
Prof. Dr. mont. Michael Nelles
Phone: +49 (0)341 2434-112
E-mail: michael.nelles@dbfz.de

Administrative Management
Dr. Christoph Krukenkamp
Phone: +49 (0)341 2434-111
E-mail: christoph.krukenkamp@dbfz.de

Heads of the Research Focus Areas

Systemic Contribution of Biomass
Prof. Dr.-Ing. Daniela Thrän
Phone: +49 (0)341 2434-435
E-mail: daniela.thraen@dbfz.de

Anaerobic Processes
Dr. agr. Peter Kornatz
Phone: +49 (0)341 2434-716
E-mail: peter.kornatz@dbfz.de

Biobased Products and Fuels
Dr.-Ing. Franziska Müller-Langer
Phone: +49 (0)341 2434-423
E-mail: franziska.mueller-langer@dbfz.de

SmartBiomassHeat
Dr.-Ing. Volker Lenz
Phone: +49 (0)341 2434-450
E-mail: volker.lenz@dbfz.de

Catalytic Emission Control
Prof. Dr. rer. nat. Ingo Hartmann
Phone: +49 (0)341 2434-541
E-mail: ingo.hartmann@dbfz.de

Executive Support Team

Research Coordinator
Dr. rer. nat. Elena H. Angelova
Phone: +49 (0)341 2434-553
E-mail: elena.angelova@dbfz.de

Coordinator for International Knowlegde and Technology Transfer
Dr. rer. pol. Sven Schaller
Phone: +49 (0)341 2434-551
E-mail: sven.schaller@dbfz.de

Coordinator for Knowledge and Technology Transfer
Karen Deprie
Phone: +49 (0)341 2434-118
E-mail: karen.deprie@dbfz.de

Coordinator Press and Media
Paul Trainer
Phone: +49 (0)341 2434-437
E-mail: paul.trainer@dbfz.de

Data Steward
Dr. Torsten Thalheim
Phone: +49 (0)341 2434-136
E-mail: torsten.thalheim@dbfz.de

The Supervisory Board

The Supervisory Board, which is chaired by the Federal Ministry of Food and Agriculture (BMEL), makes the substantive and organisational decisions for the strategic and organisational development of the DBFZ. Other members are the Federal Ministry of Education and Research (BMBF), the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), the Federal Ministry for Digital and Transport (BMDV), Federal Ministry for Economic Affairs and Climate Action (BMWK) and the Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture (SMEKUL).

In 2022, the Supervisory Board met at the DBFZ on 20 June and 15 November.

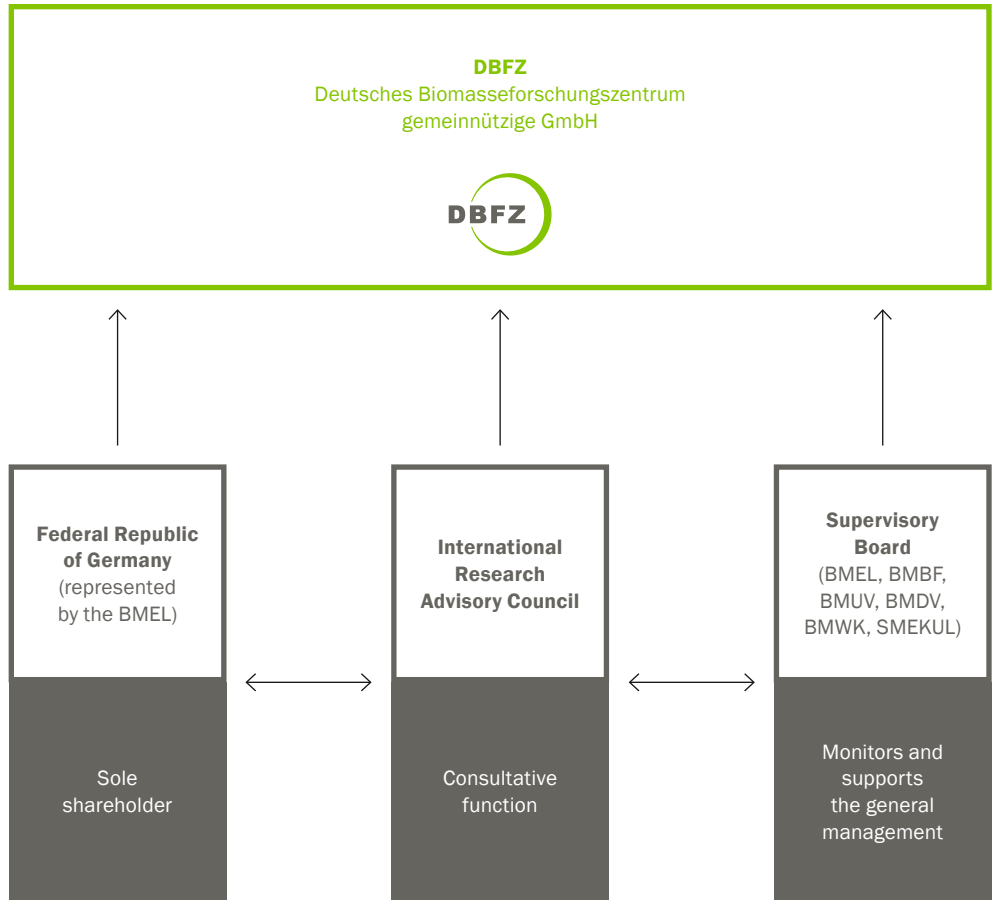

Fig. 60: The controlling bodies of the DBFZ (as of February 2023)

