



Annual Report 2013

DBFZ



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Dear Reader,



Figure 1: The Management of the DBFZ

for the sake of sustainable development, Germany's energy supply must be fully switched to renewables over the coming decades, and supplies of organic primary materials to industry must over the long term be shifted from petro- to bio-based materials. A key to the successful reversal of energy policy and implementation of bioeconomy strategy in Germany is the integrated cascaded usage of biomass as base material and as an energy source. Essential factors in attaining that goal are improvements in energy efficiency through interlinked value chains and fulfillment of sustainability criteria.

Against the background of these complex challenges, we work with our interdisciplinary team to optimise the use of biomass for energy all along the value chain. Our goal is to integrate bioenergy into the current and future energy and bioeconomy system in the most efficient, environmentally friendly way possible, backing the related development with scientific research.

Since its founding in 2008, our organisation has undergone rapid growth, and now has more than 220 highly skilled and committed staff (approximately 160 full-time posts). In the few years of its existence, the DBFZ has established itself on a national level as a multi-disciplinary federal research establishment for the utilisation of biomass as an energy source, and has also built up a high reputation internationally, including within the EU, in Eastern Europe and in China. Its laboratory instrumentation and technical plant is also state of the art. This provides a vital foundation for the leading-edge applied research conducted by the DBFZ.

Following a very rapid development phase, in 2013 the DBFZ was evaluated by the German Council of Science and Humanities (Wissenschaftsrat). The evaluation report will be published in Summer 2014, and will form a key basis for the ongoing scientific development of the DBFZ. We would like to take this opportunity to thank the members of the DBFZ's Research Advisory Council most sincerely for their outstanding voluntary contributions over the last five years. Their great efforts and commitment have played a major role in the advancement of the DBFZ.

We hope you find our latest annual report interesting and entertaining, and we look forward to meet you in Leipzig at the next opportunity!

Michael Nelles

A handwritten signature in blue ink, appearing to read 'M. Nelles'.

(Scientific Managing Director)

Daniel Mayer

A handwritten signature in blue ink, appearing to read 'D. Mayer'.

(Administrative Managing Director)

Leipzig, February 2014

Our mission

Transforming existing energy systems to renewables is one of the greatest challenge of recent decades. Biomass is playing a key role in this shift. It accounts for over eight percent of the current renewables mix – outstripping hydro, wind, photovoltaic, solar and geothermal energy. However, there remain many challenges and questions regarding the practical integration of biomass into the existing energy system. How can energy efficiency be improved? How can competing usage conflicts be circumvented? Or emissions into soil, water and the air be avoided? These and other questions are expertly and independently investigated and answered by the DBFZ.

Our mission is to develop technical solutions and devise wide-ranging concepts for the economically, ecologically and socially sustainable use of biomass as an energy source based on applied leading-edge research. We also investigate and predict potential areas of conflict between the various goals associated with the development of bioenergy, setting forth plans as to how such conflicts can be avoided and eliminated.

In 2013 the DBFZ worked on more than 100 research projects relating to the use of biomass as an energy source. Research topics covered the full spectrum of our organisation's remit, including pollution control in small-scale biomass furnaces; flexible design of biogas plants; analysis of studies on biomass potential in Africa; the production and assessment of torrefied solid fuels (SECTOR); biogenic fuels for aviation; and the use of municipal green-cut and compost wastes as an energy source based on hydrothermal carbonisation (HTC). You will find selected reference projects and an overview of the projects carried out in 2013 at the end of this report.

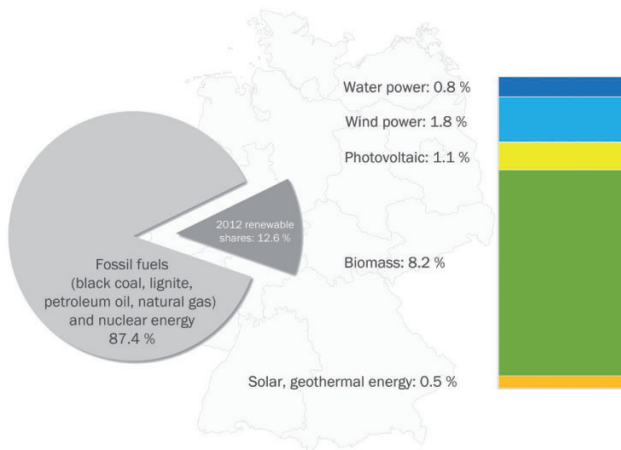


Figure 2: Percentage of total final energy consumption generated from renewables in 2012
(Source: Renewable energy in figures, BMU 2012 / Own presentation)



Our many research projects and the associated developments of new processes, techniques and concepts are carried out in close cooperation with our partners in business, the science community, professional and trade bodies as well as non-governmental organisations (NGOs) based on jointly procured national and international grant funding. We also maintain active close links with researchers in the agricultural, forestry and environmental sectors. Cooperation links in those fields include with the Research Section of the German Federal Ministry of Food and Agriculture (BMEL); large-scale extramural research projects, in particular with the Helmholtz Centre for Environmental Research (UFZ); state research establishments; selected universities; as well as German, European and other international biomass research institutes.

Our scientific work is targeted at all parties in the business, scientific and political spheres with an interest in bioenergy. In addition to the BMEL, they include other federal and state ministries, as well as national and international government agencies and non-governmental organisations, particularly in the energy and agriculture and forestry sectors. Our work also seeks to benefit linked industrial sectors with a direct and indirect interest in obtaining energy from biomass. The DBFZ in its role as a politically independent research institute provides expert advice to those target groups in relation to the utilisation of bioenergy on both a national and international scale. To that end, DBFZ scientists function as expert members on numerous national and international boards and committees.

The DBFZ seeks to actively shape knowledge in relation to the possibilities and prospects for the use of biomass as an energy source in general terms. It also aims to safeguard the leading position enjoyed by Germany in the sector for the long term.



Figure 3: The main building of the DBFZ

The DBFZ in profile

The DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH (German Biomass Research Centre; DBFZ for short) was established in Berlin on February 28, 2008 with the aim to investigate and illuminate the complex issues relating to the supply and use of bioenergy. Its mission, ownership and decision-making structures, legal form, financing and trend in workforce development are set out briefly in the following.

Mission

The DBFZ was established by the former German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) with the aim of establishing a central scientific research institution covering all the fields relevant to bioenergy, to bring together the findings of the highly diverse German research community in the sector. The scientific mission of the DBFZ is to support the efficient integration of biomass as a valuable resource for sustainable energy supply based on wide-ranging applied research. The mission incorporates technical, ecological, economic, social policy and energy business aspects all along the process chain, from production, through supply, to use. The DBFZ drives and supports the development of new processes, methodologies and concepts in close cooperation with industrial partners. It also maintains close links with public-sector research bodies in Germany in the agricultural, forestry and environmental sectors, as well as with European and global institutions. Working from this broad research base, the DBFZ is also tasked to devise scientifically sound decision-making aids for government policy-makers.

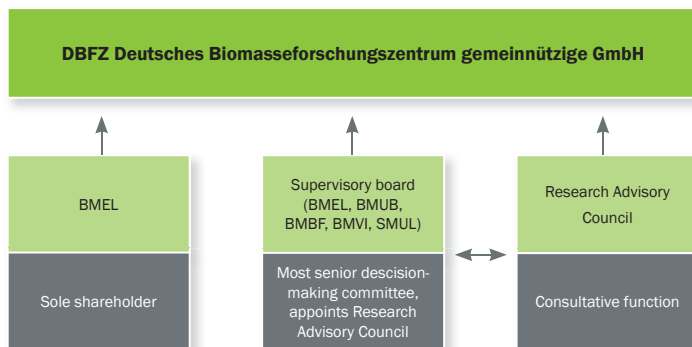


Figure 4: The decision-making structure of the DBFZ

Ownership and decision-making structure

The German Federal Ministry of Food and Agriculture (BMEL)* is the sole shareholder in the DBFZ. The key policy and organisational decisions dictating the development of the DBFZ are made by its Supervisory Board. Meeting twice a year, and chaired by the BMEL, it also comprises representatives from the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)**, the Federal Ministry of Transport and Digital Infrastructure (BMVI)***, the Federal Ministry of Education and Research (BMBF), and the Ministry of the Environment and Agriculture of the Free State of Saxony (SMUL) (Figure 4). The Research Advisory Council provides advice on the scientific work of the DBFZ. The Research Advisory Council comprises bioenergy scientists of national and international renown. The members of the Research Advisory Council are appointed by the Supervisory Board.

* Formerly German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) (ministerial designation changed since the 18th legislative period 2013-2017)

** Formerly Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (ministerial designation changed since the 18th legislative period 2013-2017)

*** Formerly German Federal Ministry of Transport, Building and Urban Development (BMVBS) (ministerial designation changed since the 18th legislative period 2013-2017)



Figure 5: The DBFZ is advised on strategy matters by a panel of leading bioenergy experts

Supervisory Board (as at 31 December, 2013)

Supervisory Board members:

Bernt Farcke (Chairman)

Head of Directorate 52 „Sustainability and Renewable Resources“,
Federal Ministry of Food and Agriculture (BMEL)

Berthold Goeke (Deputy Chairman)

Deputy Director General, Climate Policy Department,
Federal Ministry for the Environment, Nature Conservation, Building and
Nuclear Safety (BMUB)

Anita Domschke

Subdepartment head „Agriculture and Forestry“,
Saxon State Ministry of the Environment and Agriculture (SMUL)

Dirk Inger

Director Climate Change, Energy and Environmental Policy, Electric Vehicles
Federal Ministry of Transport and Digital Infrastructure (BMVI)

Karl Wollin

Head of section „System Earth“,
Federal Ministry of Education and Research (BMBF)

Research Advisory Council

The Research Advisory Council advises the DBFZ on its scientific activities. This ensures that the institutionally funded research carried out by the DBFZ is scientifically sound and of maximum relevance to the future use of bioenergy as part of the energy system.



Figure 6: 5th Meeting of the
Research Advisory Council
(22nd October 2013)

Research Advisory Council Members (as at 31 December, 2013)**Dr. Ausilio Bauen**

Imperial College London
London, Great Britain

Prof. Dr. Albrecht Bemmam

Institute of Forestry and Forest Products,
of Eastern Europe,
Dresden University of Technology
Dresden, Germany

Prof. Dr. Otto Carlowitz

Clausthaler Umwelttechnik-Institut GmbH
- CUTEC-Institut GmbH
Clausthal-Zellerfeld, Germany

Prof. Dr. David Chiaramonti (Chairman)

Research Centre for Renewable Energies
(RE-CORD / CREAR),
University of Florence
Florence, Italy

Prof. Dr. Olaf Christen

Martin-Luther-University Halle-Wittenberg
Halle (Saale), Germany

Prof. Dr. Eckhardt Dinjus

Karlsruhe Institute of Technology Campus
Nord Institute of Catalysis Research and
Technology
Eggenstein-Leopoldshafen, Germany

Prof. Dr. Mikhail Fedorov

St. Petersburg State Polytechnical University
(SPbSPU)
St. Petersburg, Russia

Dr. Hans Hartmann

Technology and Support Centre (TFZ)
within the Centre of Excellence for
Renewable Resources
Straubing, Germany

Prof. Dr. Martin Kranert

Institute for Sanitary Engineering,
Water Quality and Waste Management,
University of Stuttgart
Stuttgart, Germany

Dr. Marc Londo

ECN Petten
Petten, Netherlands

Dr. José Moreira

Instituto de Eletrotécnica e Energia (IEE/USP)
São Paulo, Brazil

Prof. Dr. Bernd Meyer

IEC – Department of Energy Process
Engineering, and chemical Engineering,
Technical University BA Freiberg
Freiberg, Germany

Prof. Dr. Miroslav Miller

Wroclaw Research Centre EIT+
Wroclaw, Poland

Dr. Ralph Overend

Journal „Biomass & Bioenergy“
Ottawa, Canada

Prof. Dr. Georg Schaub

Karlsruhe Institute of Technology (KIT),
Engler-Bunte-Institute (EBI)
Karlsruhe, Germany

Prof. Dr. David Serrano

IMDEA Energy Institute
Madrid, Spain

Prof. Dr. Georg Teutsch

Helmholtz-Centre for Environmental
Research - UFZ
Leipzig, Germany

Legal form and financing

The DBFZ was established with the legal form of a „GmbH“ (limited liability company) and as an accredited non-profit organisation. This provides it with the necessary flexibility and transparency to obtain public research funding and also to carry out research and consulting operations on behalf of third parties. The DBFZ is financed by institutional funding from the BMEL as well as by competitively procured project grants and revenue from acquired research contracts.

The BMEL provided the DBFZ with funding of approximately € 6.5 million in 2013, of which some € 1.1 million was allotted to capital investment. Despite the uncertainty regarding bioenergy policy, more than € 5 million in third-party funding was again procured in 2013. The value of projects handled stabilised around 2012 levels at € 5.7 million. The proportion of total revenue from industrial contract research and services was likewise stable at around € 1.2 million. The project revenues of the BMEL stem from research programmes of the Fachagentur Nachwachsende Rohstoffe e.V. (Regrowable Resources Agency; FNR) and the Bundesanstalt für Landwirtschaft und Ernährung (Federal Office for Agriculture and Food; BLE).

The principal expenditure of the DBFZ is its personnel cost, which accounts for some 62 % of total expenditure, followed by operating expenses (21 %) and capital investments (17 %). Following the wide range of measures funded by the economic stimulus package in 2011 and 2012, the level of required capital investment in 2013 was much lower, and related primarily to research equipment and renovation of buildings.

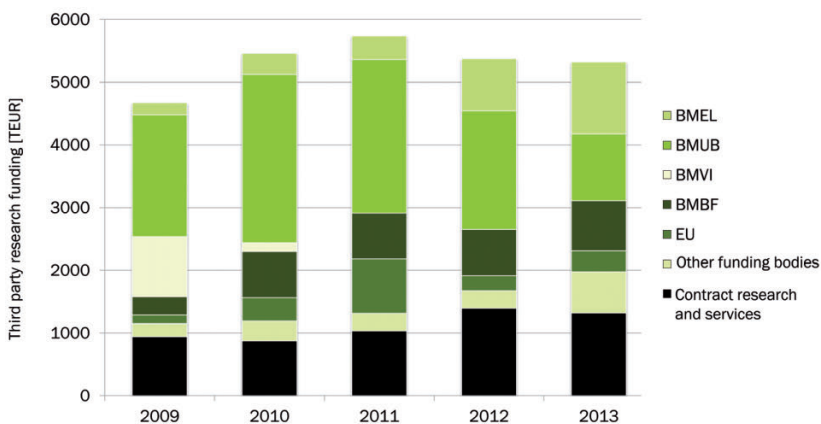


Figure 7: Schedule of sources of funds from 2009 to 2013

Workforce trend

The DBFZ's workforce grew once again in 2013, to 222 people (as of 31st December 2013). Of that total – including the newly established executive support team – 179 work in the scientific field and 43 are administrative staff. Figure 8 shows the trend in workforce development in the four research departments and in administrative functions since the founding of the DBFZ in 2008.

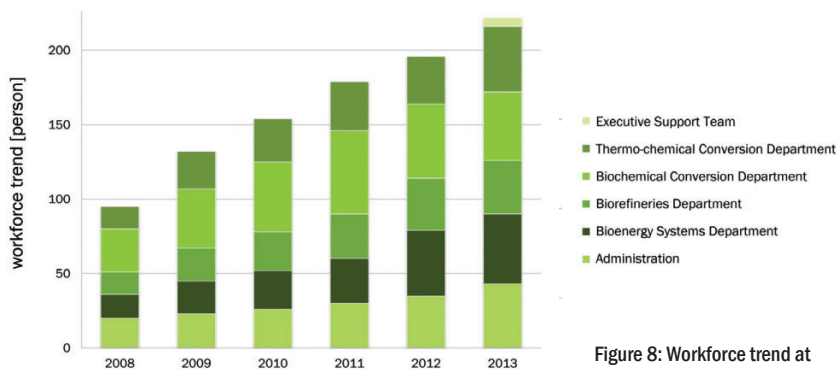


Figure 8: Workforce trend at the DBFZ

In 2013 the DBFZ supervised 45 practical and study projects as well as a total of 57 bachelors, masters degree and diploma dissertations. 32 guest scientists, non-German practical trainees and grant-funded students also worked at the DBFZ, representing a substantial increase over the 2012 figure (17). The general workforce growth trend seen since 2008 was sustained in 2013, in this area as in others.

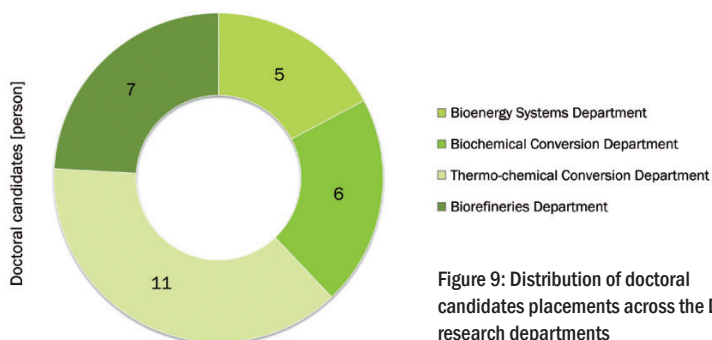


Figure 9: Distribution of doctoral candidates placements across the DBFZ research departments

In 2012 the DBFZ launched an in-house doctoral programme. As of 14th January 2014, a total of 29 people were working on their doctorates within the organisation. Of that total, nine members of staff began work on new doctoral theses at the DBFZ in 2013. Figure 9 shows the number of doctoral candidates in the four research departments of the DBFZ.

Representation on scientific bodies, advisory boards and committees

The DBFZ seeks to maintain intensive knowledge transfer with other institutions and the scientific community at large. This is in keeping with its objectives of conducting applied research and utilising its results for practical benefit. DBFZ scientists are members of a wide variety of scientific bodies, advisory boards, working groups, networks and committees.

Scientific advisory boards (selection):

- aireg: Aviation Initiative for Renewable Energy in Germany e. V.
- Bioeconomy Council of the Federal Republic of Germany
- Biomass Use Competence Centre Schleswig-Holstein
- Bundesverband Bioenergie e. V. (BBE; German Federal Bioenergy Association)
- Energy Advisory Board Saxony
- European Biomass Conference and Exhibition (EBC) - Program Committee
- Institute of Non-Classical Chemistry at the University of Leipzig
- Leibniz Institute of Agricultural Engineering Potsdam-Bornim (ATB, APECS)
- Renewable Energy Initiative Saxony (EESA)

Figure 10: DBFZ scientists are represented in various bodies and committees



Working groups/forums (selection):

- Ad Hoc working group of the German Federal Environmental Agency (UBA) on 1. BImSchV (Ordinance governing small and medium-sized furnaces under the Federal Immission Control Act)
- European Biofuels Technology (EBT) Platform WG1; European Technology Platform for Renewable Heating and Cooling (ETP-RHC)
- German-Polish Working Group (BMEL)
- International Energy Agency (IEA) „Bioenergy Trade – Task 40“
- International working group headed by York Neubauer and Markus Kleinhappl on the analysis of gases produced by biomass gasification and pyrolysis processes
- „Library Concepts“ Working Group of the BMEL departmental research establishments (BMEL)
- Senate Working Group „Regrowable resources“ (BMEL)
- Senate Working Group THG (BMEL)
- Society of German Chemists (GDCh), „Chemistry and Energy“ working group

DIN/ISO standardisation committees (selection):

- CEN Technical Committee „Solid Biofuels“ (CEN TC 335)
- Contribution to the working group on DIN 33999 „Dust collector testing“
- DIN: NA 172 „Standardisation committee: Basics of environmental protection (NAGUS)“
- DIN: NA 172-00-10 AA „Sustainability criteria for biomass“
- DIN: NA 062-05-82 AA „Solid biofuels“
- ISO committee 238, ISO/ TC 255 „Solid Biofuels“
- VDI 4630 Digestion of organic substances – Substrate characterisation, sampling, material data acquisition, fermentation experiments

Networks / Associations / Platforms (selection):

- Biofuels Research Network (ForNeBlK)
- Bioenergy network within the Energy and Environment Network (Netzwerk Energie und Umwelt e.V.)
- Combustion Institute (German section)
- DECHEMA, AG NawaRo
- Energy Raw Materials Network
- European Technology Platform on Renewable Heating and Cooling (RHC-Platform)
- KUP network
- ProcessNet technical group SuPER 2013 „Integrated material and energy use of biomass“
- RAL-Bundesgütegemeinschaft Brennholz (Federal fuel wood quality control group)
- VDI (Association of German Engineers) Clean Air Commission within VDI/DIN: VDI 3461 – Pollution control of the thermo-chemical gasification of biomass in cogeneration“ (working title)



Figure 11: Construction of a new day nursery at the DBFZ facility

Location and structural development

There were further major advances in the development of the approximately 35,000 m² DBFZ site in Leipzig-Schönefeld during 2013. The construction of a modular building incorporating two apartment units on the ground floor has enabled a children's day-care facility to be established. The DBFZ regards this as a major step in enhancing the work-life balance of its staff. Excavation work began in mid-January 2013, as snow was falling, and by July 1st the finished building was ready for use (Figure 11). By Summer 2014, the total of 10 child-care places for DBFZ employees' children between 18 months and three years of age will have been fully taken up. Above the day nursery there is the IT department, as well as four additional offices for scientific staff. The net building costs, including furnishings and fittings for the two apartment units, are around € 720 thousand. The ancillary costs, at around 5.3 %, are well below the standard rate on public-sector construction contracts. The aim in 2014 is to establish a cooperation agreement with the neighbouring centres at the Leipzig Science Park in order to obtain allocated placements for children of kindergarten age.

Extensive renovation work was carried out on Building 7 during 2013 as part of the upgrade to the DBFZ site buildings and their energy efficiency launched back in 2011 based on funding from the German government's economic stimulus package. Major works included complete renovation of the two upper floors, the creation of office facilities, the installation of energy-efficient windows, upgrading of the lift for use by personnel, as well as the development of eight laboratory rooms for the Biorefineries Department on the second floor. The works were completed in August 2013, marking the end of the renovation project for the time being. As a result, on August 28th 2013 all staff were able to relocate from the temporary „Geopark“ building back onto the DBFZ site. In mid-September, laboratory operations were also launched on the second floor.