The representatives of the Supervisory Board (as of 1 February 2023)

Olaf Schäfer (Chairman)
MinDirig.
Head of Sub-Department "Climate protection, biodiversity, sustainability and bioeconomy"
Federal Ministry of Food and Agriculture

Dr. Christine Falken-Großer
MinDirig'in
Head of Unit IIA7 – Hydrogen Policy, National Hydrogen Strategy
Federal Ministry for Economic Affairs and Climate Action

Dr. Jürgen Jakobs
Ministerial Councillor
Division G I 4 Research Officer of the BMUV, Environmental Research, Science, Coordination Technical Supervision UBA
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

Dr. Kerstin Zimmermann
Senior Government Councillor
Department 7 (Provision for the Future), Department 722 "Energy, Hydrogen Technologies"
Federal Ministry of Education and Research

Daniel Gellner
Head of Department 3 "Agriculture"
Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture

Birgit Breitfuß-Renner
MinDirig'in
Subdepartment G1, Policy Issues and Strategies for Passenger and Freight Transport
Federal Ministry for Digital and Transport

Fig. 61: Meeting of the Research Advisory Board at the DBFZ (26 September 2022)

The Research Advisory Council

The Research Advisory Council, made up of nationally and internationally renowned bioenergy experts, has been advising the DBFZ on the direction of its diverse scientific activities since it was founded in 2008. The advice of the Advisory Council 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. The term of the current board is the period 2020–2023, after which there will be a replacement of the advisory board.

Representatives of the Research Advisory Board (as of 1 February 2023)

* newly appointed as of 1 January 2023
** newly appointed as of 1 July 2022

Altenburger*, Prof. Dr. Rolf
Helmholtz Centre for Environmental Research – UFZ | Leipzig (Germany)

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 (Deupty Chairman)
China Agricultural University (CAU) – National Center for International Research of BioEnergy Science and Technology | Bejing (China)

Dornack, Prof. Dr. Christina (Chairman)
Technical University Dresden – Institute of Waste Management and the Circular Economy | Dresden (Germany)

Hartmann, Dr. Hans
Technology and Support Centre (TFZ) at the Competence Centre for Renewable Resources | Straubing (Germany)

Kemfert, Prof. Dr. Claudia
German Institute for Economic Research (DIW) | Berlin (Germany)

Kothe**, Prof. Dr. Erika
Friedrich Schiller University Jena, Professorship for Microbial Communication | Jena (Germany)

Murphy, Prof. Dr. Jerry
University College Cork – Professorship of Civil Engineering | Cork (Irland)

Schenk, Prof. Dr. Joachim
Leipzig University of Applied Sciences, Chair of Environmental Engineering | 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)

12.2 Annual financial statement

The DBFZ was founded in 2008 as a limited liability company (GmbH) in its form as an institutional funding recipient in the BMEL's portfolio and is recognised as a non-profit organisation in accordance with Section 52, Paragraph 2, No. 1 of the German Fiscal Code (AO). The aim is to make flexible and transparent use of public research funding and to be able to carry out research and advisory work on behalf of third parties. The DBFZ is financed through institutional shortfall funding from the Federal Ministry of Food and Agriculture as well as through competitively acquired project grants, contract research and services. In 2022, the DBFZ was funded with 11 million euros by the BMEL. In addition, about 10.2 million euros in third-party funding was raised (see Figure 62). On the expenditure side, personnel costs were at the forefront with 14.2 million euros. Other expenditures included 8.4 million euros for material expenses and 1.6 million euros for investments.

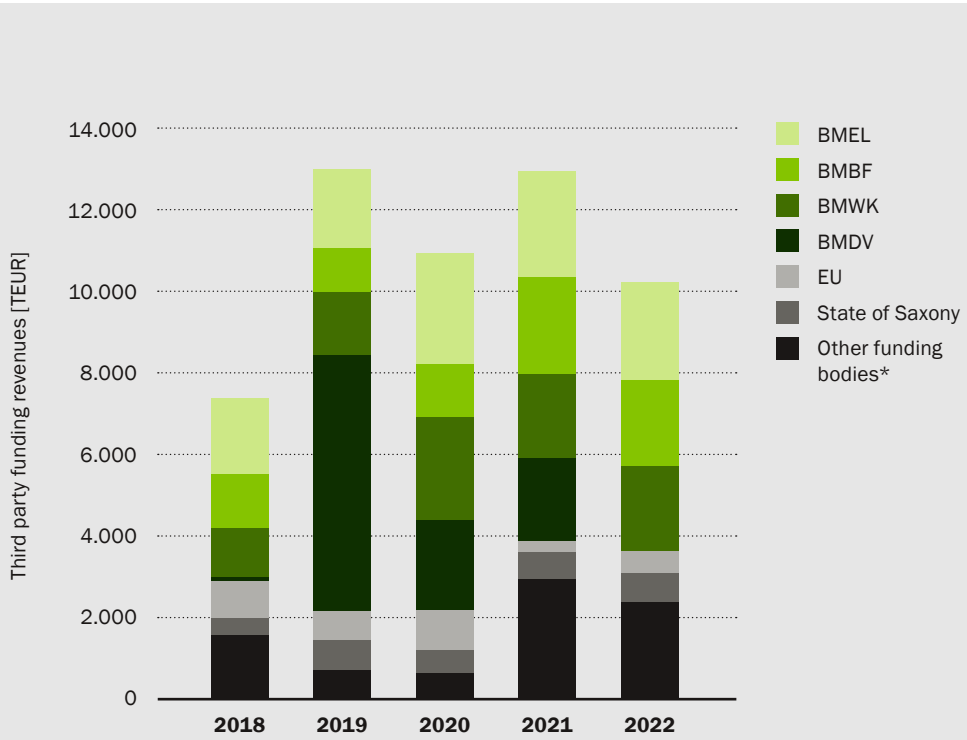

Fig. 62: Overview of third-party funding revenue from 2018–2022 (preliminary figures)
* Contract research and services from private and public clients

12.3 Personnel/Training

As of 31 December 2022, 263 people were employed at the DBFZ. Of these, 206 people (incl. executive support team) were employed in the scientific/technical area and 57 in the administration area (including the departments for Infrastructure and Property Management as well as IT). In 2022, a large number of work placements were also again supervised at the DBFZ. A total of 14 internships and student research projects as well as 38 bachelor's, master's and diploma topics were professionally supervised. In addition, a total of 27 guest researchers, foreign interns and scholarship holders worked at the DBFZ.

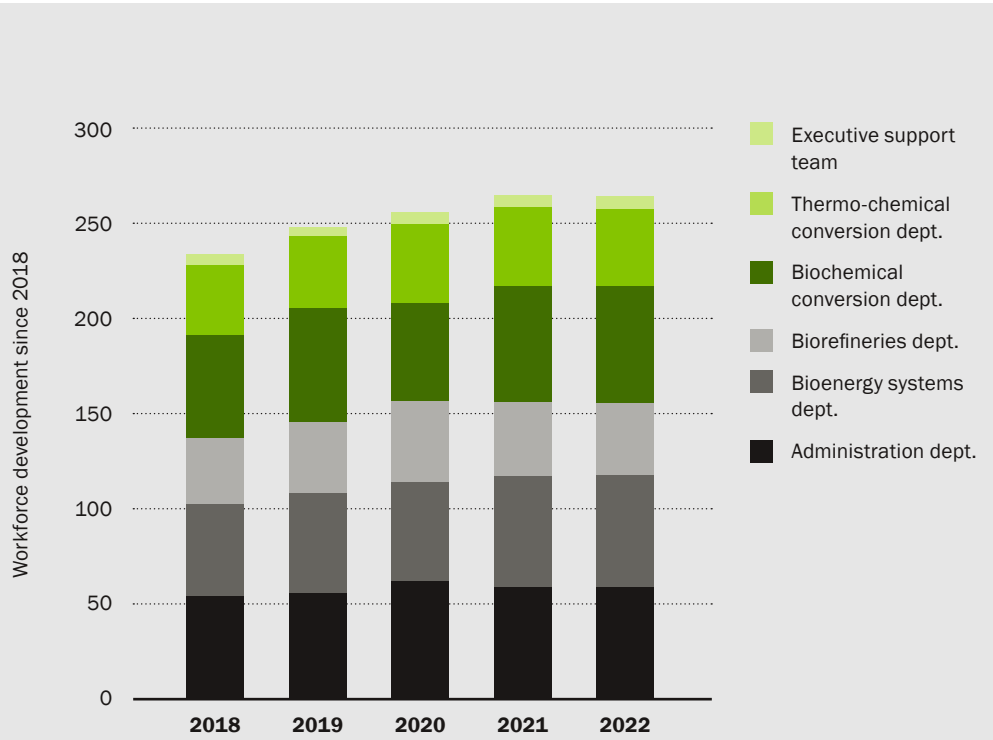

Fig. 63: Personnel development at the DBFZ (as of 31 December 2022)

Workforce by department

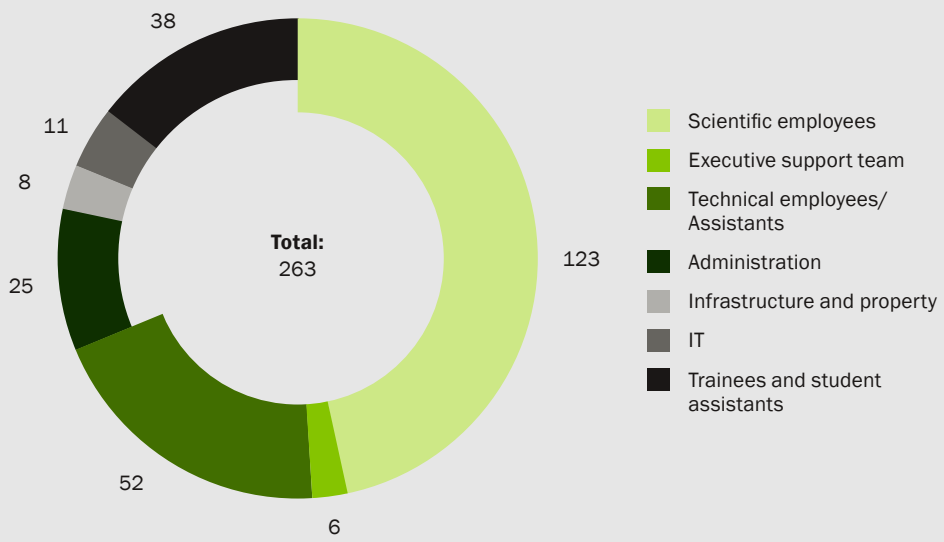

Fig. 64: Number of employees by area (as of 31 December 2022)