The key event in terms of construction projects in 2013, however, was without doubt the positive outcome of the interdisciplinary competition to build a new large-scale timber-framed technical centre, with an adjoining office and administration building. The total



Figure 12: The planned building of the new technical centre including office building, from the perspective of the Torgauer Straße towards the city (collage)

approved area is 7,082 m² of primary usage, with some 11,000 m² of gross floor space. A total of 57 architect firms applied to take part in the competition, from which 25 were selected on the basis of stringent criteria. Following the two-day award conference on July 8th and 9th, Leipzig-based architects Schulz + Schulz Architekten GmbH emerged as the winners. The new complex is the most extensive construction project to have been undertaken since the founding of the DBFZ. The gross building costs alone total € 28.1 million, plus exterior installations, services, and first-fit costs. The project is being financed entirely by funding from the organisation's sole shareholder, the Federal Ministry of Food and Agriculture. To make space for the new construction, some of the existing buildings are scheduled for demolition during the second half of 2014.



Figure 13: Architect's model of the new building plan

The DBFZ in public

In 2013, the DBFZ again took part in or hosted a wide variety of scientific events, welcomed numerous national and international student groups and high-ranking delegations, and issued a number of new publications. We were also pleased to have again received positive regional and national media coverage (press, radio and television). A selection of media reports along with the results published by our staff in the course of the year are presented in the appendix to this annual report.



Figure 14: The Biorefineries Department exhibited at the 2013 International Green Week in Berlin

The DBFZ hosted a stand at the 2013 International Green Week fair (IGW) in Berlin, marking its third year of doing so. The BMEL special exhibition forming part of the event focused on the subject of biorefineries, and featured the work of the Biorefineries research department. Attractive features including an interactive biofuel quiz, a rape-seed oil mill, a jigsaw puzzle and a range of posters provided the large numbers of visitors with insights into the various paths to biofuel production. Immediately following on from the Green Week, the DBFZ also took part in the „enertec/TerraTec“ central German trade fair as part of the joint Bioenergy stand, where it was able to make a large number of key contacts.

The DBFZ's fourth International Biomass Conference (IBC) was held from June 5th to 7th in the „Kubus“ at the Helmholtz Centre for Environmental Research (UFZ). With almost 100 participants and featuring over 20 papers on the subject of „Experiences with bioenergy in Brazil and Germany“, our appraisal of the event was generally positive. In 2014 the DBFZ's annual conference will be a completely revised event with a regional focus. We would like to take this opportunity to invite you most cordially to join us at it. The conference, under the motto „From Science to Business“, will take place on October 1st and 2nd, 2014 at the Villa Ida media campus in Leipzig. For up-to-date information on this event, visit the annual conference website at www.dbfz.de/jahrestagung.



Figure 15: Participants in the International Biomass Conference in Leipzig

The UFZ „Kubus“ also hosted the fifth status conference on the BMUB's Biomass Energy Use promotion programme from November 14th to 15th. Attracting over 200 participants, the event was one of the highlights of the past year. Focusing on the use of residual products based on economically and ecologically sustainable methods, the subjects of papers presented included pollution control in small-scale furnaces and flexible design and process optimisation of biogas plants. The scientists in attendance also considered advances in incineration and gasification technologies, as well as reflecting on the challenges of flexible bioenergy production. A wide range of smaller workshops, conferences, and the Leipzig Scientific Forums series rounded off the extensive programme of DBFZ events throughout the year.

Numerous national and international student groups and scientific delegations again visited the DBFZ in the course of the year. Among the highlights was the visit on July 2nd by international contestants in the United Nations Industrial Development Organisation (UNIDO) „World Skills“ programme, who toured the UFZ and the DBFZ, inspecting its many technical test stands. Other visitor groups came from Brazil, Costa Rica, El Salvador, Honduras, South Korea, Moldova, Ukraine, China, Japan, Russia, Ukraine/Kazakhstan, Dubai, Chile, Argentina, Thailand, the USA, Sweden and Poland. The second DBFZ Open Day on July 6th attracted large numbers of visitors, keen to experience applied biomass research in laboratories and on technical test stands live on-site. They also had the opportunity to attend scientific presentations, as well as viewing various exhibits and posters on the subject of „Energy from biomass“.



Figure 16: A delegation from UNIDO visited the DBFZ as part of the World Skills programme

Alongside their intensive event and visit management activities, the DBFZ and the team working on the BMUB-sponsored Biomass Energy Use promotion programme published numerous scientific reports, handbooks and brochures in the past year. Reports on „Wood pellet supply for small-scale furnaces“, „Algae biorefinery“, „Small-scale biomass gasification“, „Basic information on agricultural residual products“ and „Biogas measurement methods collection“ represent just some of the published scientific output in 2013. All publications are available to download from www.dbfz.de and www.energetische-biomassenutzung.de, or can be obtained free of charge in hard-copy form.



Figure 17: Strategy workshop at the DBFZ

Scientific strategy of the DBFZ

The DBFZ is a key independent research institution working to answer the question of how limited biomass resources can be utilised to enhance present – and especially future – energy systems in the most sustainable, efficient way. In their work, our scientists identify, develop, monitor, evaluate and demonstrate the most promising areas of application for bioenergy, highlighting the especially positive outstanding examples, in conjunction with scientific, industrial and public-sector partners. From this, visions of the contribution bioenergy can make within the energy mix are derived and assessed in a range of scenarios depicting trends in the energy system and in underlying conditions. This includes the contribution of biomass to a sustainable energy system and economy (using biomass in strategically key sectors, maximising value creation from biomass, climate-neutral energy production, high-efficiency technologies) and the integration of biomass into a sustainable bioeconomic system.

Research goals and focus areas

The DBFZ devises conceptual solutions and monitors them with concrete technical means and with a view to their future practicability through its own applied research in order to integrate complex bioenergy technologies into the social environment and the energy system. Apart from research to optimise biomass production, the DBFZ's work covers the complete bioenergy supply chain – from questions of availability, logistics, pre-treatment and conversion through to its use and integration into the energy system – considering technical, economic and ecological aspects.

A strategy workshop conducted in 2012 identified the following four key areas of focus in the research work of the DBFZ:

Sustainability/Sustainability assessment

Ongoing development of sustainability assessment techniques and provision of tools to establish sustainable bioenergy supply chains.

Innovative bioenergy sources

Development of efficient, environmentally-friendly methods and technical approaches to finding innovative, marketable bioenergy sources with high energy density and high quality characteristics (e.g. torrefied, hydrothermally or mechanically-processed fuels, biomethane, motor fuels), taking special account of hitherto inadequately exploited biogenic residues and waste materials.

Demand-driven technologies and master concepts for the supply of energy

Development of innovative, sustainable (i.e. low-emission, environmentally compatible, competitive and socially acceptable) methods, technical components and concepts for converting bioenergy sources into power, heat/cold and mobility, aimed at achieving an increasingly needs-driven supply of energy.

Monitoring

Establishment of a monitoring system to track the development of biomass use for energy production, taking into account available resources and prevailing framework conditions, and to pick up potential problem areas (particularly with regard to availability of resources) at an early stage. The DBFZ is also increasingly carrying out monitoring by metering, such as in relation to biomethane plants and biomass gasification.

To realise these goals, the DBFZ produces and analyses the most reliable bioenergy data, models and scenarios in Germany and evaluates them as the basis for strategic decision-making aligned to the ongoing development of bioenergy use. In doing so, it defines and assesses expected developments in bioenergy technologies over the next five years and between 10 and 15 years ahead. This provides the foundation for developing consistent bioenergy strategies which the DBFZ will support through scientific work and advisory services.

Interdepartmental research: the DBFZ Competence Groups

The wide-ranging expertise of our staff provides the DBFZ with unique competence to work on current scientific issues of macro-economic relevance within the field of bioenergy research. To that end, the DBFZ has established five Competence Groups, operating across the organisational structure of its four research departments, to cover various areas of research. This enables the DBFZ to identify what it sees as key areas of focus relating to bioenergy use in a continuous process and work on them based on the existing skills and experience of its staff.

The key areas are developed and coordinated by the Competence Group Leaders. They perform that role in addition to heading working groups within the individual research departments. The Competence Groups thus combine the skills and expertise of the DBFZ's four research departments to provide qualified answers to questions of key strategic importance and develop relevant projects, applying a high degree of scientific know-how. This organisational approach assures outstanding scientific results and ensures that policy-makers and industrial clients are able to call upon the very latest and most technically expert advice.

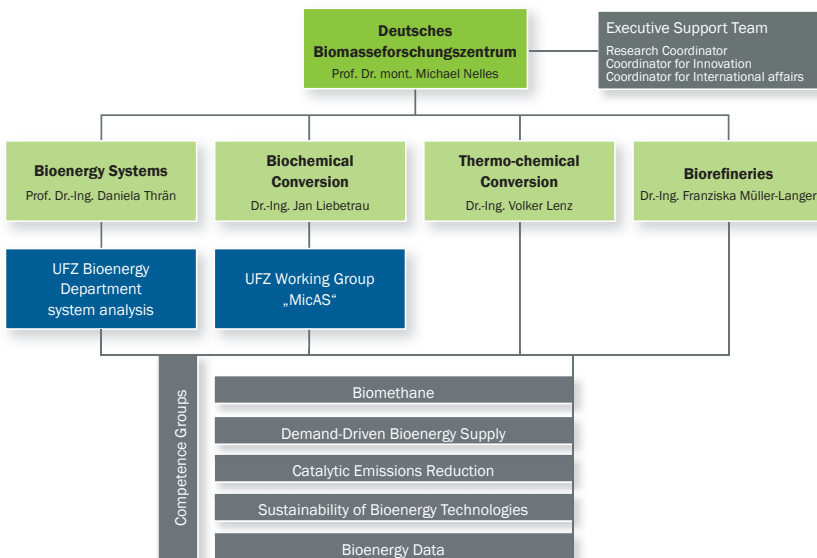


Figure 18: DBFZ structure with the interdepartmental Competence Groups



Biomethane

Background and objectives

As a substitute for natural gas, biomethane offers the possibility of using bioenergy within an established field of application – that is to say, based on use of the existing natural gas distribution and usage infrastructure. It also promises a wide variety of other benefits. It can help substantially to reduce greenhouse gas emissions. This is particularly true in relation to the transport sector, owing to the limited alternatives available to date. Furthermore, biomethane is a „green“, eco-friendly energy source, which helps local environmental protection efforts while also adding value to the regional economy, particularly in rural areas. And ultimately, biomethane can be produced and supplied in Germany irrespective of political turmoil elsewhere. Biomethane is a gaseous energy source material which can be produced by chemical conversion of biomass into biogas (that is to say, by anaerobic digestion) or by thermo-chemical conversion into bio-SNG (based on biomass gasification and fuel synthesis). Whereas the technology for producing biomethane by biochemical conversion is already available on the market and in use, the bio-SNG method is still in the commercial realisation phase. Technically mature and economically sustainable biomass gasification solutions are an essential foundation for this biomethane route.

The goal of the Biomethane Competence Group is to conduct research into the production and supply of biomethane. Other objectives of the Competence Group include bundling the biomethane R&D activities of the Biochemical Conversion and Thermo-Chemical Conversion departments in Germany and elsewhere in Europe, as well as undertaking knowledge and technology transfer. Working in conjunction with science and industry partners, it is intensifying public relations activities in order to publicise the benefits of biomethane as an energy source in a transparent way. As part of those efforts, selective concept and technology development is also one of the objectives of the Biomethane Competence Group.

Development

The recently completed „Guide to biogas processing and supply“ on behalf of the Fachagentur Nachwachsende Rohstoffe e.V. FNR (Regrowable Resources Agency) represents the second edition of this key guideline in its field. Large numbers of DBFZ staff worked on the project. The Guide is scheduled for publication in early 2014.

As part of the „Climate effects of biomethane production and supply“ research project sponsored by the Federal Ministry of Food and Agriculture (BMEL) through the FNR, an analysis of obstacles to progress in the biomethane sector was conducted. The object of the workshop held in September 2013 was to discuss the results of the survey with key players in the biomethane sector and derive a recommended action plan. In this context,

the status quo of biomethane production, supply and use, along with current obstacles to it, were presented on the basis of the results of ongoing research projects including BIOMON, MONA and EEG-Monitoring. For more information go to: <https://www.dbfz.de/biomethan>

Initial results from the „Betarübe“ project were presented at the 7th Rostock Bioenergy Forum on June 20th/21st, 2013. The question considered by the DBFZ in the project was what technical concepts would be required, and costs incurred, to make modified sugar-beet a more fruitful crop than maize and whole-crop cereal silage.



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Figure 19: Guide to biogas preparation and supply by the Regrowable Resources Agency (FNR)



Figure 20: Reflector module of a laser spectrometer to measure methane concentration around biogas plants

At the annual conference of the German Energy Agency (Dena) Biogas Partnership in December 2013, Prof. Michael Nelles in his opening presentation set forth an overview on the subject of „Balancing biomethane and climate protection – a (greenhouse gas) appraisal“. It was shown that biomethane (biogas conditioned to natural gas quality) used for combined heat and power production achieves a relevant reduction in greenhouse gases compared to all fossil-fuel reference scenarios. As an alternative motor fuel, too, biomethane achieves a major reduction in greenhouse gas emissions (of at least 50 %) compared to fossil fuels (petrol, diesel).

The Biomethane Competence Group is additionally committed to investigating the possibilities for use of biomethane as liquid fuel. In conjunction with the Institute for Biogas, Recycling and Energy, it is analysing the potential for using liquid biogas (LBG) as a fuel option for commercial and heavy-duty vehicles. This is an ideal area in terms of opening up major prospects for biomethane to achieve greater market penetration based on its wide-ranging benefits, including distributed availability and utilisation of existing vehicle tank geometries.

The Bioenergy Systems Department has established a doctoral student placement in order to focus more closely on research relating to biomethane trading in future. The aim in this is to answer questions relating to the marketing and trading of biomethane in Germany and across Europe. The Biorefineries Department has established a further doctoral student placement focused on the thermo-chemical production of biomethane – specifically methanation.

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Demand-Driven Bioenergy Supply

Background and objectives

A strategic goal of the German Federal Government is to achieve at least 80 % of electricity production from renewable energy sources by 2050. A range of studies have shown that there is in fact potential to cover 100 % of energy demand with renewables. Based on the further expansion of renewable energy use, especially wind power and photovoltaic, the proportion of total electricity production from fluctuating, entirely or barely controllable sources will rise. As a consequence of this trend, the importance of controllable power plants in providing general load balancing and stabilising the grid by supplying an operating reserve is rising, with biomass assuming increasing importance in terms of demand-oriented energy supply. Against that background, the Demand-Driven Bioenergy Supply Competence Group focuses on three key areas: „System integration“; „Technical systems“; and „Markets and market frame conditions“ (Figure 21). Environmental impact and economic viability studies are also conducted to complement those activities on a cross-Competence Group basis.

The „system integration“ focus group considers the position of demand-driven energy supply from biomass within the energy system. A key factor in this is analysis of economic viability compared to the overall system, though other aspects such as assurance of supply are also important.

The „technical systems“ focus group considers the assessment and the development of technologies for demand-oriented bioenergy supply. It analyses technical criteria and characteristics (such as requirements for the provision of operating reserve or system services, as well as grid engineering demands) in order to compare technologies on an objective basis and to accompany new developments from conception through to patenting. Important elements of this are also control engineering as well as the technical integration of biomass taking into consideration other renewable energy sources.

For the „markets and market frame conditions“ focus group, the legal and regulatory framework (including EnWG, EU Voltage Directive, BIm-SchG, EEG) plays a particularly important role. It also considers the various development promotion systems under the terms of Germany's Renewable Energy Act EEG (especially including the market and flexibility premium) and other promotional systems (legislation relating to CHP; market incentive programme). Analysis of the various markets for demand-oriented bioenergy ultimately provides a comprehensive picture.

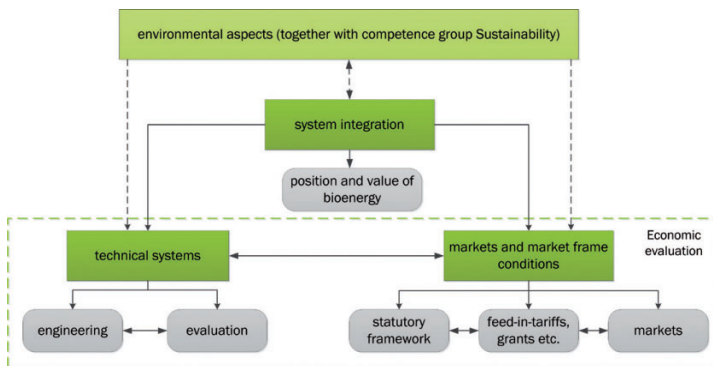


Figure 21: Focus areas of the Demand-Driven Bioenergy Supply Competence Group

Development

Research into demand-oriented bioenergy supply was driven forward by a number of different projects in 2013. Firstly, a short study on behalf of the Federal Ministry of Food and Agriculture (sponsorship number: 22403811) presented potential technological developments and assessment criteria for demand-oriented bioenergy. Secondly, a project on „Automated output safeguarding in a grid of a thousand distributed energy producers applying an ICT Cockpit approach based on the concept of supply chain management“ (backed by the EU's European Regional Development Fund within the Energy and Climate Protection programme of Sächsische Aufbaubank SAB (submission number: 100127660) constructed a test field combining various renewables with bioenergy plants. The project

included the installation of a small wind turbine and a photovoltaic plant. It also incorporated extensive information and communications technology to control the various energy producers and bioenergy plants at the DBFZ facility.

The development of distributed, flexible combined heat and power plants was intensified by two doctoral projects. A doctoral student supervised by the Technical University of Chemnitz has been working since 2012 on a system for the flexible supply of heat and power based on gasification of biocoal (e.g. charcoal, but also hydrothermally carbonised materials). Another student has been working since April 2013 on a joint doctoral project between the University of Rostock, the German-Jordanian University in Amman/Jordan, and the DBFZ to develop a flexible externally fired gas turbine providing demand-oriented heat and power from residual products of olive processing.

In another project backed by the European Regional Development Fund through the SAB (submission number: 100143221 – „Demand-based control of energy from biomass“), research is being conducted into the flexible production of biogas and synthetic, biogenic natural gas itself and into ways of making the conversion of biomethane into fuel cells more flexible.

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Figure 22: DBFZ wind turbine test field



Catalytic Emissions Reduction

Background and objectives

Gaseous, liquid and solid carbon-containing bioenergy sources are almost without exception converted into thermal energy by incineration. Biogas, as well as biodiesel and bioethanol, are used in combustion engines of combined heat and power plants, for example, to apply CHP technologies based on renewable resources in a sustainable way to maximise demand-oriented energy supply. Solid bioenergy sources such as wood pellets and firewood are extensively used nowadays in small-scale furnaces to supply private households with heat. In future, however, the aim is for solid biomass also to be used more widely, and additionally in most distributed micro-CHP plants. When bioenergy source materials are incinerated, ideally all combustible hydrocarbon-containing components are fully oxidised to form CO_2 and H_2O . Under real practical conditions, however, uncombusted and partially oxidised pollutants are always additionally released in combustion processes. This particularly entails emissions of carbon monoxide in an order of magnitude from 100 to over 1,000 ppm. Depending on the bio-energy source material and the incineration management, methane (CH_4), other volatile organic compounds (NMVOCs) as well as semi- and non-volatile hydrocarbons such as polyaromatic compounds (PACs) and polychlorinated dioxins and furans (PCDDs/PCDFs) and soot (black carbon) are emitted in relevant amounts to produce greenhouse gas effects and/or environmental harm due to toxicity. In order to enhance sustainability, emission reduction measures for incineration processes – particu-

larly where bioenergy source materials are used – focused on the air pollutants CO, CH₄, NO_x, PAC and soot particles (black carbon) are to be researched more intensively and demonstrated taking into account practical conditions. These pollutants can be substantially reduced by catalytic exhaust systems and integrated methods.

The Catalytic Emissions Reduction Competence Group is concerned with all pollution control matters relating to incinerators for gaseous, liquid and solid bioenergy source materials based on the use of solid catalysts. Two generally formulated objectives can be derived from the aforementioned background factors:

- Objective 1: Catalytic emission control principles for incinerators of gaseous, liquid and solid bioenergy source materials → secondary catalytic methods
- Objective 2: Integrated catalysts to prevent pollution in incineration processes → primary catalytic methods

Development

From the defined scope of problems, the following key areas of focus were derived as research topics and have been under investigation since 2013 based on a global view involving the four research departments of the DBFZ:

Focus group 1 (Bioenergy Systems Department): Sustainability of catalytic converters in the thermal conversion of biomass: Focus group 1 initially collated inventory data for the use of catalytic converters and application data for balancing appraisal of the use cases „supply of usable thermal energy by single-chamber furnace incineration of firewood without and with pollution control“. Evaluations are currently being conducted with regard to the environmental effects of catalytic converter production; pollution control effects through the use of catalytic converters; and the advantages and disadvantages of the environmental effects from production and pollution control. The results will be incorporated into the drafting of a submission for sustainability assessment of catalytic converters on biomass furnaces.

Focus group 2 (Thermo-chemical Conversion, Biorefineries and Biochemical Conversion departments): SCR with DeNO_x catalysts in motor combustion: Focus group 2 carried out preliminary work for the drafting of a research submission. Extensive consultations were held with industrial partners (manufacturers of catalytic converter systems, motor manufacturer and catalytic converter coating specialists) in order to draft a submission text and define the objectives.