Supervised practical training and study project

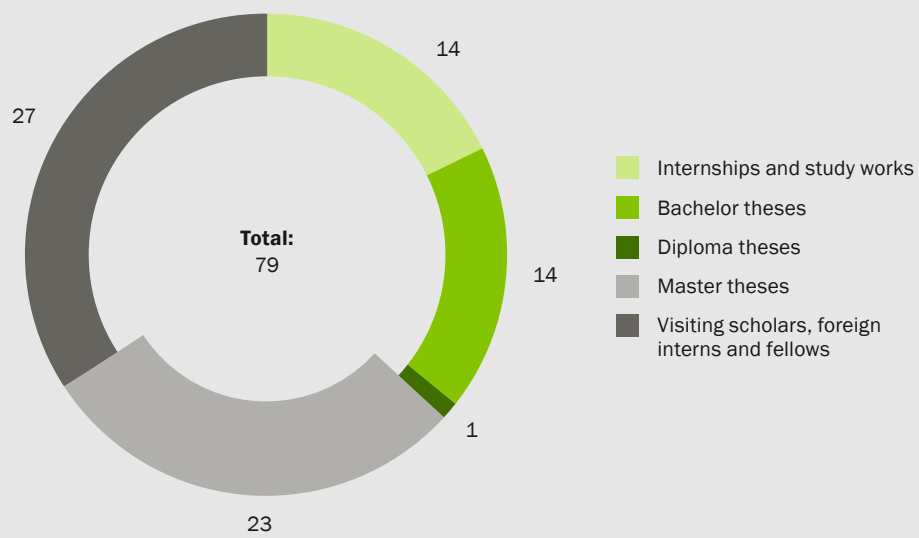

Fig. 65: Overview of work supervised at the DBFZ in 2022 (as of 31 December 2022)

Trainees at the DBFZ

The DBFZ has been a training company since it was founded in 2008. By the end of 2022, a total of 39 trainees, retrainees and students in dual study programmes had successfully completed their training. In 2022, there were 14 trainees in the occupations of “event manager”, “office management assistant”, “electronics technician for industrial engineering”, “chemical laboratory technician” and “mechatronics technician” (m/f/d). The DBFZ was the practical partner for six students from the Berufsakademie Sachsen (Saxony University of Cooperative Education) studying “Information Technology”, “Controlling” and “Laboratory and Process Engineering – Environmental, Chemical and Radiation Technology”.

“I have successfully completed my training and am pleased that I have been taken on by the DBFZ as an event manager.”

Nicole Wolf
Employee event management

→ **Further information:**
www.dbfz.de/en/career/professional-qualification

Fig. 66: Event manager Nicole Wolf

13 Appendix: Projects and Publications

Major projects and publications from 2022 are listed below to illustrate the current working areas of the DBFZ. The language of the title reflects the language of the project/publication.

Projects (a selection)

Federal Ministry of Food and Agriculture (BMEL)

A+BiOx – 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, Bundesministerium für Ernährung und Landwirtschaft, 01.01.2020–31.12.2022 (FKZ: 2819D0KA05)

AntbioHK – Auswirkungen des verstärkten Einsatzes von Geflügelexkrementen in BGA auf die Belastung der Gärreste mit Antibiotika, Bundesministerium für Ernährung und Landwirtschaft, 01.05.2022–30.11.2024 (FKZ: 2221WD002A)

BIO2HY – Wasserstoff aus Biomasse, Bundesministerium für Ernährung und Landwirtschaft, 01.04.2021–31.03.2022 (FKZ: 2221NR010A)

BioSim – Nachwuchsforschergruppe zur modellbasierten Zustandsüberwachung und Prozessführung an Biogasanlagen, Bundesministerium für Ernährung und Landwirtschaft, 01.11.2020–31.10.2023 (FKZ: 2219NR333)

DataStew – FDM: Data Steward + Data Architect + IT-Admin, Bundesministerium für Ernährung und Landwirtschaft, 01.01.2022–31.12.2024

Effektor – Kontinuierliche Überwachung der technischen Effizienz von Biogasanlagen, Bundesministerium für Ernährung und Landwirtschaft, 01.10.2019–30.06.2023 (FKZ: 22038018)

EmMinA – Emissionsminderung bei der Biogasaufbereitung, -verdichtung und -einspeisung. Teilvorhaben1: Quantifizierung und Minderung von Methanemissionen an Biogasaufbereitungsanlagen in der Praxis, Bundesministerium für Ernährung und Landwirtschaft, 01.09.2021–29.02.2024 (FKZ: 2220NR151A)

FlexiMod – Weiterentwicklung eines modellbasierten Prognosetools für die flexible Biogaserzeugung in großtechnischen Biogasanlagen, Bundesministerium für Ernährung und Landwirtschaft, 01.08.2020–31.07.2022 (FKZ: 2219NR313)

FNRUVV – Entwicklung und Praxisdemonstration der nächsten Generation an Biomasseverbrennungsanlagen: Emissionsminderungsstrategien zur umweltverträglichen Verbrennung (UVV) auf Basis von aktuellen Forschungsergebnissen “UVV – Umweltverträgliche Verbrennung”, Bundesministerium für Ernährung und Landwirtschaft, 01.04.2019–31.03.2022 (FKZ: 22038418)

GülleKOM – Kombiverfahren zur Gülleaufbereitung, Bundesministerium für Ernährung und Landwirtschaft, 01.11.2021–31.10.2024 (FKZ: 2220WD004)

HTCGas – Vergasung von HTC-Kohle, Bundesministerium für Ernährung und Landwirtschaft, 01.10.2021–30.11.2022

HypoBio – Entwicklung einer effizienten und emissionsarmen, kleinen Scheitholzfeuerung mittels kontinuierlicher Brennstoffzuführung, Bundesministerium für Ernährung und Landwirtschaft, 01.08.2020–31.12.2022 (FKZ: 2219NR273)

HYTORF2 – Herstellung und Bewertung von Torfersatzstoffen auf Basis der hydrothermalen Umwandlung aus biogenen Restoffen, Bundesministerium für Ernährung und Landwirtschaft, 01.11.2022–31.10.2025 (FKZ: 2221MT014A)

KIDA – Umsetzung der Maßnahme “KI- und Daten-Akzelerator”, Bundesministerium für Ernährung und Landwirtschaft, 01.03.2022–31.12.2025

KlimaBioHum – Klimaschutzorientierte Bioabfallverwertung in der Landwirtschaft, Bundesministerium für Ernährung und Landwirtschaft, 01.10.2018–31.12.2022 (FKZ: 281B303316)

MeBiKo – Metastudie Biokohle, Bundesministerium für Ernährung und Landwirtschaft, 18.7.2022–30.6.2023 (Inhouse)

MEMO – Methanemissionsmodell für offene Gärprodukt-/Güllelager, Bundesministerium für Ernährung und Landwirtschaft, 01.11.2021–31.10.2024 (FKZ: 2220WD003X)

Mini-WS – Emissionsarme kleinskalige Wirbelschichtfeuerungen zur Verbrennung von biogenen Reststoffen, Bundesministerium für Ernährung und Landwirtschaft, 01.06.2019–31.12.2022 (FKZ: 2219NR010)

MoBi_II – Aufbau eines systematischen Monitorings der Bioökonomie – Konsolidierungsphase; Teilvorhaben 2: Aktualisierung Reststoffmonitoring, Bundesministerium für Ernährung und Landwirtschaft, 01.11.2021–31.10.2024 (FKZ: 2221NR062B)

MoReBio – Modellregionen Bioökonomie im Mitteldeutschen Revier und im Lausitzer Revier, Bundesministerium für Ernährung und Landwirtschaft (Inhouse), 23.08.2019 -30.06.2022 (FKZ: 2219NR295)

Nährwert – Technisch unterstütztes Nährstoffmanagement im Verbund mit Biogasanlagen und Anbauregionen, Bundesministerium für Ernährung und Landwirtschaft, 01.07.2021–30.06.2024 (FKZ: 2220NR255A)

Nred – Verstärkte Nutzung stickstoffreicher landwirtschaftlicher Abfallstoffe durch biologische Stick-

stoffreduzierung, Bundesministerium für Ernährung und Landwirtschaft, 01.11.2019–31.10.2022 (FKZ: 22042118)

oNIReduce – Emissionsminderung durch angepasste Kesselsteuerung auf der Basis von Daten aus der kontinuierlichen online-NIR-Brennstoffanalyse, Bundesministerium für Ernährung und Landwirtschaft, 01.07.2019–31.12.2022 (FKZ: 22033218)

PaplGas2 – Biomethan & Torfersatzstoff aus Pappelholz – 2. Phase, Bundesministerium für Ernährung und Landwirtschaft, 01.12.2021–30.11.2023 (FKZ: 2221MT017A)

RestFlex – Eignung landwirtschaftlicher Reststoffe zur Flexibilisierung des Biogasprozesses, Bundesministerium für Ernährung und Landwirtschaft, 01.07.2019–30.06.2022 (FKZ: 22041818)

Sensomix – Entwicklung und Erprobung sensorbasierter Rührsysteme in Biogasanlagen zur Steigerung der Effizienz und Prozessstabilität bei einer lastflexiblen und bedarfsgerechten Biogasproduktion, Bundesministerium für Ernährung und Landwirtschaft, 01.05.2020–30.04.2023 (FKZ: 2219NR387)

SoBio – Szenarien einer optimalen energetischen Biomassenutzung bis 2030 (unter RED II) und bis 2050, Bundesministerium für Ernährung und Landwirtschaft, 01.12.2019–30.12.2022

TRANSBIO – Transferarbeitsgruppe für Bioenergieanlagen im zukünftigen Energiesystem, Bundesministerium für Ernährung und Landwirtschaft, 01.05.2021–31.10.2023 (FKZ: 2220NR128A)

Federal Ministry for Economic Affairs and Climate Action (BMWK)

AbfallE – Abfall-Ende-Eigenschaft unbehandelter holzartiger Reststoffe durch Aufbereitungsverfahren und Qualitätssicherung, Bundesministerium für Wirtschaft und Klimaschutz, 01.11.2019–31.12.2022 (FKZ: 03KB160A)

BeForce – Begleitforschung Bioenergie, Bundesministerium für Wirtschaft und Klimaschutz, 01.04.2021–31.03.2025 (FKZ: 03EI5400)

BEniVer – Verbundvorhaben: Begleitforschung Energiewende im Verkehr – Teilvorhaben: Ermittlung von Rohstoffpotentialen strombasierter Biokrafstoffoptionen und ökologische Bewertung von biokraftstoffbasierten Referenzszenarien, Bundesministerium für Wirtschaft und Klimaschutz, 01.06.2018–31.03.2023 (FKZ: 03EIV116C)

BioBeton – Biomassebasierte und nachhaltige Herstellung von Betonprodukten, Bundesministerium für Wirtschaft und Klimaschutz, 01.01.2021–30.06.2023 (FKZ: KK5045102KI0)