Figure 23: Mobile miniature plant for catalytic converter testing on bioenergy plants

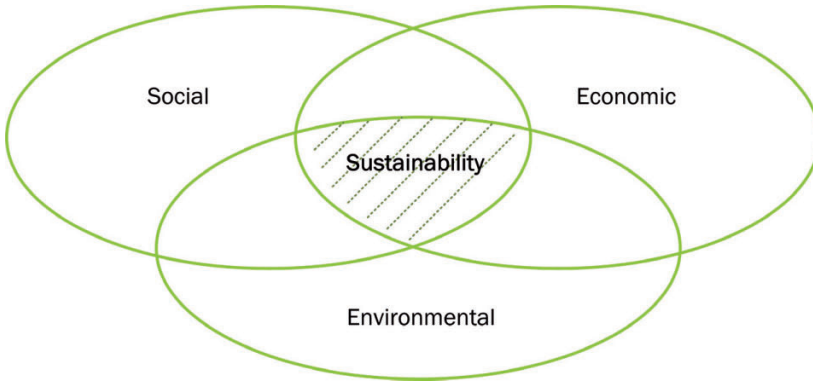
Focus group 3 (Biorefineries and Biochemical Conversion departments): Catalytic post-combustion with oxidation catalysts in motor combustion: Focus group 3 conducted research into the current state of the art in catalytic post-combustion on motors and carried out emissions measurements on the DBFZ motor test rig as well as the combined heat and power of the DBFZ biogas pilot plant. Commissioning measurements with the mobile catalytic converter pilot plant (Figure 23) were also taken. The results will be incorporated into third-party funding acquisition efforts and into ongoing industrial research projects.

Focus group 4 (Thermo-chemical Conversion Department): Catalytically activated soot particle filters based on mixed-metal oxide catalysts: Focus group 4 conducted simplified measurements of soot particle reduction on newly developed metal oxide-based catalytic converters using the catalytic flow apparatus available at DBFZ. The expected soot particle reduction was experimentally observed in connection with a demonstration of a soot particle generator. Development work was carried out in parallel on high-temperature catalysts for solid fuel furnaces as part of ongoing third-party funded projects.

Focus group 5 (Biochemical Conversion Department): Catalytic residual methane reduction: Focus group 5 conducted research into the current state of the art in residual methane reduction in biomethane supply to the natural gas grid. A research topic was defined on the basis of the findings. It seeks to investigate the possibilities of catalyst application dependent on the reprocessing method on biomethane supply plants, and additionally to develop relevant catalytic converters and techniques.

Competence Group Leader:

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Sustainability of bioenergy technologies

Background and objectives

Bioenergy offers a number of advantages over other renewable energy sources, such as simple storage and supply of control and base-load energy. Bioenergy is also a key element of German and wider European climate protection policy approaches. This is highlighted, for instance, by the ambitious development goals for various energy sectors (such as power generation, transport, etc.) at national and European level. Further expansion of bioenergy use does, however, also entail major ecological and socio-economic risks. Key aspects which may in fact run counter to bioenergy policy goals include indirect and direct effects of changes in land use, intensive industrial farming, and poor working and production conditions in third-party countries.

Appropriate assessment criteria and methods are required in order to develop sustainable, regionally adapted bioenergy strategies and concepts. As part of a number of research projects, the DBFZ is participating in development work and debate on criteria relating to different aspects of bioenergy sustainability. In order to incorporate all three areas of sustainability in assessing bioenergy source materials where possible, various methods can be applied including life-cycle assessment (LCA), life-cycle costing (LCC) and social life-cycle assessment (SLCA). The results delivered by these methods can provide indicators for the sustainability of specific bioenergy concepts. Taking into account other ecological and economic indicators (e.g. biodiversity, fertility, soil erosion; GHG avoidance costs), this enables strategies to be devised for the development of regionally adapted, sustainable bioenergy concepts.

Development

The key focus in 2013 was on the DBFZ's ongoing international networking in matters of sustainability. DBFZ scientists visited various research establishments in the USA and South America in order to exchange news and views on current topics and methodology and to develop potential cooperation in the sustainability assessment of bioenergy technologies.

On a 10-day trip including visits to the Joint BioEnergy Institute in Berkeley, California, the National Renewable Energy Laboratory in Denver and the US Department of Agriculture in Washington, concrete topics and points of address for potential future collaboration between the DBFZ and leading research establishments in the USA were identified. The potential lies primarily in relation to the ongoing development of life-cycle assessment methodology for bioenergy systems and the investigation of specific bioenergy paths (including aircraft biofuels based on unconventional raw materials such as algae, lignocellulose or jatropha oil).



Figure 24: DBFZ employee Katja Oehmichen at the 1st Congreso Interamericano de Cambio Climático in Viña del Mar, Chile

In addition to the aforementioned research establishments in the USA, in October 2013 DBFZ staff also visited the Pontificia Universidad Católica de Valparaíso (PUCV) in Chile. One outcome of that meeting was the undertaking to draw up a life-cycle assessment for the production of biofuel based on jatropha in conjunction with the Fundación Fraunhofer Chile Research and the PUCV over the coming months. At the first Congreso Interamericano de Cambio Climático in Viña del Mar, extracts were presented from the DBFZ's work to date on sustainability assessment. Further reciprocal visits as

well as scientist exchanges are planned for the future in order to pursue the activities initiated with the establishments in the USA and Chile.

Alongside the aforementioned international networking activities, the work of the Sustainability of Bioenergy Technologies Competence Group was substantively pursued on a number of levels. As one example, the DBFZ is working with scientists at the UFZ Bioenergy Department on a method to integrate local and region-specific elements more closely into the classic life-cycle assessment methodology. Additional to the basic methodological work, these activities are enabling the creation of specific life-cycle assessments for the various bioenergy paths involved in producing power, heat and biofuels in central Germany.

One of the Competence Group's key tasks is to provide ongoing support to the scientific and social debate surrounding the sustainability of bioenergy. As well as helping to provide an objective insight into this controversial issue, the Competence Group will in future direct its resources primarily towards enhancing the methods available for sustainability assessment, in order to give more consideration to sensitive topics such as biodiversity and water consumption in the ongoing development of bioenergy. The findings obtained using these tools form an important aspect of the work carried out in the research departments, and are key to the further development of the DBFZ's research strategies.

Alongside the activities described, the Sustainability of Bioenergy Technologies Competence Group supported a large number of publications (including one book, two contributions to books, and two journal articles) and conference papers (eight in all) during 2013.

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Bioenergy Data

Background and objectives

The use of bioenergy as a substitute for fossil fuels is rising steadily. In view of the increasing number of market players, and against the background of higher demands in terms of efficient usage technologies for sustainable bioenergy production, a comprehensive, up-to-date data set is the strategic key to customised planning and to the ongoing development of policy framework conditions. This includes depiction of trends in markets, trading flows and prices. The medium-term objective of the Bioenergy Data Competence Group is to also provide technological, economic and ecological data for analysis and assessment of biomass production and supply concepts and technology options.

The Bioenergy Data Competence Group collates all data flowing in from the Bioenergy Systems, Biochemical Conversion, Thermo-Chemical Conversion and Biorefineries departments. The continuously gathered data is applied in investigating research questions in the course of the DBFZ's internal and external projects. This means the scientific and industrial community can be provided with access to historical and current statistical data relating to bioenergy. The database is unique in its nature and scope.

The following DBFZ research projects relating to power and heat generation, the biofuel market and innovative fuel production, supply and usage models are of particular importance to the Bioenergy Data Competence Group:

- Monitoring the effects of Germany's Renewable Energies Act (EEG) on power generation from biomass; also preparation and supervision of EEG experience reports
- Interaction between the various market launch instruments relating to the use of biomass as an energy source
- Monitoring of the biofuel sector
- Production and evaluation of torrefied solid fuels (SECTOR)

Development

Areas of focus of the Competence Group's work in 2013 included the design and construction of an interdepartmental database for bioenergy plants for the supply of power and heat. That work will be continued in 2014, and is scheduled for completion in the second half of the year, enabling data transfer and optimisation of the database. The interdepartmental database provides a sound basis to safeguard the cross-checking and continuous updating of plant data. The DBFZ's years of work on various research projects has generated large volumes of data which will be made available for other projects and work. Consequently, the Competence Group's work also involved the launch of internal data structuring and preparation, including planning of enhanced information infrastructures for research data.



Given the large number of research projects which have collated data on biomass potential, the construction of a relevant database is planned. The draft design of the database was drawn up in 2013. The DBFZ last year also assisted the Agency for Renewable Energies (AEE) in compiling its „Bioenergy Potential Atlas“. As well as revealing the biomass potential at state level, it is also important to document current biomass use, in order to identify the potential still available to exploit. The „Bioenergy Potential Atlas“ can be downloaded from: <http://www.unendlich-viel-energie.de/de/bioenergie.html>

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Figure 25: The DBFZ's Bioenergy Data Competence Group played a key role in compiling the „Bioenergy Potential Atlas“, published by the Agency for Renewable Energies.



Figure 26: DBFZ-Report No. 11 „Monitoring Biokraftstoffsektor“ (2nd Edition)

Another area of focus was the ongoing development and optimisation of methodology to measure power and heat production from bioenergy. This involves not only knowing the numbers of existing and new plants utilising the various conversion technologies, but also the actual hours at full load of the biomass plants concerned – a parameter which is subject to some uncertainty. Power and heat production from biomass is presented in the annual monitor of trends in production from biomass (www.dbfz.de/eeg-monitoring). The calculated amounts of power and heat produced from biomass (solid biomass, biogas/biomethane and vegetable oil) are additionally used as data input by the renewable Energy Statistics Working Group AGEE Stat of the BMUB in tracking renewables trends in Germany. The listing of biomass plants in Germany was also made available in response to inquiries from international associations and organisations, including the IEA and the Swedish Gas Technology Centre.

In view of their steady growth in the transport sector, accompanied by the dwindling use of fossil motor fuels, alternative biofuels are gaining in importance. Monitoring and analysis of the biofuel sector formed part of the Competence Group's work in 2013. This resulted in publication of a revised edition of the DBFZ Report No. 11, „Monitoring Biokraftstoffsektor“ (Monitoring of the biofuel sector), in January 2014.

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Cooperation

Owing to the complexity of the research issues surrounding bioenergy, most work is carried out in close cooperation and continuous exchange with other leading German and international research institutes, including the neighbouring Helmholtz Centre for Environmental Research - UFZ and many others. At the UFZ, a joint Bioenergy Department has been established to carry out the necessary basic research to deal with the assessment of bioenergy systems, and a joint “Microbiology of Anaerobic Systems” working group (MicAS) to look into the microbiological principles underlying biochemical processes. This bundles competences and enables the basic research required in these areas to be covered comprehensively by qualified staff.

Close cooperation with industrial companies is also necessary to ensure that the research carried out has a practical application and provides an in-depth insight into the relevant markets. Independent collaboration with plant operators, plant and component manufacturers, energy and finance companies and consultants is a firmly embedded element of work at the DBFZ. This ensures that real practical questions and problems are assessed in a neutral – and above all objective – way. As a consequence, research will always incorporate those considerations, so the delivery of solutions to such issues in conjunction with cooperation partners, will safeguard the trust and respect for the work of the DBFZ within the sector. The findings obtained are regularly published by DBFZ staff, presented to national and international scientific bodies, and incorporated in recommendations for government policymakers. All this represents an active contribution to the sustainable, efficient use of biomass, to the establishment of the necessary framework conditions and to the enhancement of research funding programmes.

Findings from the DBFZ's own work are also disseminated beyond the borders of Germany and contribute substantively to the development of bioenergy use within the European Union and worldwide. As well as promoting knowledge transfer, this aids the development of research capacities in key international regions (primarily Eastern Europe and Brazil, and additionally in Africa and India) and supports the transfer of exemplary technologies. At the same time, findings from international sources must in turn be recorded and analysed in order to learn from them for the benefit of bioenergy development and to utilise the limited resources of the DBFZ in an efficient, focussed manner.

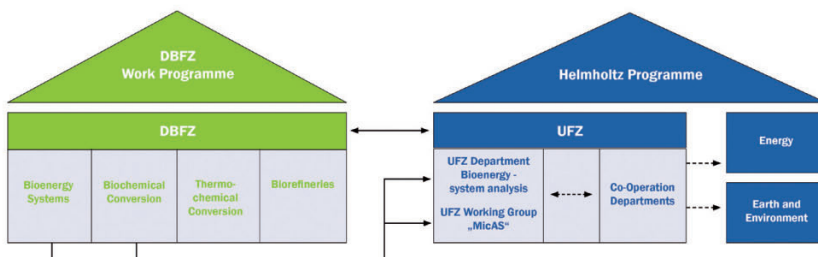


Figure 27: Cooperation between DBFZ and UFZ



Organisational structure: the four research departments

In late 2010, to provide the organisational framework for its numerous scientific research activities, the DBFZ established four closely interlinked departments: Bioenergy Systems, Biochemical Conversion, Thermo-chemical Conversion and Biorefineries. The assigned functions and key areas of focus of the individual departments are detailed in the following sections.

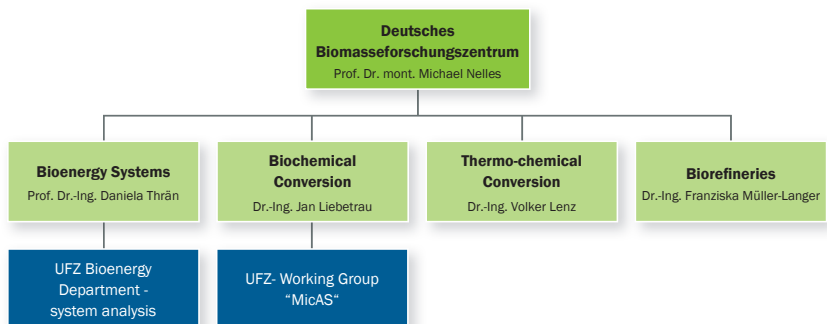


Figure 28: Organisational structure: the four research departments of the DBFZ and the working groups of the UFZ



Bioenergy Systems Department

The goal of the Bioenergy Systems Department is to help devise sustainable bioenergy strategies at national and international level. To that end, it identifies regional and global biomass potential and investigates the wide-ranging options offered by different biomass supply concepts. Those options are analysed and assessed in detail, particularly with regard to their use for sustainable energy production. The application of sound methodologies for analysing potential and devising scenarios, as well as when developing specific resources and launching innovative technologies onto the market plays a major role in its activities. In conjunction with continuous monitoring of bioenergy markets, this work provides the

foundation stone for the development of sustainable bioenergy strategies aimed at advancing biomass as an ecologically and economically advantageous energy source. The Bioenergy Systems Department also manages the BMUB funding programme “Biomass Energy Use”. This work focuses primarily on linking together all the scientific partners involved in the project by way of publications, media communications, subjectspecific workshops and conferences. The Bioenergy Systems Department has for the last three years collaborated closely with the Bioenergy Department of the Helmholtz Centre for Environmental Research - UFZ, also based in Leipzig. The focus of their cooperation is on plugging gaps in research relating to the sustainable use of biomass for energy production, founded on the specific areas of expertise of the DBFZ and the UFZ respectively. In particular, the joint research work is expected to deliver synergies based on the complementary character of their research projects.



Head of Department

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The Bioenergy Systems Department is divided into four Working Groups:

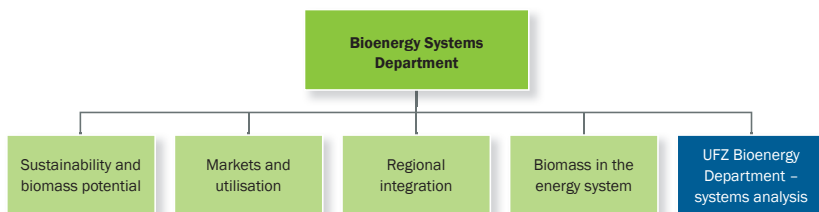


Figure 29: The working groups in the Bioenergy Systems Department

Research focus areas



Sustainability and biomass potential

Dipl.-Ing. Stefan Majer
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- Sustainability analyses relating to various biomass energy options (greenhouse gas emissions, changes in land use, hydrologic balance, humus balance, etc.)
- Development and standardisation of sustainability assessment methodologies, e.g. relating to life-cycle assessment (LCA), life-cycle costing (LCC) and social life-cycle assessment (SLCA)
- Development of methodologies to identify the potential of different biogenic raw materials for bioenergy production, taking into account competing usage, geographical, structural and political constraints as well as sustainability aspects



Markets and utilisation

Dr.-Ing. Janet Witt
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- Monitoring of fuel, market and technology trends in bioenergy production and supply against the background of current framework conditions; predicting future development potential
- Market observation and data acquisition relating to the national and international trading of bioenergy source materials and bioenergy: costs, prices and quantities
- Devising optimised concepts for improved biomass production and supply for alternative energy crops (permanent crops) and residual timber

- Evaluation of production paths and conversion technologies for the use of conventional and torrefied biomasses
- Development of solutions to issues relating to fuel standardisation and certification and to quality management as a means of safeguarding fuel standards



Regional integration

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-
- Concepts for the exploitation of regionally unused biomasses, including their integration into existing energy and material flows
 - Enhancing regional added value by optimising existing material flows and extending biomass usage cascades
 - Analysis of the heat market; quantification of biogenic heat; development of ecologically and economically efficient heat usage concepts



Biomass in the energy system

Dr.-Ing. Nora Szarka
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-
- Devising medium- and long-term supply scenarios and usage strategies
 - Devising methodologies and modelling in relation to potential competing use among different bioenergy applications
 - Systems analysis for demand-oriented bioenergy supply
 - Analysis and assessment of bioenergy technologies and supply chains



UFZ Bioenergy Department – Systems Analysis

Prof. Dr.-Ing. Daniela Thrän
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-
- Investigating the environmental impact of the supply of different bioenergy sources
 - Development of regional management tools, including based on localised LCAs
 - Modelling and scenarios for bioenergy within a decentralised renewable energy supply system
 - Interdisciplinary bioeconomics assessment and management methodologies

Services and technical equipment

Services

- GIS analyses of local, regional, national and global biomass potential
- Material, substance and energy life-cycle assessment
- Stakeholder analysis
- Feasibility studies; economic viability analyses; cost-supply curves
- Technology screening and learning curves; efficiency analyses
- Life-cycle assessment methodology (LCA, LCC, SLCA)
- Risk and obstacle analysis
- Multi-criteria assessment, indicator development
- Scenario development
- Monitoring and conformity analyses based on available standards/certification methodologies
- Quality assurance of bioenergy data (bioenergy crop growing areas, raw material input, energy production from biomass)

Methodologies are also developed relating to the acquisition and improvement of the database for the following areas:

- area and quantity data for the supply of bio-energy source materials
- biomass trading flows and price trends
- verification and enhancement of existing statistical data relating to biogenic heat and power production, fuel/substrate usage in the specific bioenergy systems
- regional analyses of bioenergy demand
- preparation of standards and certification systems

Technical equipment

Databases

The Bioenergy Systems Department collects wide-ranging data to monitor trends on the bioenergy market and systematically extends it. The data includes technical and economic information, details relating to licensing law and information of relevance to stakeholders, such as for the German bioenergy plant portfolio or for market trends in biogenic fuels. In many cases, time series charts are provided. Standardised data management tools and geographic information systems (GIS) are used for data evaluation and retention. The available data relating to the bioenergy plant portfolio in Germany and to international fuel markets and trading flows offers private and public-sector decision-makers an outstanding means of considering strategic policy issues and making market-related decisions based on validated facts. Such users are also enabled to assess market dynamics against the background of changing framework conditions and to predict future development trends.

Assessment methods and scenarios

The limited biomass potential must be utilised efficiently to safeguard the long-term future of the energy system. In view of the many and varied properties and usage options of biomass, methods and tools are required to manage the deployment of biomass by sector in accordance with social needs (such as for climate protection or to deliver system services). To that end, the Bioenergy Systems Department devises and develops methods for assessing the technical, ecological, social and economic effects of biomass use for energy production. The development of dynamic scenarios provides the option of assigning the results to various contexts. In conjunction with the DBFZ's database of current bioenergy technologies, they can be deployed to support decision-makers in the political and business spheres.

Indicator tool to depict regional bioenergy development

As part of the technical and economic research activities supporting the federal "Bioenergy Regions" competition, the DBFZ created an online tool for documenting and evaluating regional bioenergy development trends. Over 50 indicators map "hard facts" such as regional bioenergy use or the development of the regional (bioenergy) economy, but also incorporate "soft" factors such as infrastructure and public relations work. It is also possible to draw comparisons with national averages across Germany. The tool is available to all interested regions. More information: <http://bioenergie-regionen.dbfz.de>

Analyses of potential

In order to assess the availability of sustainable raw materials and residues, the DBFZ is developing a far-reaching model which can be used to calculate regional, national and international biomass potential for energy production. Tools employed include geographic information systems (GIS) to localise biomass potential. Scenarios are then developed within this framework in conjunction with the latest statistics, official geobase data and freely available geodata. Alongside freely accessible information, a joint project enables a large number of individual topics specific to the needs of the client concerned to be covered.

Figure 30: Regional bioenergy development



Reference projects

Technical-economic research accompanying the Bioenergy Regions programme

As part of the "Bioenergy Regions" competition, 25 regions in Germany were sponsored by the Federal Ministry of Food and Agriculture (BMEL) for a period of three years beginning in 2009 to establish regional networks aiding the development and optimisation of regional bioenergy production. The DBFZ provided accompanying technical-economic research in support of the development programme. The main areas of focus were:

- Description of the starting situations in the various regions (e.g. socio-economic structure)
- Analysis of regional bioenergy development in the competition period
- Depiction of regional value creation effects
- Balancing of greenhouse gas emissions and the greenhouse gas savings linked to bioenergy use

The DBFZ conducted three material flow surveys during the programme, questioning operators of biogas plants, vegetable oil mills and heat and combined heat and power plants as well as fuel producers in the bioenergy regions. This provided a map of regional material flows, as well as identifying changes to fuel composition and sourcing or to heat usage over the competition period. At the same time, the influence of regional management, coordinating all measures in the bioenergy regions, on new plant constructions and modifications was recorded in order to draw conclusions as to the impact of the development programme.