BioFeuSe – Neue Sensorik für die Prozessoptimierung von SCR-Verfahren und Partikelabscheidung an Biomasseverbrennungsanlagen, Bundesministerium für Wirtschaft und Klimaschutz, 01.07.2021–30.06.2024 (FKZ: 03EI54346A)

BioGrid – SmartBioGrid: Optionen zum Einsatz von fester Biomasse in dekarbonisierten Wärmenetzen, Bundesministerium für Wirtschaft und Klimaschutz, 01.09.2019–31.12.2022 (FKZ: 03KB159)

FLXsynErgy – Flexible und vollenergetische Nutzung biogener Rest- und Abfallstoffe: Faulungen und Biogasanlagen als Energieverbraucher, -speicher und -erzeuger, Bundesministerium für Wirtschaft und Klimaschutz, 01.10.2020–30.09.2023 (FKZ: 03EI5420C)

Greenfee – Green Feedstocks for a Sustainable Chemistry – Energiewende und Ressourceneffizienz im Kontext der dritten Feedstock-Transformation der chemischen Industrie (GreenFeed), Bundesministerium für Wirtschaft und Klimaschutz, 01.03.2022–28.02.2025 (FKZ: 03EI5003C)

H2Verg – Wasserstoff aus der Vergasung von Biomasse-Feldmessungen, Ermittlung von Anwendungsbedingungen und Prozessbewertung, Bundesministerium für Wirtschaft und Klimaschutz, 01.08.2022–31.07.2025 (FKZ: 03EI5445A)

HanfNRG – Untersuchungen der energetischen Nutzungsoptionen von Hanffaserreststoffen zur exemplarischen Einbindung in das Energiekonzept eines Verarbeitungsstandorts, Bundesministerium für Wirtschaft und Klimaschutz, 01.10.2022–30.09.2025 (FKZ: 03EI5448)

IdDiaPro – Identifikation von Methoden zur Diagnose, Prognose und Behebung von nicht-nominalen Betriebszuständen in biomassebasierten Versorgungsystemen, Bundesministerium für Wirtschaft und Klimaschutz, 01.03.2021–31.08.2022 (FKZ: 03EI5425A)

KeVergAv – Bestimmung von brennstoffspezifischen Kennzahlen zum Vergasungs- und Ascheverhalten, Bundesministerium für Wirtschaft und Klimaschutz, 01.02.2021–30.09.2023 (FKZ: 03EI5416)

KonditorGas – Industrielle Prozesswärmeerzeugung durch katalytische Konditionierung von biomassebasierten Synthesegasen; Teilvorhaben II: Katalytische Konditionierung von Synthesegasen aus der autothermen Vergasung, Bundesministerium für Wirtschaft und Klimaschutz, 01.09.2020–31.08.2023 (FKZ: 03EI5417B)

KoSaTZ – Behandlung und kombinierter Einsatz von Stroh- und Getreideausputzmischungen für eine Biogas-Technologiekette mit Zukunft, Bundesministerium für Wirtschaft und Klimaschutz, 01.01.2020–31.03.2022 (FKZ:03EI5403D)

MoBiFuels – Analyse und Beseitigung von Markthemmnissen von technisch modifizierten Bioenergieträgern, Bundesministerium für Wirtschaft und Klimaschutz, 01.11.2018–30.04.2023 (FKZ: 03KB136A)

NAMOSYN – Nachhaltige Mobilität durch synthetische Kraftstoffe, Bundesministerium für Wirtschaft und Klimaschutz (assoziierte Projektbeteiligung), 01.04.2019–31.03.2022

NormAKraft – Normung alternativer Kraftstoffe, Bundesministerium für Wirtschaft und Klimaschutz, 01.01.2020–31.12.2022 (FKZ: 03EIV241C)

OBEN – Öl-Ersatz Biomasse Heizung, Bundesministerium für Wirtschaft und Klimaschutz, 01.09.2019–31.08.2023 (FKZ: 03KB156)

PaCoSil – Verbrennung regionaler Reststoffe zur energetischen Nutzung von Biomasse mit gekoppelter Erzeugung von biogenem Silika für Feinstaubfilter-Prozesse, Bundesministerium für Wirtschaft und Klimaschutz, 01.07.2021–30.06.2024 (FKZ: 03EI5436A)

PlasmaCrack – Nachweis der Faulgassteigerung und Reduktion endokriner Substanzen, Bundesministerium für Wirtschaft und Klimaschutz, 01.01.2019–31.12.2022 (FKZ: 16KN041344)

Pülpegas – Verbundvorhaben Pülpegas – Entwicklung einer Pilotanlage zur Vollverwertung von Weizenpülpe und automatisierte Systemintegration in die industrielle Stärkeproduktion, Bundesministerium für Wirtschaft und Klimaschutz, 01.05.2022–31.10.2025

VergaFlex – Flexibilisierung der Biomassevergasung durch Nutzung des Vergaserkokses als Biomaterial für die stoffliche Verwertung und als Brennstoff für Kleinstvergaser <5 kWel, Bundesministerium für Wirtschaft und Klimaschutz, 01.10.2019–31.12.2022 (FKZ: 03KB157A)

Federal Ministry of Education and Research (BMBF)

BiogeniV – Starterprojekt BV-3 Basiskonzept Bioraffinerie: Analyse und Bewertung der Reststoffe zur Nutzung in einer Vergasungsanlage, Bundesministerium für Bildung und Forschung, 01.12.2022–30.11.2023 (FKZ: 03WIR4903C)