The analysis of regional value creation effects was based on the idea that the activities of the regional bioenergy networks are reflected in measures and projects at various stages of the bioenergy value chain (Figure 31). It is to be expected that the structures created by the networking efforts in the bioenergy regions will help establish bioenergy use in the respective regions for the long term.



Figure 31: Stages of a standardised bioenergy value chain.

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The more extensively a link in a value chain is integrated into a region, the more sustainable positive effects the region is likely to enjoy. To that end, the scientists twice recorded measures and projects in the Bioenergy Regions and assigned them to the various value chains. They also identified indicators for the creation of new jobs in relation to various classes of plant size. These can be applied to estimate the direct gross employment at bioenergy plants.

To enable the regions to record, monitor and compare their regional bioenergy development themselves, an indicator system was also developed and subsequently adapted into an online tool: <http://bioenergie-regionen.dbfz.de/>

The BMEL has extended the Bioenergy Regions programme by a further three years. 21 regions are being provided with follow-up sponsorship in the period 2012 to 2015. Each region was also required to choose a partner region in order to ensure direct knowledge transfer (Figure 32). The DBFZ will also again be conducting the accompanying technical-economic research.

Areas of focus in the second phase of the programme, in addition to depicting the bioenergy situation in the regions, include analysis of efficiency along the material and usage streams, with a particular view to the use of heat. In this context, the technical biomass potential for the Bioenergy Regions and their partner regions is being determined on the basis of a unified methodology and the latest available data. The latest official statistics and geo-base data are being applied. The key focus, compared to previous studies, is on analysing the geographical breakdown of the potential identified using a Geographical Information System (GIS). Geographical differentiation of biomass potential provides a basis for assessment of future usage concepts in the Bioenergy Regions. The results will provide comparability between Bioenergy Regions and enable preferential areas to be identified. Additionally, the technical biomass potential identified in this way will be set in relation to the material flows actually occurring in the regions.

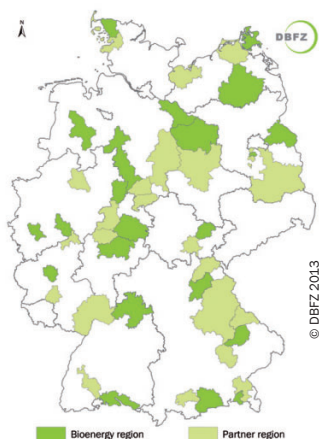


Figure 32: Bioenergy Regions and partner regions in the second phase

The second phase of the programme is being run in cooperation between the Sustainability and Biomass Potential (Potential Analysis) working group and the Regional Integration working group.

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Flexible design of bioenergy – a multi-disciplinary task: Technology, markets, integration processes

Demand-Oriented Bioenergy Supply

Wind and solar energy are in future planned to be the main sources of power supply, though their ability to adapt to actually demand is limited. Thanks to its flexibility, bioenergy in itself and in conjunction with other measures, such as storage and demand-side management, can help to balance the discrepancy between fluctuating power supply and power demand. This is done either by selling on electricity markets (EPEX, OTC, operating reserve) directly dependent on the electricity price signals, or as part of a pool (such as a virtual power plant) with a schedule based on the pool strategy. Above all, distribution networks must now receive the power – a role for which they are rarely prepared either technically or administratively. Consequently, alongside building generating infrastructures and adapting electricity markets, development of grids in conjunction with intelligent generation and capacity management poses an additional challenge for the power industry. The process of integrating renewables, especially bioenergy, is still in its early days.

Challenge of heat generation concepts

The electricity (price) led operating mode results in a schedule which very rarely matches the heat demand of the surrounding heat sinks (such as households, trade and industry, contract drying operations). For the sake of high overall efficiency allied to meeting the demands of the electricity market, an economically and ecologically sustainable combination of multiple options must be selected specific to location. This can be done by adapting the schedule to the heat demand, though this restricts the possibilities of demand-oriented electricity production, by building-in heat storage capacity, using local heat grids as storage and making the heat generation concepts themselves (especially contract drying) more flexible.

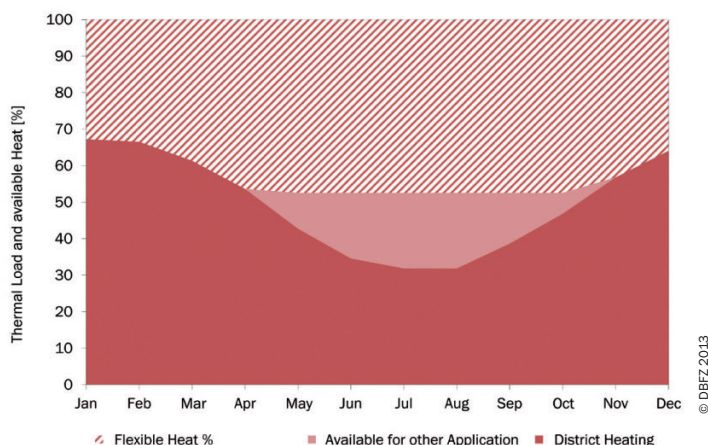


Figure 33: Example of a thermal load profile of a biogas plant

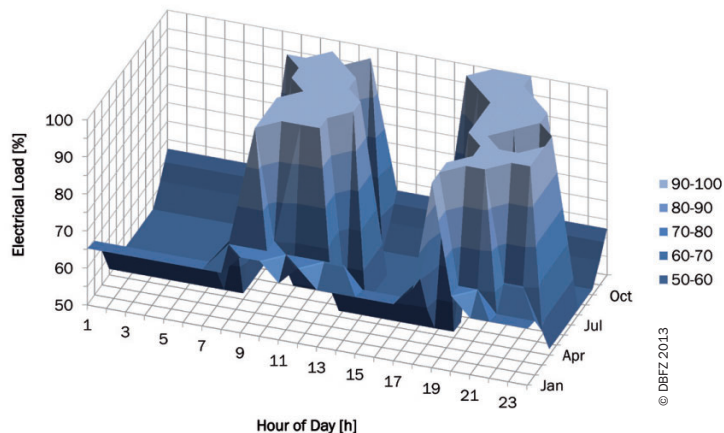


Figure 34: Example schedule of a flexible CHP plant

Challenge of the electricity market

At the end of 2012, 7,500 biogas plants with a total installed capacity of 3.2 GW were supplying 24.8 TWh of power and 12.1 TWh of heat. The percentage of total electricity supply covered by biogas plants in Germany was thus approximately 4 %. There are two basic ways to make bioenergy as a key pillar of the power sector more flexible: variable conversion of the produced gas quantities and variable gas production. The first variant, detailed here, is based on a conversion capacity above the production capacity of the fermenter. This can be effected by reducing gas production, increasing conversion capacity (with one or more CHP plants), or a combination of the two. Load shifting, supported by gas reservoirs, can be effected either by a part-load or start-stop mode. This mix of different measures results in a kaleidoscope of flexible design scenarios. The configuration of the individual plant depends on the relationship between the revenue and expenditure sides. The latter is influenced by the technical possibilities and their costs, as well as by the management and marketing costs.

Interdisciplinary cooperation between working groups and departments of the DBFZ

To incorporate these widely differing influences on bioenergy into project management, different working groups within the Bioenergy Systems Department of the DBFZ work together: The Markets and utilisation working group focuses on the markets; the Biomass in the Energy System working group focuses on grids and transformation processes; and the Sustainability and Biomass Potential working group focuses on the associated impact in terms of sustainability. The equally important technical aspects are processed on an interdepartmental basis between the Bioenergy Systems and Biochemical Conversion departments.

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5-year contribution to the BMUB's "Biomass Energy Use promotion programme" by the DBFZ

Back in 2008, the DBFZ began its scientific work accompanying the BMUB's Biomass Energy Use promotion programme, providing support to 36 projects being conducted all over Germany. The programme supervisors are now responsible for networking and public relations for a total of 90 projects, with 225 single projects, from 160 different institutions. The DBFZ alone is involved in 27 projects, including "Milestones 2030", "Greenbelt Energy Havelland", "OptFlex", "FlexiTor" and "Basic information on agricultural residual products", all coordinated by the Bioenergy Systems department. Our organisation is thus able to look back on five successful years supporting the programme, and also on project promotion within the BMUB promotional programme.

On November 14th and 15th, 2013 the programme supervisors organised a conference marking the programme's anniversary: "5 years of the BMUB's Biomass Energy Use programme – pathways to efficient bioenergy!" Over 200 participants from the fields of science, practice and policy-making took up the invitation to the Leipzig event. At the conference, a summary appraisal of the programme was set forth, and scientists and users alike were offered the opportunity to present relevant efficient and sustainable solutions for bioenergy use. The projects presented focused on the use of residual products based on economically and ecologically sustainable methods. In order to develop and optimise the required technologies, numerous new concepts and process optimisations and demonstration and pilot plants have been developed over the past five years. The scientists and industrialists participating in the conference presented results relating to pollution control for small-scale furnaces and to flexible design and process optimisation for biogas plants. Other presentations related to advances in incineration and gasification technologies as well as challenges in the context of flexible bioenergy supply. Those topics were the main areas of research focus in the promotional programme but also represented key challenges for the entire bioenergy sector.



Figure 35: Podium discussion at the 5th annual conference of the BMUB's Biomass Energy Use promotional programme

Innovative ideas are mostly created in close cooperation between scientists and practitioners. Over the past five years the programme supervisors have initiated numerous networking activities and made the results of the projects accessible to a broad public. Media communications, a dedicated website, numerous publications, 20 topic-specific workshops, three scientific conferences and five status conferences were among the many public activities forming part of the promotional programme.



Figure 36: Series of papers published by the BMUB's Biomass Energy Use promotional programme

More than 50 publications were issued in conjunction with various project partners. One of the key products is the series of papers conceived specially for the programme and published by the programme supervisors. The series already comprises 12 publications issued in conjunction with DBFZ projects. They include:

- Series No. 02, “Basic information on agricultural residual products”
- Series No. 10, “Guide to greenbelt energy”
- Series No. 12, “New concepts for use of biogenic solid fuels”

As well as the discourse relating to the relevant sustainability criteria within the promotional programme, the programme supervisors also coordinate the process of harmonising applied methods. This included the compilation of guidelines formulating concrete framework conditions for the projects in collaboration between DBFZ scientists and the promotional programme. The guides concerned were: “Methodology handbook for material flow oriented balancing of climate gas effects”; “Biogas methodology collection – Methods for determining analytical and process parameters in the biogas sector”; and “Fine dust methodology collection – Proposed methods for fine dust recording on furnaces for solid biogenic fuels”.

Information on the projects and programme activities, along with the publications, can be accessed on the portal at www.energetische-biomassenutzung.de.

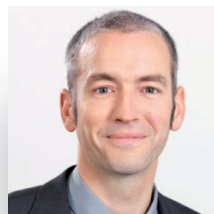
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Biochemical Conversion Department

The Biochemical Conversion Department researches the production of energy source materials from biomass using micro-organisms. Its focus is on technologies for biogas recovery and use. A wide range of challenges has to be overcome in order to attain technically optimized biochemical conversion, with technical, biological, chemical, logistical, legal, ecological and economic issues all equally involved. One of the key objectives of the research activities in this context is to improve the efficiency of the overall process whilst cutting costs. The department also researches topics arising from the need for increasing flexibility in the operation of biogas plants – in particular the new demands in terms of technology and process control. It also considers the efficient use of material flows and closed nutrient circles, as well as supporting the demonstration of new and improved plants and components. All activities are undertaken against the background of detailed evaluation of the market and of the technical state of the art, assured by participation in various monitoring projects. As part of its intensive cooperation with the Helmholtz Centre for Environmental Research - UFZ, it also provides answers to wide-ranging questions relating to the properties and population dynamics of the micro-organisms involved.



Head of Department

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The Biochemical Conversion Department is divided into four working groups:

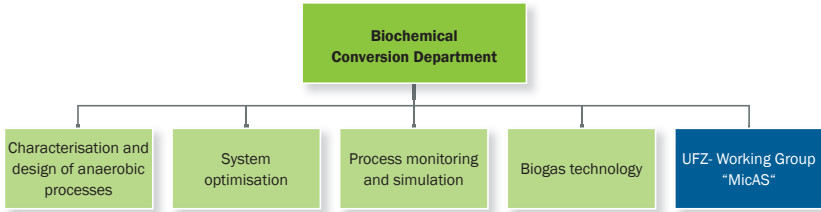


Figure 37: The working groups in the Biochemical Conversion Department

Research focus areas



Characterisation and design of anaerobic processes

Dr.-Ing. Jürgen Pröter
(juergen.proeter@dbfz.de)

- Substrate and process characterisation
- Disintegration
- Additives
- Process development



System optimisation

Dipl.-Umweltwiss. Jaqueline Daniel-Gromke
(jaqueline.daniel-gromke@dbfz.de)

- System optimisation and integration
- Emissions situation and measurements
- Biogas/biomethane economic viability assessment
- Biogas/biomethane monitoring/plant database
- Policy advice

**Process monitoring and simulation**

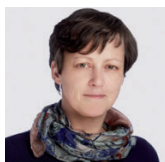
Dr. H. Fabian Jacobi
(fabian.jacobi@dbfz.de)

- Microbiological understanding
- Process optimisation
- Process simulation and control
- Flexible structuring
- Process monitoring/metrology

**Biogas technology**

Dipl.-Biotechnol. Elmar Fischer
(elmar.fischer@dbfz.de)

- Identification of technical deficiencies in operation
- Analysis of the overall efficiency of biogas plants
- Technical assessment of plants and components
- Concept design for the production of biogas from residual and waste products

**UFZ working group****Microbiology of Anaerobic Systems (MicAS)**

Dr. Sabine Kleinsteuber
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- Composition and activities of microbial communities – process understanding
- Monitoring tools and microbial early-warning systems
- Lignocellulose-rich substrates
- Pre-treatment methods and bioaugmentation

Services and technical equipment

Services

- Discontinuous fermentation experiments to identify biogas and residual gas potential
- Conducting continuous experiments in fermenter sizes from 5 – 500 l
- Substrate and digestion residue analysis
- Consulting and expert reports
- Support to demo plants

- Process development for special substrates
- Advancing existing methods of laboratory analysis and establishing new ones
- Model-based process simulations to assess specific process states
- Acquisition of data on biogas plants in Germany (including state of the art, substrate usage, remuneration structure)
- Emission measurements and leak detection
- Assessment of systems and concepts for the supply and use of biogas/biomethane with regard to technology, ecological sustainability and economic viability
- Analyses of the potential of biomass to supply biogas/biomethane
- Policy advice for the biogas sector
- Assessment of systems and concepts with regard to technical and economic feasibility
- Evaluation of the energy efficiency and economic viability of the various biogas supply options
- Large-scale experimentation (biogas pilot plant)
- Concept development of technical measures to reduce emissions
- Microbiological monitoring of biogas plants by molecular biology and microscopy methods (population mix and activity of functional groups),
- Identification of methanogenesis routes based on biogas isotope signature

Technical equipment

Biogas lab

The biogas laboratory is designed and equipped to simulate large-scale technical processes on a laboratory and semi-technical scale, complete with the corresponding analytics. Its aims are to optimise processes and to improve basic understanding of the individual sub-processes involved in methane formation. It operates extensive (continuous and discontinuous) pilot plants with reaction volumes between 0.25 and 500 litres, as well as the biogas pilot plant. It investigates a wide variety of substrate mixes from agriculture, the waste management sector and industry on behalf of various research and industrial partners. Alongside in-process analytics, the laboratory's trace analytics function is one of its key areas of activity. Resources available to the scientists include high-performance liquid chromatography (HPLC) as well as gas chromatographs (GCs) for analysis of intermediate products.



The cooperation agreement with the Helmholtz Centre for Environmental Research - UFZ means microbiological analyses are also possible. As well as laboratory simulation and the associated stationary systems, resources also include various instruments for conducting field measurements. In combination, these resources enable plant efficiency and emissions from large-scale plants to be assessed.

Figure 38: Work in the DBFZ Biogaslab

Emission measurements

The Biochemical Conversion Department has an extensive range of measuring instruments for the identification of diffuse methane leakage. The portfolio includes an imaging system capable of visualising methane losses in real time, a methane laser, as well as various hand-held instruments with which point sources of methane can be detected. There is also an extensive range of equipment for quantifying climate-related emissions, from both controlled and diffuse sources. Methodological resources include open and closed hoods, whilst optical remote measurement methods can also be employed to determine emissions based on dispersion models.

Biogas pilot plant

The biogas pilot plant extends the range of application-oriented research being carried out at the DBFZ to enhance process understanding and improve the efficiency of biogas production. The dimensioning of the fermenters allows experiments to be conducted on a technical scale, so ensuring good transferability of results into practice. The facility features two independent lines with identical capacity which can be operated as a single- or two-stage system, with optional hydrolysis. The first line is a wet fermenter with a main fermenter in the form of a stationary stirred tank with a central agitator.

The second line can optionally be run with a main fermenter of identical design or with a plug-flow fermenter. A post-digester with a gas reservoir cover collects the fermentation residues from both lines and routes them to the fermentation residue store. The biogas is used in a 75 kW_{el} CHP (combined heat and power) plant to cover the facility's own energy demand. Surplus power can be fed into the DBFZ grid. For substrate supply, small amounts of self-produced silage can be stored on-site. To measure the gas production volumes precisely, the fermenters are fitted with permanent covers. Terminal units in the pipeline system and at the gas capture point permit sampling and the installation of measuring instruments.



Figure 39: Use of an infrared camera to detect diffuse gas methane losses on the DBFZ biogas pilot plant

Reference projects

Precision demand-based control of energy from biomass

With the increasing development of widely fluctuating renewable energy sources (wind power, photovoltaic) in recent years, the intelligent integration of those new energy sources into the German power system with a view to safeguarding stable supply for industry and domestic use poses a key challenge. In meeting that challenge, suitable controllable power sources must be combined with the increasing but non-controllable sources in such a way that supply and demand are always balanced, and so the stability of the grid and of supplies can be ensured.

Gases can be produced from biomass for power generation by two different processes: 1. Biogas from anaerobic digestion of organic substances (such as biowaste, agricultural residual products and regrowable resources); and 2. Synthesis gas from thermo-chemical gasification, for example of residual products such as sawdust or straw. Power generation by these two processes is fundamentally controllable in a flexible way, though that flexible design is not currently implemented in practice. The object of the ongoing project “Precision demand-based control of energy from biomass” is to develop controls for the plannable, demand-based operation of these techniques for the generation of power from biomass. The aim is to control both processes based on demands from the electricity grid, implementing demand-controlled energy production right from the biomass conversion stage. For both cases, production of the source gases is to be controlled in such a way that complex and costly local storage can be bypassed and maximum flexibility attained.

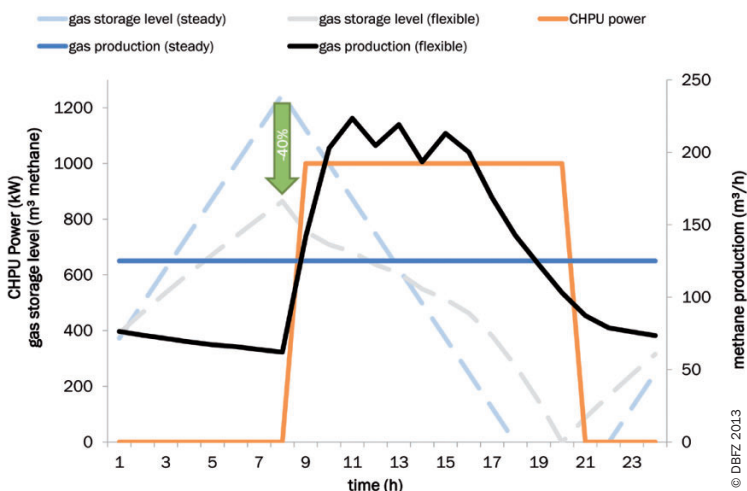


Figure 40: Extrapolation of laboratory results to practical scale for the required methane gas storage capacity. Controlled – i.e. flexible – biogas production requires fewer gas reservoirs than continuous biogas production.

To implement flexible biogas processes, experiments are being conducted on a laboratory and pilot plant scale, and practice-scale trials are also planned. Based on targeted input to the process, the gas is to be produced mainly during periods of demand, so saving on the gas reservoirs required for interim gas storage. The biogas process is shown to be highly flexible even in the laboratory (see black and blue lines in figures 40 and 41). Extrapolated to practical operational scale, this means that the same flexibility can be retained with much lesser storage volume (figure 40, green arrow) or with the same storage volume a higher degree of plant flexibility can be achieved (figure 41, green arrows: higher output in shorter time). This might deliver a major cost advantage for the plants. Whether this process behaviour is actually exhibited on a practical scale is unclear. Usually, in practice, there is less dynamism to the process – but here the input is likewise evenly spread through the day. The extent to which a similar dynamism as in the laboratory can be produced by the targeted use of suitable substrates at the right times will be investigated in the further course of the project.

Alongside the development of controls for demand-oriented power generation, conventional plant concepts are being analysed in relation to flexible design. To that end, the use of fuel cells as an alternative to conventionally operated combined heat and power plants is being evaluated in practical trials.

The flexible plant design concepts derived from the trials will be subjected to economic viability studies, the potential for the flexible design of plants in Saxony evaluated, and the supporting effects of such a modification on grid stability and on the life-cycle assessment with regard to the bioenergy input materials studied.

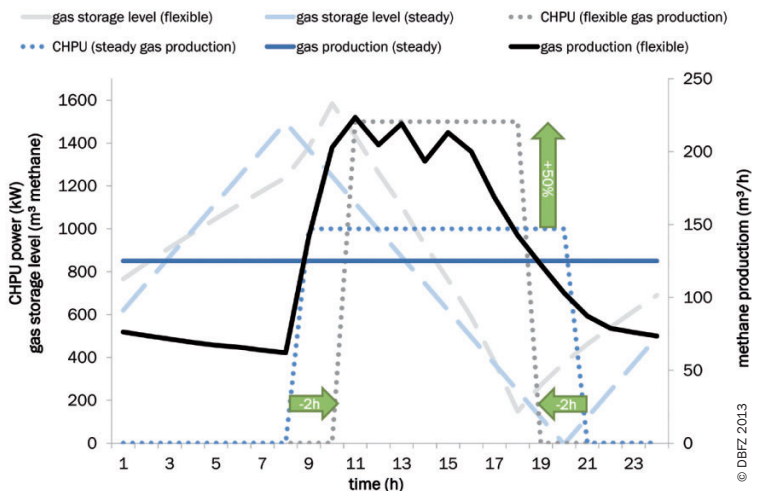


Figure 41: Extrapolation of laboratory results to practical scale for the possible capacity level (CHP plant size) and load distribution (duration of power generation) with a fixed gas storage volume. With flexible biogas production, greater flexibility can be attained with the same storage volume.

The results of the project will be applied to establish basic principles for the use of bioenergy to compensate for the demand bottlenecks which wind power and photovoltaic energy by their nature entail.

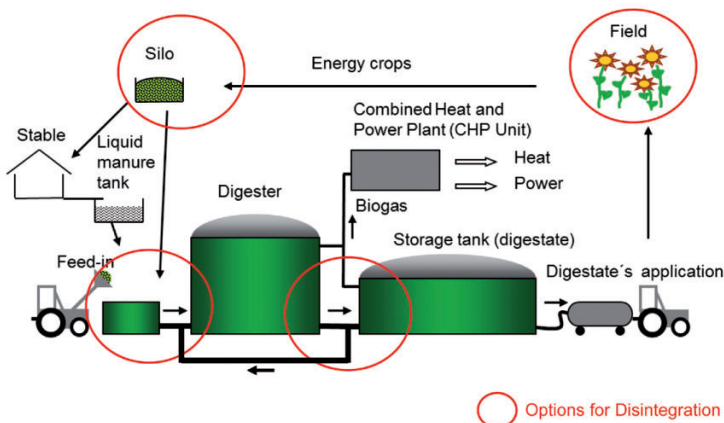
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Inventory of biomass decomposition methods for biogas/bioethanol

As a producer of seeds, including of energy crops, KWS Saat AG is at the leading edge of technological developments in biomass decomposition processes as the preliminary stage to the production of biogas and bioethanol, and is also interested in estimating the downstream consequences. Against that background, a study produced by the DBFZ aimed to answer questions relating to the state of the art in technology and research in physical, chemical and biological disintegration processes for energy crops. For the purpose, technologies of biomass disintegration for the processing of biomass into biogas and bioethanol worldwide were researched. These physical, chemical and biological methods were assigned to the various „Technology Readiness Levels“ set out in the US Department of Energy's „Technology Readiness Assessment Guide“.

For more detailed analysis, only disintegration methods installed upstream of the main fermenter on biogas plants or capable of being used for recylcate decomposition were selected (Figure 42). The project did not consider harvesting and storage methods, which also influence biomass degradation. Where market availability was identified, the manufacturers/distributors were researched and asked to provide data including in relation to



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Figure 42: Possible locations for application of disintegration methods on agricultural biogas plants

energy consumption, capital investment and operating costs. The plausibility of data from external studies or corporate brochures relating to yield increases, changes in degradation kinetics and other positive effects described was subjected to critical appraisal. Based on model biogas plants, comparative economic viability studies were conducted for typical biogas substrates in combination with various disintegration methods.

The results of the study are to be used as the basis for recommendations of further procedure and for narrowing the scope of possible follow-up studies.

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BioEconomy Leadership Cluster – “Energy use and optimisation within the overall context of cascaded usage”

As part of the „BioEconomy Leadership Cluster“ project, the use of residual product flows from the decomposition of beechwood (the Organosolv process) is being investigated. The background to the project is the sustainable material use of regrowable resources from the non-food sector, and in particular the production of sustainable products for various industries, as well as use of the residual products from the processes to produce energy. The aim is to maximise the value creation of non-food biomass in a sustainable way based on linked production and cascaded usage to produce chemicals, new materials, input materials and energy in a biorefinery. The work of the Biochemical Conversion department is focused on the development of a method for anaerobic treatment of the by-products from the process which cannot be used as materials.

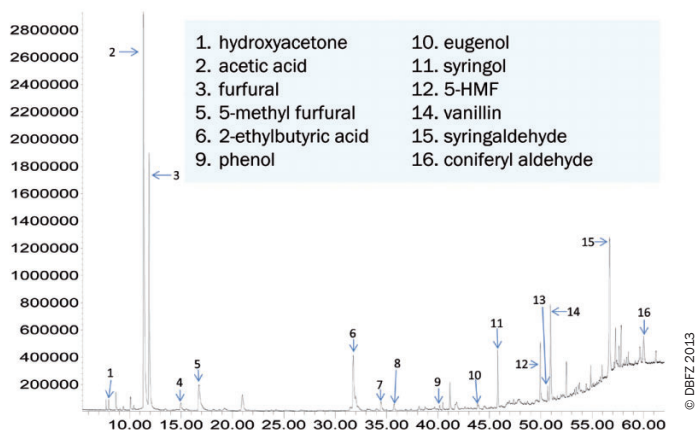
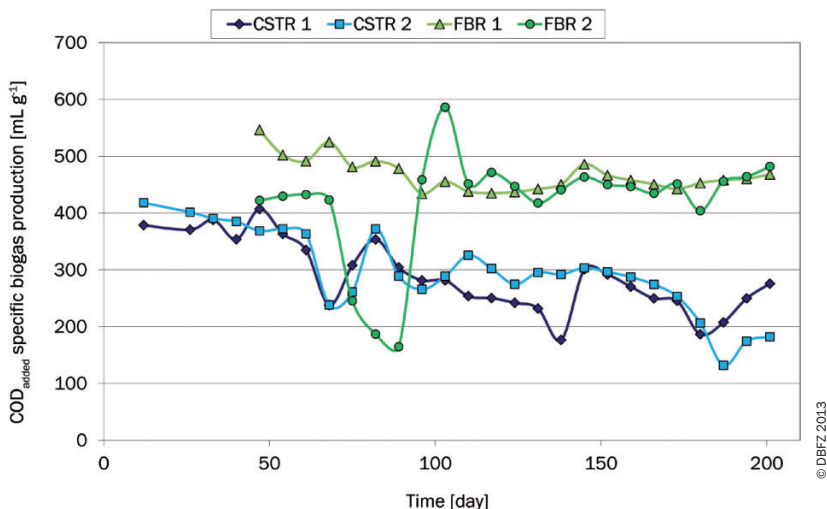


Figure 43: HPLC chromatograph showing phenols and other chemical compounds in the substrate

The substrate used for biogas production is a liquid residual product created by the decomposition of wood in the Organosolv process. This is a marsh residue containing primarily ethanol, acetic acid, xylose as well as other sugars and organic substances in smaller concentrations. The challenges for anaerobic digestion lie in the low pH value, the inadequate concentrations of macro-nutrients and trace elements, and in a possible inhibition of the process by the included phenols and furfurals (Figure 43).

In the project to date, various batches of the residue have been investigated in terms of their composition, optimised by the addition of nutrients and trace elements, and applied as substrate in continuous fermentation tests. This was done using both fully-mixed stirred-tank reactors and fixed-bed reactors. In both systems there were sporadic process instabilities and accumulations of organic acids. Adaptation of the micro-organisms to the substrate was made difficult by widely fluctuating substrate properties in the various batches (e.g. sulphur contents between 6 and 513 mg L⁻¹). All in all, however, the fixed-bed reactors exhibited a more stable process, and at around 450 L kg⁻¹ much higher specific CSB biogas production compared to the stirred-tank reactors, in which a trend towards decreasing gas formation is detectable (Figure 44).

Methane concentrations between 60 and 70 %, and in part extremely high concentrations of hydrogen sulphide (up to 20,000 ppm), were measured in the biogas. Analyses by HPLC (High Performance Liquid Chromatography) revealed that potentially inhibiting substances such as furfurals were effectively degraded.



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Figure 44: Gas production in the reactors over time in ml per g CSB input

In the ongoing investigations, the digestion process will be further optimised and ultimately a basis created for upscaling. In addition, based on the results data mass and energy balances will be drawn up covering the complete process to serve as the basis for energy efficiency and ecological sustainability assessment of the biorefinery concept.

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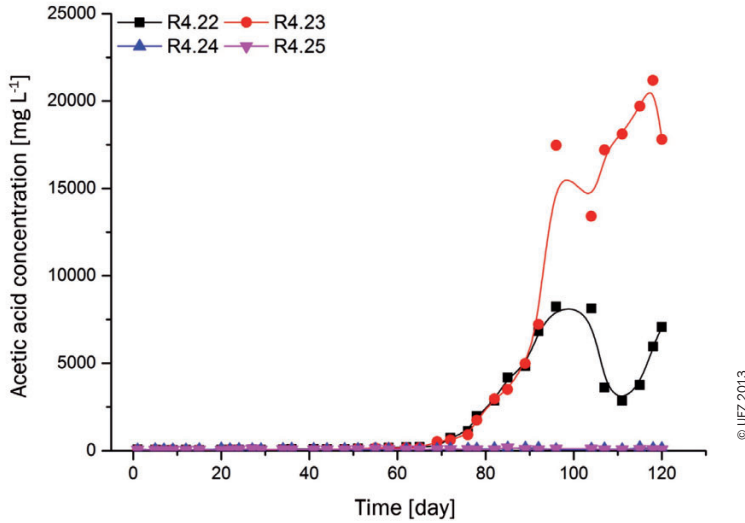
Stable isotope composition of biogas as a pre-warning signal of process failure

Future biogas plants will probably use more heterogeneous substrates and wastes with fluctuating quality or will be operated more flexible according to the needs of electricity production. Such situations require a better control of the anaerobic digestion process, especially the activity of methane producing microorganisms. Current methods are elaborate and time-consuming, or the measured parameters do not unambiguously detect the process imbalance or show only a delayed response.

Determination of stable isotope characteristics of the produced biogas allows an alternative rough estimation of the predominant methanogenic pathway in anaerobic digesters with potential industrial applicability. Methanogenesis is associated with an isotope fractionation effect due to the preference of the microorganisms to use and convert molecules containing lighter carbon isotopes (^{12}C) over heavier carbon isotopes (^{13}C). The isotope signature of methane and CO_2 can be used to analyze methanogenic pathways, since methane formation from H_2 and CO_2 (hydrogenotrophic methanogenesis) results in larger isotope fractionation than methane formation from acetic acid (acetoclastic methanogenesis). This method is frequently applied in environmental research but only few studies are available for biogas reactors. Therefore our aim was to test the method in laboratory-scale biogas reactors and to demonstrate its suitability for process monitoring.

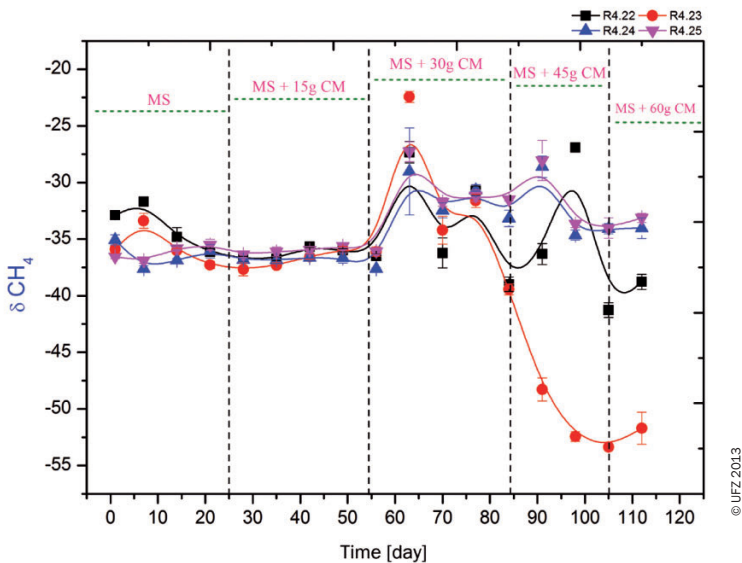
In a first experiment, the influence of different substrates (maize silage, stillage, chicken manure) and of different organic loading rates on the isotopic signature of the produced biogas was investigated. We validated the isotope results with molecular analysis of the active methanogenic microorganisms. In general, the isotope signatures of the biogas supported the results of the molecular analyses. However, the isotopic signature of the biogas produced from maize silage was different due to the specific isotope composition of maize as a C4 plant. Consequently, the isotope composition of the substrate has to be taken into account when interpreting the isotopic signature of biogas.

The ability of stable isotope fingerprinting to follow short-term activity changes was demonstrated by observing the shifts in isotopic values shortly after substrate feeding. The carbon isotopes of the produced methane represented well the dynamics of the microbial activity changes of the biogas process.



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Figure 45: Acetic acid concentration increase in continuous stirred tank reactors R4.22 and R4.23, as a function of addition of chicken manure as co-substrate to maize silage. R4.24 and R4.25 are control reactors fed with maize silage only.



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Figure 46: The changes of the isotope composition of the produced biogas in ammonia inhibited systems (R4.22 and R4.23) and in control reactors (R4.24 and R4.25)

To follow long term effects and to detect process inhibition by isotope fingerprinting, two parallel reactors were fed with maize silage and two reactors with an increasing amount of chicken manure in addition to maize silage. Under anoxic conditions ammonia is produced from chicken manure which inhibits mainly aceticlastic methanogens. As a result of substrate change, the ammonia concentrations in these reactors gradually increased. The gas production in these ammonia inhibited reactors continuously decreased and volatile fatty acids, especially acetic acid, started to accumulate indicating a process imbalance mainly due to the partial inhibition of methanogenesis (Figure 45). In the later period one reactor failed completely as visible by very low gas production and foaming. In contrast, the process in the other reactor stabilized but it produced much less biogas compared to the control reactors. Despite the accumulation of acids the pH values remained stable due to the buffer capacity of the reactor content. The methane content of the biogas was also not informative regarding the approaching process failure. The stable isotope composition (expressed as $\delta^{13}\text{C-CH}_4$) showed a trend of depletion in heavy carbon (resulting in more negative values) as shown in Figure 46. The sharp decrease in case of R4.23 predicted the complete process failure, while in the other chicken manure fed reactor also the isotopic values stabilized at higher level. Already around day 85 a marked difference between the two inhibited reactors was observed, while other parameters were still similar at this time. Therefore, we can conclude that the isotope signature indicated earlier the approaching process failure than other process parameters. Application of optical spectrometry based measurement of the isotope composition of biogas allows an on-line monitoring of the biogas process.

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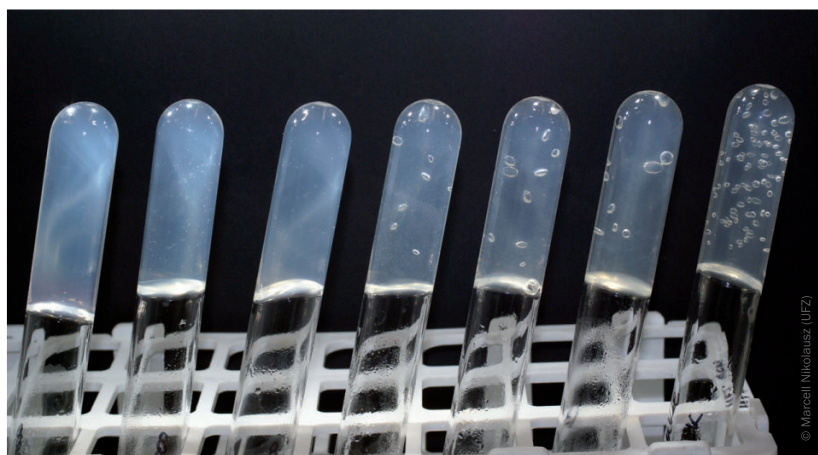


Figure 47: Accumulation of fermenting micro-organisms (clostridia) from a biogas reactor in agar cultures.



Thermo-chemical Conversion Department

The Thermo-chemical Conversion Department addresses a range of topics associated with the thermo-chemical conversion of biogenic solid fuels for the efficient, demand-based supply of power and/or heat or cold. All scientific and technical aspects along the entire utilization chain are considered, i.e.: production, supply and modification of the solid fuels; the conversion plant and its control; emissions cleaning as well as system and net integration. The approach is both theoretical, by means of monitoring and basic observation, as well as practical, based on development work and optimisation. In order to expand the share of Germany's energy mix obtained from renewables, as demanded by the government's Climate Protection Initiative, the efficiency of the use of solid biofuels must be significantly increased. At the same time, environmental impact of energy related biomass utilization must be reduced – in particular, emission of fine dust, volatile organic compounds (VOCs) and nitrogen oxides (NOx) –. In response to those demands, the Thermo-chemical Conversion department investigates how the available biomass resources can be exploited, such as by the use of mixed biofuels. It is involved in the further optimisation existing combustion systems and the development of new equipment. Furthermore emission reduction and control including catalytic processes are investigated. Other efforts include the design of



Head of Department

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innovative control systems for combinations of bioenergy with other renewable energies, the development and optimization of combined heat and power (CHP) systems in all power ranges; and enabling efficient frameworks for demand-based energy production and integration of bioenergy into grids.

The Thermo-chemical Conversion Department is divided into three working groups:

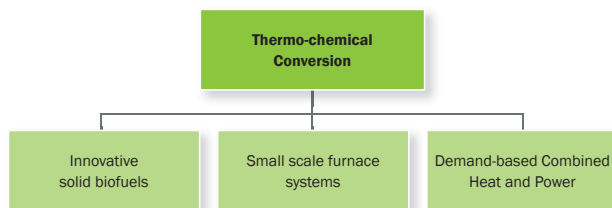


Figure 48: The working groups of the Thermo-chemical Conversion Department

Research focus areas



Innovative solid biofuels

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Stellvertretung: Dr. agr. Jan Hari Arti Khalsa

(jan-hari-arti.khalsa@dbfz.de)

- Processing (including torrefication) and pelletisation of biomass together with process optimisation
- Influencing fuel properties by conditioning
- Investigations into interaction mechanisms between fuel properties and fine dust and emissions creation in combustion of biogenic solid fuels in furnaces of less than 1 MW thermal capacity
- Research into and development of new alternative (combination) fuels from biomass
- Creation of a fuels database including combustion-related properties



Small-scale furnace systems

Dr. rer. nat. Ingo Hartmann

(ingo.hartmann@dbfz.de)

- Optimisation and development of single-chamber furnaces
- Development and optimisation of flexibly operable high-efficiency, zero-emission automatic biomass solid fuel incinerators in the 2 to 400 kW power range
- Development and optimisation of catalytic emission reduction techniques

- Development, optimisation and integration of combination dust separators
- Development, optimisation and integration of thermo-chemical conversion components for small-scale furnaces



Demand-based Combined Heat and Power

Dr.-Ing. Andreas Ortwein
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Integration concepts – control strategies

- Development and optimisation of controllers for biomass-based building combined heat and power systems, including storage and integration of other renewables
- Development of controllers and control concepts for demand-oriented integration of biomass CHP plants into the grid system (including control energy)
- Devising master concepts and drafting requirements specifications for single plants supplying demand-oriented energy

Development of flexible (micro) CHP technologies

- Development of micro-CHP plants with 0.2 – 20 kW_{el} capacity for biogenic solid fuels
- Concept design and development of next-generation biomass combined heat and power plants (e.g. IGCC)

Computational Fluid Dynamic (CFD) research group

- Development and implementation of models for the thermo-chemical conversion of biogenic fuels in numerical flow simulation
- Support to all development work by CFD simulations of the thermo-chemical and thermo-dynamic processes

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Dr. Fouzi Tabet (fouzi.tabet@dbfz.de)

Accredited test body D-PL-14603

Dr. rer. nat. Justus von Sonntag
(justus.von.Sonntag@dbfz.de)

- Test stand measurements and field measurements
- Development of instrumentation and measurement techniques (also in particular for emissions measurement, including secondary aerosol effects and toxicity characterisation)
- Testing of separators, including development of test methods
- Contribution to the national and international standardisation of emission measurement methods
- Specifying scientifically founded limit values and grant aid criteria
- Participation in international round-robin tests

Services and technical equipment

Services

- Development of fuels and combustion tests including pre-treatment and additive input (i.e. influencing combustion-related properties) and pelletisation; also trial incineration in small-scale furnaces
- Characterisation of biomasses and analysis of their suitability as fuel
- Assessing and advancing the technical aspects of fuel preparation and feed
- Feasibility studies / Assessment of usage concepts
- Analysis of small-scale furnace systems, including secondary exhaust gas treatment on the test stand and in practice with regard to efficiency and emissions
- Contribution to standardisation and drafting of directives
- Development of small-scale furnace systems (firing, exhaust gas cleaning) for all biogenic solid fuels
- Technical and economic assessment of CHP concepts for biogenic solid fuels
- Development of miniature CHP and CHPC (combined heat, power and cold) plants
- Appraisal of power generated from biogenic sources and heat from co-incineration
- Development of new control concepts for the integration of biomass boiler plants into supply facilities
- Development of small-scale furnace systems and system components for biogenic solid fuels
- Testing and assessment of new separators
- Catalyst characterisation
- Accredited dust and CO measurements including assessment of results



Figure 49: DBFZ combustion lab

Technical equipment

Technical centre with ten combustion test beds

In the combustion lab, the DBFZ conducts experiments on raw or pre-conditioned biomass by means of thermo-chemical conversion. It is also able to carry out detailed analysis of gaseous emissions and particulate formation. The combustion lab is equipped with a full-flow dilution tunnel test bed, two separator test beds with variable volumetric flow, a tiled stove test bed, a catalytic converter development stand, 15 exhaust analysers (including FTIR, SMPS, exposition chamber) and seven dust measurement devices as well as eight boiler vessels on various different experimental setups. An additional test bed for micro CHP systems has been installed.

Fuel conditioning lab

Based on its extensive and widely respected experience and know-how, the DBFZ's fuel conditioning and combustion lab together with its analytics lab conduct a wide variety of tests and experiments in close cooperation with leading scientific and industrial partners. Fuel conditioning experiments can be performed on a wide variety of different fuels. A warehouse facility covering an area of over 800 m² currently holds more than 250 different fuel variants. The fuel conditioning and combustion lab has dedicated conditioning systems and a 20kW ring-die press for the production of various innovative solid biofuels including fuel mixtures. The pellets produced can be fully characterised in accordance with European standards governing solid biofuels.