BioNET – Biomasse-basierte Negativ-Emissions-Technologien, Bundesministerium für Bildung und Forschung, 01.01.2022–31.12.2024 (FKZ: 01LS2107B)

BioZ-RP – Rahmenprojekt III: Life Cycle Assessment/ Nachhaltigkeitsbewertung & Wirksamkeitsanalyse, Bundesministerium für Bildung und Forschung, 01.09.2022–31.08.2025 (FKZ: 03WIR5303)

E-Boot II – Entwicklung einer Ernteprozesskette mit Erntetechnologie zur umweltschonenden Ernte von Wasserpflanzen, 01.08.2021–30.07.2024 (FKZ: 031B1095)

HemiFuel – Simultane Herstellung von 2-Methylfuran in Lignocellulose-Ethanolanlagen: Entwicklung eines hydrothermalen Verfahrensansatzes zur Verwertung der Hemicellulose, Bundesministerium für Bildung und Forschung, 01.10.2021–30.09.2022 (FKZ: 031B1190)

HTKkChem – Umwandlung von wasser- und kohlenhydratreichen Reststoffen der Biomasseverarbeitung in Chemikalien und Kraftstoffkomponenten durch hydrothermale Prozesse, Bundesministerium für Bildung und Forschung, 01.11.2018–31.12.2022 (FKZ: 031B0674A)

HTPyr1 – Vorstudie zur Entwicklung einer Hochtemperaturpyrolyseanlage zur Stromerzeugung und Nutzung von Reststoffen, Bundesministerium für Bildung und Forschung, 01.07.2021–31.12.2022 (FKZ: 03EI5433)

LabTogo – Aufbau von Forschungskapazitäten und Demonstration von Technologien zur Nutzung der Biomassepotenziale in Togo, Bundesministerium für Bildung und Forschung, 02.01.2020–31.12.2023

MycoForm – Formteile und Dämmstoffe auf Basis von organischen Reststoffen und Speisepilzen, Bundesministerium für Bildung und Forschung, 01.01.2023–31.12.2023 (FKZ: 031B1323)

VFAsense – Entwicklung eines praxistauglichen mikrobiellen elektrochemischen Sensormoduls zur hochaufgelösten Prozessüberwachung anaerober Bioprozesse, Bundesministerium für Bildung und Forschung, 01.10.2022–30.09.2023 (FKZ: 031B1312)

Wachstumskern abonoCARE – TP 2.V – Entwicklung der säure- und membranbasierten Phosphorabscheidung während der HTC sowie der energieeffizienten Trocknung von HTC-Kohle im Labormaßstab, Bundesministerium für Bildung und Forschung, 01.04.2019–31.12.2022 (FKZ: 03WKDI2E)

WaSSGhan – Hybrid Waste to energy as a sustainable Solution for Ghana, Bundesministerium für Bildung und Forschung, 01.01.2020–31.12.2023 (FKZ: 03SF0591D)

ZirkulierBar – Interkommunale Akzeptanz für nachhaltige Wertschöpfung aus sanitären Nebenstoffströmen Nährstoffwende – von linearer Sanitärspülung zur zirkulären Nährstoffverwertung, Bundesministerium für Bildung und Forschung, 01.07.2021–30.06.2024 (FKZ: 033L242H)

Federal Ministry for Digital and Transport (BMDV)

BIOKRAFT – Rohstoffverfügbarkeit von holzartiger Biomasse zur Produktion von Biokraftstoffen in DE und EU bis 2040, Bundesministerium für Digitales und Verkehr, 01.01.2020–31.12.2022
Pilot-SBG – Forschungs- und Demonstrationsvorhaben | Bioressourcen und Wasserstoff zu Methan als Kraftstoff – Konzeptionierung und Realisierung einer Anlage im Pilotmaßstab, Bundesministerium für Digitales und Verkehr, 01.11.2018–31.12.2022

EU projects

BIOFIT – Bioenergy retrofits for Europe's industry, European Commission, 01.10.2018–31.03.2022 (GA 817999)
BIOMETHAVERSE – Demonstrating and Connecting Production Innovations in the Biomethane Universe, European Commission, 01.10.2022–31.03.2027 (GA 101084200)
BRANCHES – Boosting Rural Bioeconomy Networks following multi-actor approaches, European Commission, 01.01.2021–31.12.2023 (GA 101000375)
CAFIPLA – Pretreatment of organic waste for application of the carboxylic acid and fiber platform, European Commission, 01.06.2020–31.05.2023 (GA 887115)
CARINA – CARinata and CamelINA boosting the sustainable diversification in agricultural production systems, European Commission, 01.11.2022–31.10. 2026 (GA 101081839)
GreenMeUp – GREEN bioMEthane market UPtake, European Commission, 01.08.2022–31.07.2025 (GA 101075676)
MUSIC – Market Uptake Support for Intermediate Bioenergy Carriers, European Commission, 01.09.2019–28.02.2023 (GA 857806)
SEMPRE-BIO – SEcuring doMestic PRoduction of cost-Effective BIOmethane, European Commission, 01.10.2022–30.04.2026 (GA 101084297)
SUSTRACK – Supporting the identification of policy priorities and recommendations for designing a sustainable track towards circular bio-based systems, European Commission, 01.11.2022–31.10.2025 (GA 101081823)