Figure 50: Pellet production at the DBFZ fuel conditioning and combustion lab

Reference projects

Development and testing of a low-emission firing process for wood shavings

As part of a cooperation agreement with the Universidad de Talca in Chile, the Small-scale Furnace Systems working group of the Thermo-Chemical Conversion department is participating in the development of low-emission wood furnaces. The aim is to reduce pollutant emissions from domestic furnaces and to increase the efficiency of wood use for energy. 20 % of primary energy consumption in Chile is attributable to wood, with 58 % of home heating generated from fuel wood. Consequently, wood burning is even ahead of natural gas or petroleum as the key domestic energy source.

At the same time, wood furnaces are a major source of airborne pollutants such as fine dust and soot (black carbon). In the majority of towns and villages in southern Chile, most dust pollution is caused by burning (often excessively damp) wood in chimneys, boilers and stoves. Owing to the outdated firing techniques compared to European standards, very high

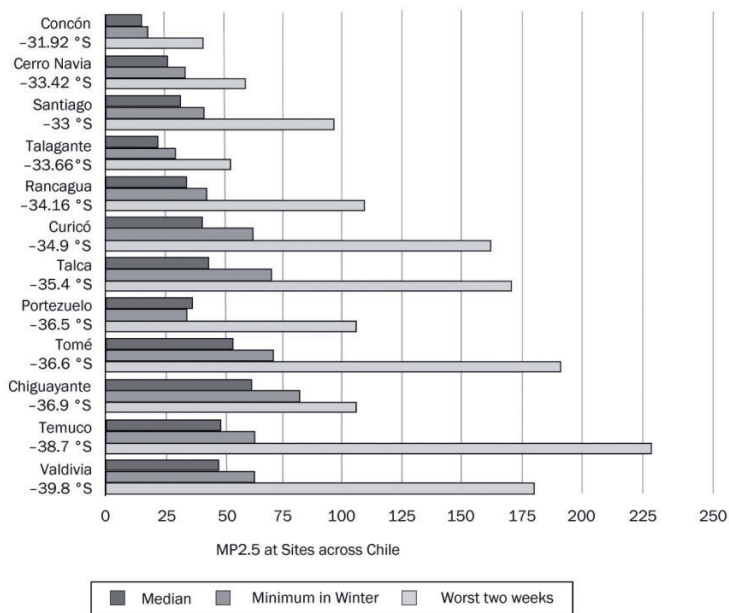


Figure 51: Particle concentrations (PM 2.5 in $\mu\text{g}/\text{m}^3$) in the ambient air of Chilean towns (data source: Chile, Ministry of Environment, SINC (Sistema de Información de Calidad del Aire) 2011) / Graphic: Smith/Pillarsetti: A Short History of Woodsmoke and Implications for Chile

concentrations of fine dust occur in the flue gas. Moreover, the woodsmoke contains high quantities of toxic compounds such as soot and polycyclic aromatic hydrocarbons (PAHs). The guide value stipulated by the World Health Organisation for the maximum permissible level of fine dust pollution in the ambient air of $20 \mu\text{g}/\text{m}^3$ (PM 2.5) is frequently surpassed many times over, especially in the Winter months.

As part of the cooperation agreement, primary and secondary pollution control measures are being investigated and tested. In order to attain the most extensive possible reduction in fine dust pollution, two main approaches are being pursued: converting/retrofitting older furnaces and developing new systems. These approaches seek particularly to take into account specific local circumstances, such as the type of installed furnaces, the available wood and the buildings being heated, as well as economic aspects, so as to offer practicable solutions which will be accepted by the users and are financially affordable.

In relation to installed furnaces, measures being investigated include the following: Retrofitting the combustion chamber/grille; integrating controlled air supply; catalytic emissions reduction; fitting of dust filters.

The development of new furnace systems is being undertaken in cooperation with a Chilean producer, with the aim of complying with existing and future emission limits without use of secondary measures. The furnaces being developed must offer high tolerance to use of damp wood in terms of their emissions, as Chilean homes often use fuel wood with water content above 30 %.

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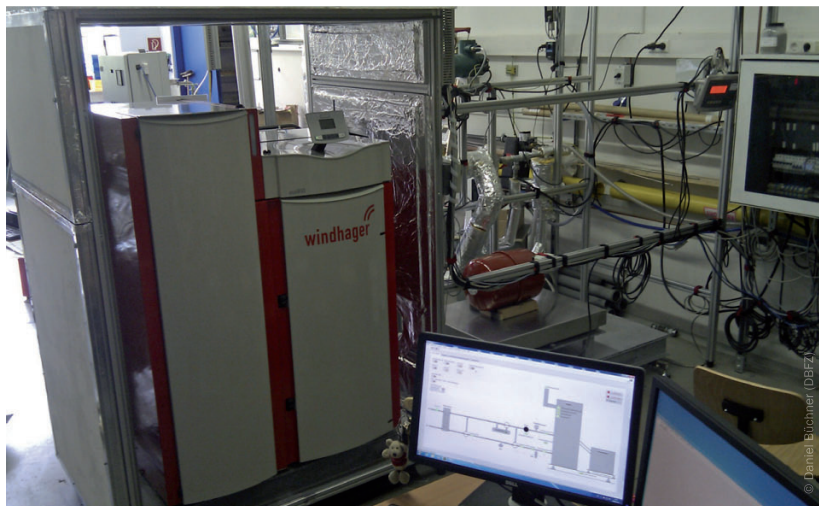


Figure 52: Test bed for measurement of radiation losses from pellet boilers (in the picture the front and rear covers have been removed)

BioMaxEff: Cost-effective pellet boilers delivering maximum efficiency and minimal emissions

Declining fossil fuel energy sources, more stringent climate protection controls and associated legal restrictions as well as the continually rising energy prices of recent years have led to increased demand for energy-optimised supply concepts. Energy efficiency is also increasingly perceived as a key economic factor by society at large. The object of the BioMaxEff project is to develop low-cost pellet boilers offering maximum efficiency and minimum emissions for different building types, test them under laboratory conditions and evaluate them in the field as part of a joint project incorporating seven selected European countries. The focus of the investigations is on systems for room heating and hot water supply in renovated buildings and low-energy housing, and when replacing boilers.

The DBFZ is investigating all of the aforementioned topics in conjunction with the following partners: Bioenergie 2020+ (BE2020), Bio Intelligence Service (BIOIS), Technologie- und Förderzentrum (TFZ), Università Cattolica del Sacro Cuore (UCSC), Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), Centre for Research and Technology Hellas (CERTH), Windhager Zentralheizung Technik, Windhager Zentralheizung, ELK Fertigteilhaus, Nilan, Consulting with Purpose (CWP) and BIOS Bioenergiesysteme (BIOS).

In the project, extensive measurements were performed on various pellet boilers under laboratory conditions, and field measurements were carried out to acquire data relating to the usage rates and emissions of state-of-the-art pellet boilers. Particular attention was paid to conducting comparable and reproducible load cycle tests to determine the annual usage

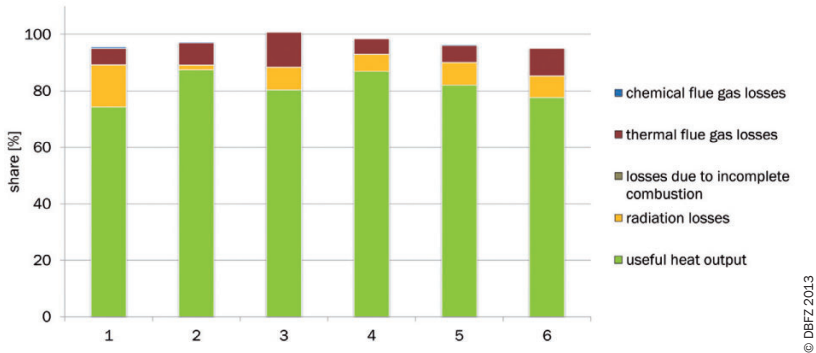


Figure 53: Energy balance of selected tests at the DBFZ

rates and emission factors of pellet boilers. For direct measurement of the radiation losses, an enclosed test bed was set up at the DBFZ (Figure 52). It enabled all relevant loss quantities to be measured. The test stand makes it possible to measure the energy balances of pellet boilers to an accuracy of 5 % (Figure 53).

The field measurements carried out by the DBFZ at two locations confirmed the results of the test bed measurements. The installed measuring systems permit detailed analysis of the boilers' operating modes and, from that, their usage rates and emissions at cycle level. With the data obtained, the efficiency losses in a year can be quantified. This enables the various optimisation approaches to be assessed in terms of their relevance to annual usage rates

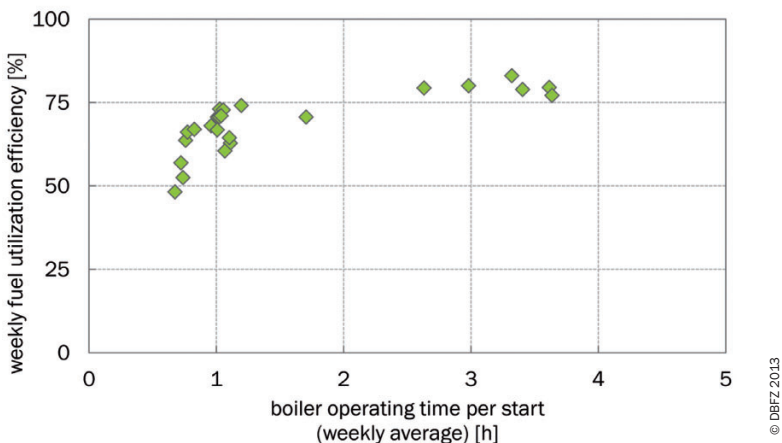


Figure 54: Weekly usage rates dependent on average running time per start-up for a boiler in the project field test

and emission factors. From those findings, conclusions can be drawn in turn as to suitable test procedures to determine annual usage rates and emission factors in the course of type testing.

The emission factors determined will serve as a key basis for calculating ecological and economic impact. The results will be incorporated into the decision-making processes of the European Commission. Additionally, the DBFZ conducted an inter-laboratory comparison to analyse various locally available pellet qualities which obtained a good match with partners' results.

As part of the project, the DBFZ is supervising a survey of some 2,000 building owners in the selected countries. To assess operating modes and estimate annual usage rates, the average boiler running time per start-up is evaluated. On state-of-the-art pellet boilers, this value can be read directly from the boiler controller, and based on the results of the field measurements can be applied as a good indicator (Figure 54). Of the 47 boilers investigated in the preparatory phase of the survey, only about 20 % have an average running time of more than 2 hours. Most boilers have average running times of, in some cases substantially, less than 2 hours.

Based on the annual usage rates and pellet qualities determined, the DBFZ is comparing standard and innovative heating systems in the participating countries. The comparison is based on the supply of heat and hot water for selected building typologies, market segments and energy standards. The reference buildings used are oriented to the country-specific building typology from the IEE's TABULA project.

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Investigations into the design and potential simplification of the approval process for boilers and fuels according to §3 group 8 of 1. BImSchV



Figure 55: Biomass incineration at the DBFZ

Rising fossil fuel prices have led to a steady increase in demand for wood as a material for generating energy. The result is a general shortage of this regenerative resource, in part because its use for other purposes – particularly as a building material – is currently also on the rise. Owing to the resultant rise in prices of high-grade wood fuels, a trend is being seen towards the use of alternative solid fuels. Stalk materials, in particular, are being considered as possible alternatives. In recent years efforts have been made to integrate

these alternative solid fuels into the market for small-scale furnaces. Progress is very slow in some cases however. The main reason for that is the framing of the tasks incumbent upon the applicants and the approval authorities resulting from the amendment to the 1st Regulation under the Federal Immission Control Act („1.BImSchV“) issued in March 2010. The unclear legal situation, together with the very high cost of obtaining the certification required, has proved a massive obstacle to the spread of the use of alternative biogenic fuels.

The aim of the project is thus to produce two test fuels as defined under the terms of section 5 (3) 1. BImSchV and to test a range of boilers with them. The targeted outcome will be a certified approval of the boiler range and thus legal usage of standard fuels in accordance with § 5 (3) No. 8 within the scope of 1. BImSchV. The project seeks to reliably investigate the challenges which these fuels pose in terms of firing technique using test fuels. After having procured suitable raw materials, they will first be characterised. Then test fuels will be produced by mixing and pelletising, and an adapted QM system will be developed. The boilers will be tested with the test fuels and, for comparison purposes, with fuels in practical use, and will be prepared for certification testing by a notified furnace test body. A boiler manufacturer will be integrated into the project accordingly based on a tender process. The results will be applied to develop implementing provisions for a test programme, including possible reliefs, as a proposal for submission to the LAI Committee on system-specific immission control/precautions against disturbance (AISV).

Additional information is available at www.dbfz.de and www.fnr.de.

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Biorefineries Department

Against the background of the growing challenges in terms of the competitiveness of existing bioenergy plants, the Biorefineries department develops, analyses and evaluates processes, technologies and master-concepts for so-called poly-product plants. Its focus is on biofuels. In order to deliver an informative assessment other products, such as other energy source materials or base materials, are also studied.



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The department focuses on developing biofuel production methods and evaluating and simulating biorefineries. This also includes biofuel production in the fuel technical centre, incorporating laboratory analytics for comprehensive chemical-physical characterisation of biomasses and biofuels as well as test bed investigation of the motor behaviour of liquid and gaseous biofuels. Activities are rounded off by technical assessment, costing and ecological evaluation of master concepts. Another aim is to initiate demonstration projects and monitor them scientifically.

The department also undertakes analysis and optimisation of processes and concepts based on stationary and dynamic process flow simulations. Complementing those activities, it extends and optimises existing plant concepts (such as for biofuel production) and develops innovative biorefinery concepts. This also includes multi-criteria assessment of master concepts, taking into account technical, economic and ecological objectives. Another area of focus is on the development of efficient gasification processes for de-

fined synthesis gas qualities and the ongoing development of hydrothermal techniques. The department also continuously acquires and maintains overview data on the current state of technological and scientific progress in process engineering for biofuel plants and biorefineries.

The Biorefineries Department is divided into five working groups:

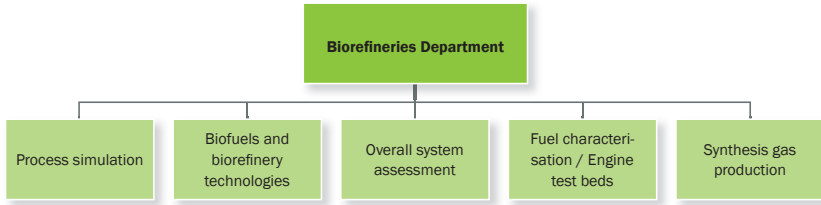


Figure 56: The working groups in the Biorefineries Department

Research focus areas



Process simulation

Dr.-Ing. Stefan Rönsch
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- Stationary process flow simulations for plant planning, life-cycle assessment and optimisation
- Dynamic process flow simulations for demand-oriented plant control
- Methodology and data to simulate biomass converters (e.g. kinetic measurements)



Biofuels and biorefinery technologies

Dipl.-Ing. Arne Gröngroft
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- Analysis and optimisation of existing biofuel plants and system components
- Upgrading of biofuel plants to biorefineries, for optimised conversion of biogenic raw materials into energy source materials and other products
- Development of innovative concepts and technologies to utilise alternative raw material sources (e.g. lignocellulose, residual products and algae)

**Overall system assessment**

Dr.-Ing. Michael Seiffert
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-
- Strategy development and policy advice; monitoring
 - Assessment of biofuel and biorefinery concepts based on (i) singular criteria (technology, ecological and economic aspects) and (ii) multi-criteria objectives
 - Feasibility studies
 - Initiating and supporting demonstration projects

**Fuel characterisation / Engine test beds**

Dr. rer. nat Sascha Förster
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-
- Development of methodology and routine analysis of the properties of biomass, substrates and biofuels, (by-) products and residues
 - Use of engine test stands to investigate the behaviour of liquid and gaseous fuels and resultant emissions

**Synthesis gas production**

Dr.-Ing. Marco Klemm
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-
- Component development focused on thermo-chemical processes (e.g. gasification with gravimetric reaction retorts, catalytic processes with tubular reactor and plate reactor)
 - Analysis and experimental optimisation of biomass gasification (e.g. innovative biomass conditioning methods, multi-stage process control taking into account effects for gas conditioning and product synthesis)
 - Investigating processes and technologies for hydrothermal biomass conversion

Services and technical equipment

Services

- Feasibility studies
- Plant simulation and evaluation for stand-alone reactors and master concepts
- Laboratory analyses including upgrading of existing and establishment of new methods (for bio-raw materials, motor fuels, by-products, among others)
- Investigation of the behaviour of biofuels on the engine test stand
- Expert reporting

Technical equipment

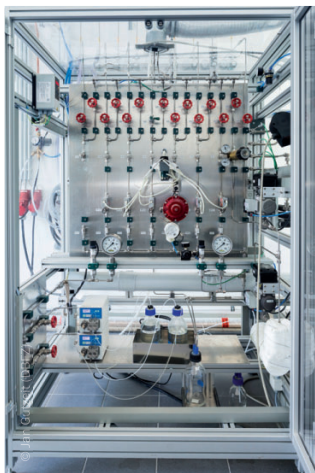


Figure 57: Gas/water vapour dosing of the methanation plant in the DBFZ fuel technical centre

Fuel technical centre

The department conducts extensive simulations to enhance the SNG production chain. To validate those simulations, the complete production chain – comprising gasification, gas purification and methanation – is mapped in the fuel technical centre. For the purpose, it provides the methanation reactors themselves as well as other equipment including a dust gasifier and a reactor for adsorptive gas purification. The dust gasifier can be operated at temperatures up to 1100 °C with air and oxygen as the gasifying agents. Different biomass dusts including sawdust and straw dust are being investigated as fuels.

A fixed-bed tubular reactor, a plate reactor and a kinetics measuring station are currently installed in the pilot plant to research into the catalyst-supported methanation of synthesis gases. Subjects investigated include reaction kinetics, response to unusual and fluctuating synthesis gas qualities, data collection for reactor upgrading, as well as endurance tests with

commercial and innovative catalytic converters, such as in relation to toxicity and coking. A unique feature is the broad temperature and pressure window (max. 850 °C, 60 bar) in which the reactors can be operated.

A stirred-tank reactor (max. 300° C, 200 bar) and a tubular reactor (max. 400° C, 200 bar) are operated to investigate hydrothermal processes. Research subjects are carbonisation, multi-stage liquefaction and, in future, gas generation. Other apparatus is operated to complement and validate plant simulations. An isothermal tubular reactor is used to determine the reaction kinetics of catalytic gas phase reactions, while a dust gasification plant pro-

duces tar-free synthesis gases from biogenic residues. A test bed to obtain characteristic data for fixed-bed gasification is also under construction. The facilities for researching the production by fermentation of fuels are being expanded. The aim is to investigate different fermentation substrates as well as micro-organisms and associated processing technologies on flexible apparatus.

Engine test bed

In response to the increasing complexity of demands placed on engine fuels, the DBFZ commissioned a single cylinder test bed for scientific tasks. The primary goal of the test bed is to test new-style renewable-based fuels in combustion engines. Specifically, the single cylinder research engine is used to test thermodynamic correlations (such as power output and consumption), legally limited and unlimited untreated emissions, the material compatibility of the fuel system, engine oil dilution and the application of exhaust gas aftertreatment systems in terms of the fuel. A variety of different measurement and analytical techniques are used. Exhaust emissions can be measured by FTIR spectrometer, smoke meter, PMD, FID, lambda meter and NDIR. The combustion process is analysed by high-pressure indication, with online visualization. The modular design of the test bed also enables typical engine characteristics such as the rail pressure, supercharged air pressure, engine oil temperature and coolant temperature to be freely configured. The existing engine is currently capable of analysing diesel and diesel substitutes.

Analytical lab

The analytical lab investigates the chemical composition of liquid engine fuels and solid fuels, biogas substrates, by-products and residual products, ashes, filtration dusts and waste water in order to assess the possibilities for use of the various biomasses. The lab is equipped with: a Karl Fischer headspace titrator; two bomb calorimeters; a Stabinger viscometer; an ion chromatography; a voltammetric measuring place; an elementary analysis system; EC/OC; ICP-OES; a flash point analyser; a copper corrosion test; two microwave digestion systems; a freeze drying equipment; and a distillation system. Analysis is carried out in accordance with commonly applied standards and based on a problem-oriented methodology. The lab offers the following services: fuel analytics and analysis of biogas substrates/nutrients



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Figure 58: Work in the DBFZ analytical lab

Reference projects

Integrated recycling plant and strategy for municipal biomass – HTC Hallesche Wasser und Stadtwirtschaft

The situation regarding supplies to bioenergy plants of energy sources such as wood is characterised by steadily rising competition. Conversely, large amounts of municipal biogenic residual and waste products have to date remained unused as energy sources. In the joint project „Integrated recycling plant and strategy for municipal biomass – HTC Hallesche Wasser und Stadtwirtschaft“, DBFZ and Hallesche Wasser und Stadtwirtschaft (HWS) GmbH, a municipal utility of the town of Halle, are jointly investigating the production and supply of alternative biogenic solid fuels based on the recovery and efficient use of municipal biogenic residual products by hydrothermal carbonisation (HTC). The aims of the project are to construct an HTC demonstration plant and create an optimised recycling strategy for municipal biogenic residual products based on HTC. The concept will be transferable to a large number of municipal and non-municipal waste management corporations based on the comparability of the material fractions. In addition to HTC of biogenic residual products, the research project is also focused on use of the produced HTC chars to generate energy in small-scale furnaces and on technical, economic and ecological evaluation of the integrated recycling concept. The project, which is running from December 1, 2010 to August 31, 2014, is being sponsored by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) as part of its programme to promote research and development in the climate-efficient optimisation of biomass energy use.