Services/Contract Research

AGEEstat – Wissenschaftliche Analysen zu ausgewählten Aspekten der Statistik erneuerbarer Energien und zur Unterstützung der Arbeitsgruppe Erneuerbare Energien Statistik, Marktprojekt, 01.04.2019–15.10.2024
Balance – Silierversuche und Batchtests mit Pappelholzhäcksel, Marktprojekt, 01.12.2021–30.06.2022
BioEL – Biomassepotenziale für eine nachhaltige Energieversorgung der Stadt Leipzig, Marktprojekt, 19.09.2022–31.12.2022 (FKZ: 4700110424-65)
BioH2BW – Kurzstudie zur Wasserstoffherstellung aus Biomasse in Baden-Württemberg, Marktprojekt, 18.04.2022–31.07.2022
Biolube – Biobasierte und biologisch abbaubare Hochleistungsschmierstoffe auf Basis von Insektenfett, Marktprojekt, 01.05.2021–30.04.2024 (FKZ: 031B1111B)
BLAUEAb1 – Unterstützung bei der Erarbeitung von Vergabekriterien für Staubabscheider für den Blauen Engel, Marktprojekt, 01.12.2020–31.12.2022
CoFire3 – Begutachtung der Biowärmebereitstellung der Wärme Hamburg GmbH bis einschließlich 2023, Marktprojekt, 01.01.2020–29.12.2023 (FKZ: B25-4503965126)
EEGMon – Dienstleistungsauftrag: "Vorbereitung und Begleitung bei der Erstellung eines Erfahrungsberichtes gemäß § 97 Erneuerbare-Energien-Gesetz (EEG 2017) zum spartenspezifischen Vorhaben "Stromerzeugung aus Biomasse sowie Klär-, Deponie- und Grubengas", Bundesministerium für Wirtschaft und Klimaschutz, 06.08.2020–31.08.2023
EUProTK1 – Demonstration of integrated cross-sectoral management to decarbonise energy communities via optimized utilisation of local sustainable resources, Marktprojekt, 01.02.2022–30.04.2022
Grundi – Literaturstudie zu Speicherfeuerstätten, Marktprojekt, 01.02.2022–31.08.2022
H2India – Einordnung der Wasserstofferzeugung aus Biomasse in Indien, Gesellschaft für internationale Zusammenarbeit, 01.08.2022–31.01.2023
H2Mech – Machbarkeitsstudie zur biobasierten Wasserstoffherstellung – Abfallwirtschaftszentrum Mechernich, Marktprojekt, 01.10.2021–31.10.2022
IEA T37 – IEA Energy from Biogas, Marktprojekt, 20.09.2016–31.12.2024
IEA T39 – Lessons learned biofuels (Intertask project with T40, T45), Marktprojekt, 01.07.2020–31.03.2023
IEA T40 – IEA Bioenergy Task 40 Deployment of biobased value chains 2019–2021, Marktprojekt, 01.01.2019–31.03.2022
IEA T40 – IEA Bioenergy Task 40 Deployment of biobased value chains 2022–2024, Marktprojekt, 01.01.2022–31.03.2025
IEA T44 – IEA Bioenergy Task 44 Flexible Bioenergy and System Integration 2022–2024, Marktprojekt, 01.01.2022–31.03.2025

IEA T45 – Compliance and verification in sustainability certification schemes for forestry biomass, Marktprojekt, 01.01.2019–31.12.2022
IEA T45 – A guide for the confused, Marktprojekt, 01.01.2019–31.03.2022
K4Klima – Kompost4Klima – Grüngutverwertung zur kombinierten Bereitstellung biogener Wärme und Kompost, Marktprojekt, 01.07.2021–31.12.2022
KFA13.0 – Voruntersuchungen zur Herstellung und Verbrennung von Bagassepellets in einer Kleinfeuerungsanlage, Marktprojekt, 20.10.2022–01.02.2023
KoGerste – Kontinuierlicher Gärtest Gerstenfaser-Kuchen, Marktprojekt, 01.08.2021–22.03.2022
KontiGSK – Kontinuierlicher Gärtest von Gerstenspelze und Gerstenkleie, Marktprojekt, 01.06.2022–31.12.2022
KS_BFKES – Kurzstudie zur Rolle von Biogas für ein klimaneutrales, 100 % erneuerbares Stromsystem 2035, Marktprojekt, 25.04.2022–01.07.2022
OMHeika – Prüfung eines elektrisch heizbaren Katalysators an einem Kaminofen, Marktprojekt, 01.10.2022–31.12.2022
Strohpapier – Substitution von Altpapier durch Getreidestroh und Spelzen, Marktprojekt, 05.11.2020–31.12.2022
SUVALIG – Bioraffineriekonzept Vietnam, Marktprojekt, 11.11.2019–31.07.2022 (FKZ: 5610)
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VCIPOT – Biomassepotenziale für die Chemieindustrie, Marktprojekt, 01.09.2021–31.03.2022
WEPart – Untersuchung der Wirkung bestehender primärer und sekundärer Emissionsminderungstechniken an Feuerungsanlagen zur Partikelanzahlminderung abhängig von Brennstoff und Feuerungstechnik, Marktprojekt, 01.03.2022–31.07.2024 (FKZ: 3721533040)

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Contact:
DBFZ Deutsches Biomasseforschungszentrum
gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig
Phone: +49 (0)341 2434-112
E-mail: info@dbfz.de

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DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH
Torgauer Straße 116
04347 Leipzig
Phone: +49 (0)341 2434 112
E mail: info@dbfz.de

www.dbfz.de/en

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