HTC is a thermo-chemical conversion process which takes place in hot pressurised water as the reaction medium. HTC works at a temperature of 160 to 250 °C and a pressure of 6 to 40 bar. The reaction takes several hours. Its product is an HTC char which in its chemical and fuel properties lies between wood and lignite. Based on the work in the aqueous

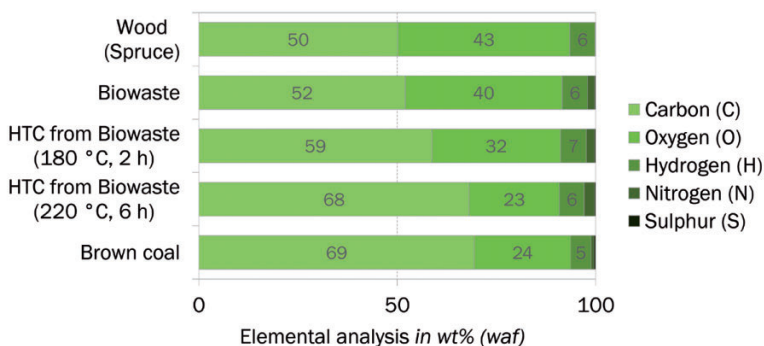


Figure 59: Change in composition of biogenic residual products in HTC

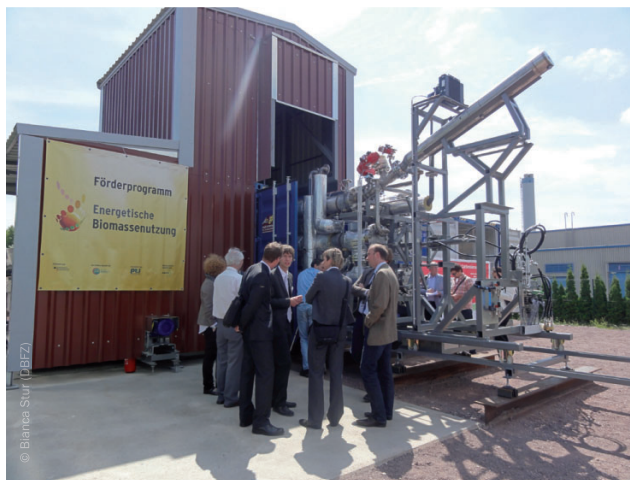


Figure 60: Opening of the HTC plant in Halle-Lochau (July 1st, 2013)

phase, primarily wet but hard to biodegrade biomasses, which are only suitable to a limited extent for conventional applications in incineration, gasification, pyrolysis and biogas production, are suitable as feedstock for HTC. HTC thus offers the possibility to utilise this potential comprising previously largely unused biogenic residual products such as biogenic municipal waste, fermentation residues, horticultural and agricultural residual products, residues from the food industry and, in particular, sewage sludge, for efficient energy use.

In order to determine the availability and quality of the biogenic residual product flows (municipal greencut, biowaste and fermentation residues), the material flows were tested over a period of one year and their chemical and fuel properties analysed. Complementing those activities, the DBFZ conducted extensive laboratory experiments to assess the suitability of the aforementioned material flows for HTC and investigate the influence of the process parameters on the carbonisation process. This involved carbonising the biogenic residual products in a laboratory autoclave. The solid phase, designated HTC char, and the liquid and gas phases of HTC were characterised chemically and in terms of their technical fuel properties.

As a result of the testing, the seasonal fluctuations in chemical and technical fuel properties of the material flows could be mapped. The annual quantities produced were also documented. The HTC laboratory experiments showed that for all three material fractions investigated the carbon content – and thus the calorific value – could be increased by HTC. They were additionally able to determine the influence of the process parameters of retention time and temperature on carbonisation, among other methods based on the characteristic values of mass yield, carbon increase and increase in calorific value, as well as determining the energy efficiency of HTC. Building on the laboratory experiments, the material and energy flows of the planned demonstration plant could be estimated and the results applied for plant planning.

On July 1st, 2013 a major milestone was marked. The demonstration plant was officially commissioned into operation in the presence of politicians, practice partners and media representatives at the Halle-Lochau landfill site (Figure 60). The HTC plant will be integrated into HWS's existing recycling lines, and is planned in future to convert 2,500 tonnes of municipal greencut a year into biogenic solid fuel by HTC.

In the remaining project runtime, the DBFZ will be supporting its municipal project partner in optimising plant operations, technically evaluating the conditioning and energy use of the HTC char in the DBFZ's combustion lab, and assessing the recycling concept economically and based on its greenhouse gas emissions in ecological terms compared to the existing concept.

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Concept development for marketable SNG production

Background. A key challenge in restructuring energy supply lies in the cost-effective avoidance of greenhouse gas emissions. The use of biomass for the thermo-chemical generation of biomethane and synthetic natural gas (SNG) as a substitute for natural gas offers a possibility to reduce emissions. After production, SNG can be fed into the existing natural gas grid, stored there, distributed, and used in efficient CHP (combined heat and power) plants as fuel or to generate heat. The production process – comprising biomass pre-treatment, gasification, gas purification, methanation and raw SNG conditioning – promises to deliver high methane yields allied to low greenhouse gas emissions.



Figure 61: Gasification of wood dust at the DBFZ

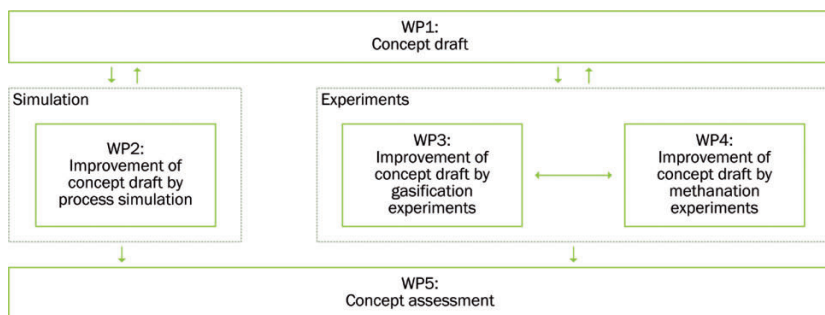
Problem. The process of conversion from biomass to SNG is currently in the development phase. The following main obstacles currently exist to market launch of the technology in Germany in the short term:

- SNG production plants are currently highly complex in process engineering terms, and are typically designed in sizes with gas capacity of around 20 MW SNG. Consequently, the processes entail (for biomass conversion plants) high levels of capital investment. A further problematic aspect of such plant sizes – alongside logistical challenges in fuel procurement – is the efficient use of process waste heat in the Megawatt range.
- At present, SNG production plant are technically tied to specific high-grade fuels (such as wood chip and pellets). The economic viability of the plants is thus dictated by the prices of a small number of fuels.

Aims. The aim of the project is therefore to develop a plant concept for the production of SNG based on fundamental experimental and simulation-aided analyses. The concept is intended not to be subject to the aforementioned obstacles to market launch, and so be feasible for construction in Germany in the short term.

Solution. With a view to the project aims cited, a solution is proposed (Figure 62) whereby a concept design will be drafted, developed by simulation and experimentation, and subsequently assessed.

The basic concept design will be based on extensive research, ensuring that weakspots are avoided and the advantages of existing concept approaches are utilised. The subsequent simulation to develop the concept design will provide an outline specification of relevant plant components as well as supporting the planned experiments. The experimental development of the concept design (Figure 61) is divided into gasification and methanation phases, and will focus on specific issues identified as the causes of existing obstacles to



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Figure 62: Overview of project methodology

market launch (such as tar conversion rate in the gasifier and catalyst operation time of the methanation process). A final economic viability and ecological sustainability assessment will subject the work results to critical review. This will also point the way to the downstream steps required, and help avoid errors in development.

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Hy-NOW: Evaluation of the processes and technologies for producing hydrogen based on biomass

Conversion of biomass is regarded as a key option for the future supply of sustainably produced hydrogen to the mobility sector. The “Hy-NOW” study, sponsored as part of the hydrogen and fuel cell technology National Innovation Programme (NIP), evaluated various methods and technologies suitable for producing hydrogen based on biomass. This includes thermo-chemical methods, such as gasification of solid biomass or vapour reformation of biogas, as well as methods using micro-organisms, such as biomass digestion to create hydrogen or splitting of water into hydrogen and oxygen.

Following a basic classification of all suitable options, three methods were selected which appear promising for short- to medium-term implementation in a demonstration plant.

Figure 63: Hydrogen based on biomass - fuel of the future?



Plant and supply concepts were subsequently designed for them and subjected to detailed analysis. Two of the plant concepts investigated are based on fluidised bed gasification (concepts 1 and 2), while a third is based on the vapour reformation of biogas (concept 3). The respective outputs are 270 kg/h H_2 for concept 1, 90 kg/h H_2 for concept 2 and 180 kg/h H_2 for concept 3. The detailed analysis assessed the plant and supply concepts in technical, economic and ecological terms. Raw material availability was analysed in advance.

It was shown that adequate raw materials are available for a demonstration project implementing the three concepts investigated. However, the existing raw material potential in Germany is largely already taken up by other applications, so thorough location planning giving special consideration to regional or local raw material availability is essential. Advantages for gasification-based plant concepts were identified in relation to raw material availability however.

The technical assessment reveals disadvantages for the digestion-based plant concept 3 in terms of efficiency. Taking into account energy use assessment criteria, gasification-based methods appear more advantageous, as they are generally characterised by lower losses – especially at higher plant outputs.

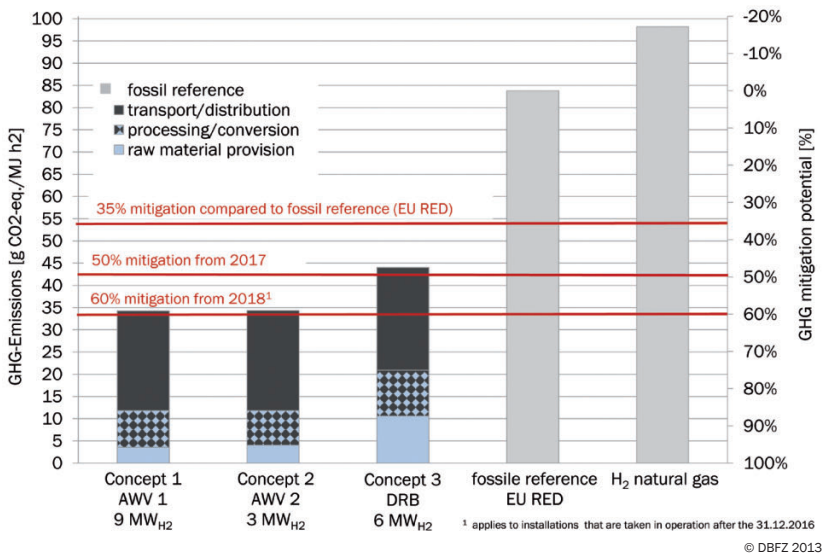


Figure 64: Greenhouse gas emissions and reduction potential of the biohydrogen concepts investigated

The gasification-based plant concept 1 entails specific costs for hydrogen production of 7.1 EUR/kg H₂ on a similar level to the digestion-based plant concept 3 (6.5 EUR/kg H₂). The likewise gasification-based plant concept 2 is approximately 30 % higher (9.1 EUR/kg H₂) owing to the plant size. In total, however, 30 to 40 % of the production and supply costs are incurred by hydrogen distribution.

The life-cycle assessment demonstrates the major influence of hydrogen distribution on emissions, energy input and reduction of greenhouse gas emission potential. The use of electric power to condense the hydrogen is the main factor in this. In converting the raw material into hydrogen, the differences in terms of life-cycle assessment are minor. There are differences, however, in raw material supply. For the gasification-based concepts, logging residues are assumed as the input material, whereas for the substrate of the digestion-based concept 60 % regrowable resources are assumed. This means that the gasification-based concepts attain the target specified for biofuels as from 2017 of 50 % greenhouse gas emissions reduction as opposed to digestion-based hydrogen production. The higher rates of renewable energy use in the (future) power mix will cut the greenhouse gas emissions of all three concepts significantly, so that the gasification-based plant concepts will also be able to meet the greenhouse gas emission reduction target from 2018 onwards.

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Executive Support Team

"The world of science is becoming ever more complex and dynamic. Good management is therefore a key factor in the success of scientific establishments looking to survive and prosper in the international competitive environment." (Dr. Nikolaus Blum, Commercial Director of the Helmholtz Centre Munich)



Figure 65: Heads of the DBFZ executive support team

In mid-2012 the DBFZ established an executive support team reporting directly to the scientific management. The Research, Innovation and International coordinators work closely with the research departments to utilise synergies in strategic research and project management, consortium creation and internationalisation for the entire research centre. The areas of focus of the Executive Support Team together with a review of activities in 2013 are presented in the following.

Research Coordination

The Research Coordination acts as an interface between the scientists in the various working groups and departments and with the Scientific Managing Director. The Research Coordination supports links among scientists between the disciplines and research departments, and so helps to utilise synergies and promote expertise in-house. The main duties of the Research Coordinator, Dr. rer. nat. Elena H. Angelova, include:

- Monitoring and evaluating national and international invitations to tender for sponsorship programmes and contract research information conforming substantively and methodologically to the research topics and approaches identified and documented in advance within the DBFZ. The Research Coordinator also advises and supports the scientist across all departments in devising and implementing application submissions.
- Coordination of information exchange and reporting on the research activities of the DBFZ to its institutional sponsor, the BMEL, the Research Advisory Council and the public at large (in cooperation with the Press and Public Relations department).
- Optimising the DBFZ's scientific management and quality assurance based on good scientific practice. Monitoring of medium- and long-term research planning and design and implementation of quality assurance procedures (including documenting scientific outputs based on performance indicators and in-house research conferences).

- Preparing, organising and supervising internal and external evaluations and supporting the Research Advisory Council.
- Implementing the doctoral programme and supporting the DBFZ's doctoral candidates.

The Research Coordination is also responsible for collating and evaluating the DBFZ's scientific data; supporting the management in conducting in-house conferences; evaluating the work of the departments and their research success, including by external comparison with similar research departments.

2013 activities

The main task in 2013 was supporting the evaluation of the DBFZ by the German Council of Science and Humanities (Wissenschaftsrat). In April, the Research Coordination submitted a 230-page report which served as the basis for the two-day inspection visit by the expert assessors in September 2013. The final assessment of the Wissenschaftsrat is expected in April 2014.

In relation to research financing, the main focus was on advising DBFZ's scientists on the changes and new requirements in the course of restructuring of the HORIZON 2020 European research programme. The Research Coordination conducted both interdepartmental and departmental information events in the third quarter of 2013.



Figure 66: Participants in the doctoral candidates' meeting at the DBFZ

As part of the administration department's role in promoting doctoral work, in third quarter 2013 the Research Coordinator supported the scientific interchange between the doctoral candidates and their supervisors. To that end, a doctoral candidates' seminar was held in the Spring of 2013 at which 11 ongoing doctoral projects were presented and discussed. The next doctoral candidates' seminar is scheduled for March 2014.

Since mid-2013 the Research Coordinator has been managing the restructuring and optimisation of knowledge management at the DBFZ. The object of this is to aid the recording, administration and documentation of the results of the DBFZ's work, such as by way of publications, project reports, presentations and position papers; to assure better access for all staff, and to ensure that results are publicised effectively. The Research Coordinator is also supporting the planning and organisation of the DBFZ annual conference "From Science to Business". The annual conference will be held on October 1st/2nd, 2014 at the Villa Ida media campus in Leipzig-Gohlis. All information on this event can be found on the Internet at: www.dbfz.de/jahrestagung

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Coordinator for international affairs

The use of biomass as an energy source is steadily growing in importance in many countries. Against a background especially of increasingly scarce (and expensive) fossil fuels (particularly petroleum) and the predicted climate change, the use of biomass to provide energy is becoming a focus of efforts to restructure the energy mix. Major countries such as China, Brazil and Russia have enormous potential for biomass use which to date has been largely unused however. The reasons for this lie, firstly, in the absences of the necessary political and economic framework conditions, but also in a lack of know-how, outdated technologies, inadequate training of staff and scientists, and insufficient international networking.

The task of the Coordinator of International Knowledge and Technology Transfer, Dr. rer. pol. Sven Schaller, is – against that background – to make the accumulated expertise of the DBFZ accessible to interested partners worldwide through joint research projects, exchange of doctoral candidates and reciprocal research secondments (working in close cooperation with the Research Coordinator). A further task of the International executive support team is to support and selectively expand the established international network. This work also includes proposing and arranging reciprocal visits by decision-makers, and organising international workshops and conferences.



Figure 67: German-Brazilian match-making at IBC 2013

2013 activities

One of the highlights was the International Biomass Conference held on June 5th to 7th, 2013 in Leipzig. Focusing on Brazil as its keynote subject, the conference promoted interchange between science, business and public-sector administration in relation to three key aspects of biomass use: biorefinery concepts; biogas and biomethane; and the sustainability of bioenergy.

A series of conferences in Bonn and Rio de Janeiro helped strengthen links with Brazil and establish new partnerships which bore fruit in numerous (approved) projects (INOPA). The strength of German development cooperation efforts in Brazil made it possible to utilise contacts there for GIZ projects (DKTI). The DBFZ is now consulted as an official expert agency in Brazil. Links with other countries in South America are also beginning to bear fruit. Joint project ideas with partners in Chile, Mexico and Peru were developed and are scheduled to be implemented in early 2014. In North America (specifically in Canada), projects are likewise being launched, while a delegation of DBFZ scientists to the USA has put out some initial feelers and established links.

On the other side of the world, in Asia, China remains a focus. The DBFZ is a key contributor to a feasibility study on the creation of a Chinese-German biogas research and development centre. Excellent links with China also exist through the Scientific Managing Director. Relations with Japan have also been intensified. Numerous meetings with ministers, scientists and embassy staff laid the foundations for closer collaboration in 2014 aimed at establishing Japan as a keynote region for our international activities.



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Coordinator for Innovation

The rapid implementation of the scientific results obtained by the DBFZ and its partner into marketable products, processes and services is supported and coordinated by the Coordinator for Innovation, Dipl. Holzwirt Romann Glowacki. His administration department establishes network links among partners in the fields of industry, finance and applied bioenergy research, as well as involving public-sector administration. One of the key tasks of the Coordinator for Innovation is to consolidate and utilise competencies along the innovation chain in order to create an environment which promotes innovation. The networks are created in close cooperation with regional and trans-regional cluster structures within the energy and environmental sectors. In this way the DBFZ's research infrastructure is integrated into those networks. The innovation structures are converged in the Bioenergy Innovation Centre, opened in 2013.

The key task of the Coordinator for Innovation is to build innovation structures:

- Interlinking research establishments, businesses in the bioenergy sector and other key players
- Building, demonstrating and institutionalising such network structures
- Regular network meetings
- Coordinating patents
- International networking in innovation management
- Supporting hive-offs and new business start-ups as well as company relocation
- Integration into other clusters, such as the BioEconomy Leadership Cluster
- Realisation of financing options for innovation processes

Its development will be driven from within the environment of the DBFZ. Principal components are the bioenergy network comprising businesses and research establishments around the region; nascent trans-regional networking; the establishment of fruitful links and trust-based collaboration with the municipal authorities; economic promotion through the Energy & Environment Network; as well as international components such as through the TREC (Transregional Renewable Energy Cluster) project.



Figure 68: Official opening of the Bioenergy Innovation Centre on September 16th, 2013

2013 activities

In cooperation with the management organisation of the energy and environmental technology cluster of the Leipzig region „Netzwerk Energie & Umwelt e.V.“ (NEU), the Bioenergy Innovation Centre was opened on the DBFZ site on September 16th, 2013. Its aim is to enable interested companies to establish a presence in the direct surroundings of the DBFZ and to benefit from their proximity to the research centre, the city of Leipzig as an energy trading exchange, and the local energy and sustainability research establishments. It will be complemented by a climate promoting the establishment and relocation of businesses and backed by local specialists in entrepreneurship, innovation and knowledge transfer research. The objective is to speed up innovation processes (from the idea through to market launch) especially for small and medium-sized enterprises. The Innovation Centre will serve as an incubator for hived-off and newly established businesses, offering a platform integrated into bioenergy networks.



Figure 69: BioEconomy Leadership Cluster

During 2013 the department also prepared patenting procedures, proposed projects with companies, brokered contacts from the networks and promoted the DBFZ in the Saxony region as an expert consulting and cooperation partner. Coordinating energy-related subjects, the Coordinator for Innovation also serves as an interface to the BMBF-sponsored BioEconomy Leadership Cluster.

Networking will be expanded further during 2014: regionally, trans-regionally and internationally in south eastern Europe. In addition to patenting procedures, hive-offs from the DBFZ will be supported. Also, the new Bioenergy Innovation Centre will be intensifying its work and taking in more tenants.

More Information (german):

<http://www.dbfz.de/web/forschung/kooperationen.html>

<http://www.innovationszentrum-bioenergie.de/>

<http://www.energiemetropole-leipzig.de/index.php/bioenergie.html>



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Below the most important publications from 2013 are listed to show the current working areas of the DBFZ. The language of the title reflects the language of the publication.

Book publications

- Bockreis, A.; Faulstich, M.; Flamme, S.; Kranert, M.; Nelles, M. (Hrsg.): Tagungsband zum 3. Wissenschaftskongress Abfall- und Ressourcenwirtschaft der Deutschen Gesellschaft für Abfallwirtschaft (DGAW), 21./22. März 2013, S. 1–302, Stuttgart 2013 – ISBN: 978-3-9815546-0-1.
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- Schumacher, B.: Technische Bewertung von Verfahren zur Substratdesintegration an landwirtschaftlichen Biogasanlagen; Vortrag im Rahmen des Leipziger Biogasfachgesprächs Innovative Verfahren, Leipzig 2013.
- Schüch, A.; Höfs, F.; Nelles, M.: Gestaltungsmöglichkeiten für die flächendeckende Bioabfallsammlung in Mecklenburg-Vorpommern; Vortrag im Rahmen der 13. Münsteraner Abfallwirtschaftstage, Münster 2013.
- Stinner, W.; Angelova, E. H.; Schandera, S.: The Soyuz bioenergy network; Presentation at Biomass: Fuel and Power 2013, Moscow/Russia 2013.
- Stinner, W.: Potenziale und Möglichkeiten zur Bioenergie- und Biomethanerzeugung in Russland; Vortrag auf der BAFA-Informationsveranstaltung zum Thema: „Biogas in Russland“, Berlin 2013.
- Stinner, W.: Herausforderungen und Lösungsansätze der Nährstofflogistik bei der Biogaserzeugung in Brasilien; Vortrag auf der International Biomass Conference 2013, Leipzig 2013.
- Stinner, W.: Südbrasilien – Nährstofflogistik als Schlüssel zur Wirtschaftlichkeit von Biogasanlagen; Vortrag beim 5^o Seminário de Biogás Brasil-Alemanha 2013, Porto Alegre/Brasilien 2013.

- Stinner, W.: Was ist und kann Bioenergie leisten?; Vortrag beim Tag der offenen Tür am DBFZ, Leipzig 2013.
- Schicketanz, S.; Stinner, W.: Ökologische Analyse ausgewählter Einsatzstoffe – Wirkfaktoren und Bewertungen; Vortrag beim 1. Meeting des Projektbegleitenden Arbeitskreises (PAK) „Evaluierung und Untersetzung der relevanten Regelungen zu Naturschutzanliegen bei der Stromerzeugung aus Biomasse im aktuell verabschiedeten Erneuerbare-Energien Gesetz“, Leipzig 2013.
- Stinner, W.: Technologien zur Biogaserzeugung – Systematik für die Ableitung künftiger relevanter Bereitstellungspfade; Vortrag im Rahmen des DBFZ/DLR Workshops – Rahmenbedingungen und Annahmen in BMU-Vorhaben: „Elemente und Meilensteine für die Entwicklung einer tragfähigen nachhaltigen Bioenergiestrategie – Meilensteine 2030“, Stuttgart 2013.
- Stinner, W.; Daniel-Gromke, J.: Biogas. Vortrag im Rahmen des Workshop „Bioenergie 2050 – Rohstoffe, Technologien, Nachhaltigkeit“ (Side-Event zur 5. Statuskonferenz Fünf Jahre BMU-Förderprogramm „Energetische Biomassenutzung“ – Wege zur effizienten Bioenergie), Block 2 Herausforderungen Technologien 2050, Leipzig 2013.
- Thiel, C.: Emissionsminderung durch integrierte und kombinierte Maßnahmen an einer Einzelraumfeuerung; Vortrag auf der 5. Statuskonferenz Fünf Jahre BMU-Förderprogramm „Energetische Biomassenutzung“ – Wege zur effizienten Bioenergie, Leipzig 2013.
- Thrän, D.: Herausforderung einer nachhaltigen Bioenergienutzung in Deutschland; Vortrag auf der Informationsreise für japanische Multiplikatoren – Technologie-schwerpunkt: Bioenergie, AHK, Berlin 2013.
- Thrän, D.: Biogas Production and Use; Presentation at the HIGRADE-Course – Introduction to Research in Environmental Technology, Leipzig 2013.
- Thrän, D.: Biokraftstoffe als Versuchsfeld für Klimaschutz und nachhaltige Agrarproduktion; Fair Fuels? Biokraftstoffe zwischen Sackgasse und Energiewende: Diskurse, Effekte und Konflikte aus transnationaler Perspektive; Vortrag beim IÖW -Institut für ökologische Wirtschaftsforschung, Berlin 2013.
- Thrän, D.; Pfeiffer, D.: Biofuels from residues. Status and prospects; Presentation at the Congress Kraftstoffe der Zukunft, Berlin 2013.
- Thrän, D.; Majer, S.: Bioenergie – Umwelteffekte und Ökobilanzen; Gastvorlesung am Institut für Allgemeine Ökologie und Umweltschutz, TU Dresden, Dresden 2013.
- Thrän, D.; Majer, S.: Potenziale und Rahmenbedingungen der Bioenergienutzung in Deutschland; Vortrag auf der International Biomass Conference – Fokus: Erfahrungen mit Bioenergie in Brasilien und Deutschland, Leipzig 2013.
- Thrän, D.; Majer, S.: Globale Biomassepotenziale und nachhaltige Regionalentwicklung (Best Practice), Governing the Transition to a Bio-based Economy; Presentation at the Summer School, Einsiedeln/Schweiz 2013.
- Thrän, D.: Die Rolle der Biomasse in der zukünftigen Energieversorgung; Vortrag im Rahmen des Sommerfeld Seminars, Universität Leipzig, Leipzig 2013.
- Thrän, D.; Krautz, A.: Bedarfsgerechte Bereitstellung durch Biogasanlagen; Was geht? Wo drückt der Schuh?; Vortrag auf der 15th Leibnitz Conference of Advanced Science: Erneuerbare Energien 2013, Berlin 2013.
- Thrän, D.: Herausforderung Energiewende – welche technischen und sozialen Innovationen brauchen wir? Zukünftige Forschungsthemen; Vortrag auf dem 10. BMBF-Forum Nachhaltigkeit FONA, Leipzig 2013.
- Thrän, D.; Pfeiffer, D.: Nachhaltigkeit und Effizienz im BMU-Förderprogramm „Energetische Biomassenutzung“; Vortrag auf der 5. Statuskonferenz Fünf Jahre BMU-Förderprogramm „Energetische Biomassenutzung“ – Wege zur effizienten Bioenergie, Leipzig 2013.
- Thrän, D.: Bioenergy for Climate Protection – How Much Can it Contribute?; Presentation at the 2nd International Conference Energy & Meteorology – Weather & Climate for the Energy Industry, Toulouse/France 2013.
- Thrän, D.; Schaubach, K.; Kiel, J.; Carbo, M.; Wojcik, M.: First results of the SECTOR-project: Production of Solid Sustainable Energy Carriers from Biomass by Means of Torrefaction; Presentation at the European Biomass Conference & Exhibition, Copenhagen/Denmark 2013.
- Thrän, D.: Umgang mit der begrenzten Ressource Biomasse und integrierte Berücksichtigung der Sektoren Land- und Forstwirtschaft als Ressourcen und Emissions-Sektoren (Vorhaben „Elemente und Meilensteine für die Entwicklung einer tragfähigen nachhaltigen Bioenergiestrategie“); Vortrag auf der Fachtagung des Bundesumweltministeriums (Forschen – Diskutieren – Vernetzen), Berlin 2013.
- Trommler, M., Barchmann, T., Daniel-Gromke, J.: Flexible Biogaskonzepte im wirtschaftlichen Vergleich; Vortrag auf der 5. Statuskonferenz Fünf Jahre BMU-Förderprogramm „Energetische Biomassenutzung“ – Wege zur effizienten Bioenergie, Leipzig 2013.
- Trommler, M., Denysenko, V.: „Welche Biogasprojekte lohnen sich noch? Aktuelle Nutzungskonzepte im wirtschaftlichen Vergleich“; Vortrag auf dem DBI Fachforum Biogas, Leipzig 2013.
- von Sonntag, J.: Anforderungen an Kleinfeuerungsanlagen – Typenprüfung und Vor-Ort-Messung; Vortrag im Rahmen des LAI-Fachgesprächs „Holzfeuerungen in Ballungsräumen“, Essen 2013.
- von Sonntag, J.: Optimierung der Feinstaubminderung von Abscheidern für Biomassefeuerungen unter Berücksichtigung der toxikologischen Relevanz mittels mikrobieller Testsysteme; Vortrag auf der 5. Statuskonferenz Fünf Jahre BMU-Förderprogramm „Energetische Biomassenutzung“ – Wege zur effizienten Bioenergie, Leipzig 2013.
- von Sonntag, J.; Gutierrez, A.; Lenz, V.: Roadmaps to a Measure of Toxicity for Particulate Matter Emissions.; Presentation at the Workshop on Aerosol Emissions from Fossil Fuel and Biomass Combustion, Prague 2013.
- Wedwitschka, H.: Funktionalisierte Extrudate auf Basis von Getreide- und Gärrestkomponenten für den Einsatz in Biogasfermentoren. Vortrag auf der Gemeinschaftsveranstaltung „Gärprodukt – Abfall oder Wertstoff“, Biozentrum Halle, Halle 2013.
- Weinrich, S.; Nelles, M.; Jacobi, H. F.: Praxisnahe Modellierung von Biogasanlagen – Vergleich unterschiedlicher Modellansätze; Vortrag auf dem 20. SIMBA-Treffen/ Ifak Workshop: Steuerung, Regelung und Simulation von Biogasanlagen, Leipzig 2013.
- Witt, J.: SECTOR – Production of Solid Sustainable Ener-

gy Carriers from Biomass by Means of Torrefaction; Presentation at the 28th Meeting of the VGB European Working Group "biomass", Berlin 2013.

Witt, J.; Sauter, P.: Eigenversorgung mit Strom und Wärme durch Biomasse; Vortrag auf dem Informationstag „Eigenversorgung mit Erneuerbaren Energien als unternehmerische Handlungsoption“, Erfurt 2013.

Witt, J.: Chancen und Trends – Bioenergie in der Zukunft; Vortrag beim Tag der offenen Tür am Deutschen Biomasseforschungszentrum, Leipzig 2013.

Witt, J.; Bosch, J.: Holzhackschnitzel – Brennstoffanforderungen und Qualitätssicherung; Vortrag beim Normen-Workshop "Qualität & Nachhaltigkeit" zum EU-Projekt „SolidStandards“, Leipzig 2013.

Witt, J.: Energetische Biomassenutzung in Deutschland; Vortrag im Rahmen des Fachgesprächs „Feste Biomasse“ auf der enertec/ TerraTec, Leipzig 2013.

Wirkner, R.: Identifikation und Analyse naturschutzseitiger Anforderungen an die Strom- und Wärmebereitstellung aus Energieholz. Vortrag auf dem 7. Rostocker Bioenergieforum, Rostock 2013.

Wirkner, R.; Adler, P.: Potenzialanalysen, Methodik, Anwendung und Folgerungen. Vortrag im Modul Energetische Holznutzung, TU Dresden, Tharandt 2013.

Wollensak, M.; Luschnitz, T.; Nelles, M.: „Strategiefeld Energie – Entwurf für das Operationale Programm EFRE 2014 – 2020“; Vortrag im Rahmen der „Technologie- und Industriepolitische Konferenz Mecklenburg-Vorpommern, Rostock 2013.

Zech, K.: Evaluierung der Verfahren und Technologien für die Bereitstellung von Wasserstoff auf Basis von Biomasse: Pre-Scening; Vortrag im Rahmen der Studienvorstellung NOW, Berlin 2013.

Zech, K.: Evaluierung der Verfahren und Technologien für die Bereitstellung von Wasserstoff auf Basis von Biomasse: Ökonomische Bewertung; Vortrag im Rahmen der Studienvorstellung NOW, Berlin 2013.

Zech, K.: Evaluierung der Verfahren und Technologien für die Bereitstellung von Wasserstoff auf Basis von Biomasse; Vortrag auf der Tagung zur Verkehrswirtschaftlichen Energiestrategie (VES), Berlin 2013.

Zeng, T.; Lenz, V.; Pollex, A.: Verwertungskonzepte zur energetischen Nutzung von geeignetem Grünlandaufwuchs im Naturpark Drömling; Vortrag auf dem 7. Rostocker Bioenergieforum, Rostock 2013.

Zeng, T.: Voraussetzungen für eine breite energetische Nutzung von Miscanthus in Deutschland; Vortrag auf dem 3. Sächsischen Miscanthus-Fachgespräch, Leipzig 2013.

The language of the title reflects the language of the project.

Projects (selection)

AUFWIND – Algenproduktion und Umwandlung in Flugzeugtreibstoffe: Wirtschaftlichkeit, Nachhaltigkeit und Demonstration, Teilvorhaben 3: Systemanalyse, Ökonomie und Ökologie – Technische und ökonomische Gesamtbewertung, Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 06/2012 – 11/2015.

Automatisierte Leistungssicherung in einem Netz tausend dezentraler Energieerzeuger mit Hilfe eines IKT-Cockpitansatzes basierend auf dem Konzept des Lieferkettenmanagements, Sächsische Aufbaubank (SAB), 08/2012 – 07/2014.

Bedarfsgenaue Regelung von Energie aus Biomasse, Sächsische Aufbaubank (SAB), 01/2013 – 09/2014.

Bestandsaufnahme Biomasseaufschlussverfahren für Biogas/ Bioethanol, Marktprojekt, 06/2012 – 06/2013.

Bestimmung des Einflusses unterschiedlicher Allokationsalgorithmen auf die THG-Bilanz von Biokraftstoffen, Marktprojekt, 03/2013 – 10/2013.

Bewertung des Einflusses des Biogasprozesses auf die Inaktivierung von Erregern von Bestandserkrankungen (Biogas-Sanitation), Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 05/2013 – 04/2015.

Biodiesel auf der Basis tierischer und pflanzlicher Abfallöle und -fette – Erarbeitung eines Vorschlags zur Überarbeitung des THG-Standardwertes, Marktprojekt, 04/2013 – 10/2013.

BioEcoMatic – Construction of small-to-medium capacity boilers for clean and efficient combustion of biomass for heating, EU-Projekt, 04/2012 – 06/2015.

Biogastechnologie für den Bedarf und die Rahmenbedingungen Brasiliens – Studie und Zusammenstellung deutscher (und europäischer) Anbieter, Marktprojekt, 10/2013 – 12/2014.

BioMaxEff – Cost efficient biomass boiler system with maximum annual efficiency and lowest emissions, EU-Projekt, 04/2011 – 10/2014.

Biomassepotenziale und Nutzungskonkurrenzen, Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS), 10/2012 – 06/2013.

Biomethane Trade, Marktprojekt, 15/2013 – 12/2013.

BIOMON – Evaluierung der Biomethanbereitstellung, -verteilung und -nutzung in Deutschland durch Marktmonitoring, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PJ), 09/2009 – 05/2013.

Detaillstudie zu ausgewählten energetischen Klärschlammnutzungsverfahren für den Standort Klärwerk Rosenthal, Marktprojekt, 12/2010 – 05/2013.

Deutsch-amerikanische Zusammenarbeit auf dem Gebiet der Agrarforschung – Reise von zwei Wissenschaftlern in die USA, Bundesanstalt für Landwirtschaft und Ernährung (BLE), 04/2013 – 06/2013.

Development of a method for the determination of substrate characteristics for an anaerobic percolation processes, Alberta Innovates, 12/2012 – 05/2014.

Dienstleistungen zur Unterstützung der Weiterentwicklung von Systemen zur Abgaswärmenutzung und Abgasnachbehandlung, Marktprojekt, 05/2013 – 07/2013.

Durchführung von Teermessungen an einer Versuchspy-

- rolyseanlage, Marktprojekt, 07/2012 – 02/2013.
- Einsatz der Hydrothermalen Carbonisierung (HTC) für die nachhaltige Behandlung und Verwertung von Fraktionen des Sanitärsektors im Sinne eines Biochar/Sewchar-Konzepts (CARBOWERT), Bundesanstalt für Landwirtschaft und Ernährung (BLE), 10/2013 – 09/2016.
- Emissionsarmer Scheitholzvergaserkessel mit integriertem Katalysator und optimierter Verbrennungsregelung; Durchführung und Auswertung von Technikumsversuchen zur Entwicklung eines Scheitholzvergaserkessels mit integriertem Katalysator, Arbeitsgemeinschaft industrieller Forschungsvereinigungen „Otto von Guericke“ e. V. (AiF), 01/2013 – 06/2015.
- Emissionsminderung durch Spurenelemente in Abfallanlagen, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 09/2011 – 08/2014.
- Emissionsminderungen durch integrierte Maßnahmen in Biomasse-Kleinf Feuerungen, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 01/2011 – 03/2014.
- Entwicklung eines Gasreinigungskonzeptes zur Nutzung von Synthesegas aus der Biomassevergasung für die Herstellung von Methan; Entwicklung, Erprobung und Optimierung des Gesamt-Gasreinigungskonzeptes, Arbeitsgemeinschaft industrieller Forschungsvereinigungen „Otto von Guericke“ e. V. (AiF), 07/2013 – 12/2015.
- Entwicklung eines katalytisch-adsorptiven Heißentwässerungssystems zur Behandlung biomassestämmiger Synthesegase – Katsyn, Sächsische Aufbaubank (SAB), 03/2012 – 04/2014.
- Entwicklung eines nachhaltigen Energiemarktes in Serbien, Marktprojekt, 11/2013 – 04/2015.
- Entwicklung eines Verfahrens für die anaerobe Vergärung von Reststoffen aus einem Biomasseaufschluss, Marktprojekt, 11/2012 – 06/2015.
- Entwicklung eines Verfahrens zur Vergasung von asche- und chlorhaltiger Biomasse am Beispiel Stroh, Deutsche Bundesstiftung Umwelt (DBU)/ Projektträger Jülich (PtJ), 08/2013 – 03/2016.
- Entwicklung und Validierung neuer Online-Messmethoden zur Bewertung und Optimierung der anaeroben Fermentation in Biogasanlagen, Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 03/2013 – 09/2015.
- Entwicklung und Erprobung einer emissionsarmen Feuerung für Holzhackschnitzel, CONICYT - Comisión Nacional de Investigación Científica y Tecnológica, 01/2012 – 12/2013.
- Enzymatic and microbial enhancement of anaerobic digesters, Novozymes Group Entity, 05/2011 – 04/2013.
- Erarbeitung und Bewertung von Züchtungsansätzen und technischen Optimierungspotenzialen für eine im Vergleich zum Erdgaspreis wettbewerbsfähige Biomethanproduktion aus Betarüben in Deutschland, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV)/ Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 08/2010 – 07/2013.
- Erstellung einer Benchmarking-Betrachtung: „Sorghum vs. Maissilage zur Erzeugung und Bereitstellung von Biomethan“, Marktprojekt, 12/2012 – 11/2015.
- Evaluiert und Unterbreitung der relevanten Regelungen zu Naturschutzanliegen bei der Stromerzeugung aus Biomasse im aktuell verabschiedeten Erneuerbare-Energien-Gesetz, Bundesamt für Naturschutz (BfN), 11/2012 – 10/2014.
- Evaluiert der Verfahren und Technologien für die Bereitstellung von Wasserstoff auf Basis von Biomasse, NOW GmbH, 05/2011 – 02/2013.
- FlexiTor – Flexibilisierung der Energiebereitstellung in Biogaskleinanlagen durch den Einsatz von torefizierten Brennstoffen, Projektträger Jülich (PtJ), 09/2013 – 08/2015.
- Glycerol Biorefinery Approach for the Production of High Quality Products of Industrial Value, EU-Projekt, 11/2013 – 10/2017.
- Gutachten Biowärme- u. Biostrombereitstellung 2009 – 2013, Marktprojekt, 11/2009 – 12/2013.
- Innovationskordinator Bioenergie, Leipziger Stiftung, 11/2010 – 10/2013.
- Innovatives bedarfsangepasstes Kommunal-Energieträger-Konzept – IbeKET, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 09/2013 – 03/2015.
- Integrierte Verwertungsanlage und Strategie für kommunale Biomasse „HTC Hallesche Wasser- und Stadtwirtschaft“, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 12/2010 – 08/2014.
- KACELLE – Demonstrating Industrial Scale Second Generation Bioethanol Production – KAlundborg CELLulosic Ethanol plant, EU-Projekt, 08/2009 – 01/2014.
- Klein aber effizient – Kosten- und energieeffiziente Biomethanproduktion (ERANET Bioenergy – SE.Biomethan), Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 02/2013 – 01/2016.
- Kleine Feuerungsanlagen für feste Brennstoffe – Ermittlung des Standes der Technik, Marktprojekt, 07/2012 – 06/2013.
- Klimaeffekte einer Biomethanwirtschaft, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV)/ Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 03/2011 – 02/2014.
- Konsistentes Recht der energetischen Biomassenutzung, Marktprojekt, 11/2012 – 04/2013.
- Konzeptentwicklung zur marktnahen SNG-Produktion, Sächsische Aufbaubank (SAB), 07/2012 – 06/2014.
- Kooperation zur Aufnahme und Evaluierung von Primärdaten zu pflanzenölbasierten Bioraffinerien in Chile sowie Austausch zu erfolgversprechenden Technologien, Bundesministerium für Bildung und Forschung/ Deutsches Zentrum für Luft- und Raumfahrt (DLR), 09/2012 – 08/2014.
- Kraftstoffe im Flugbetrieb, Marktprojekt, 09/2010 – 12/2013.
- Kurzstudie zum Einsatz von Biomasse zur bedarfsgeordneten Energieerzeugung, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV)/ Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 08/2012 – 03/2013.
- Kraftstoffpotenziale aus Abfällen und Reststoffen, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV), 01/2013 – 07/2013.
- Kurzstudie zur Preis- und Mengenentwicklung von ausgewählten holzartigen Reststoffen im Einzugsgebiet eines Biomasseheizkraftwerkes, Marktprojekt, 04/2013 – 09/2013.

- Leistungsfähigkeit von Biogasanlagen im Energiemix der Zukunft am konkreten Beispiel Honigsee, Gesellschaft für Energie und Klimaschutz Schleswig-Holstein GmbH (EKSH)/ BGA Honigsee, 07/2012 – 03/2013.
- Lignobiofuel – Entwicklung eines Verfahrens zur Herstellung von stofflich und energetisch nutzbaren Bioagglomeraten auf der Basis von Lignin, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 07/2011 – 06/2013.
- Machbarkeitsstudie zum Aufbau eines Chinesisch-Deutschen Biogasforschungs- und Entwicklungszentrums in China, Marktprojekt, 08/2013 – 03/2014.
- Meilensteine 2030 – Elemente und Meilensteine für die Entwicklung einer tragfähigen nachhaltigen Bioenergiestrategie, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 01/2012 – 02/2014.
- Meilensteine 2030 – Elemente und Meilensteine für die Entwicklung einer tragfähigen nachhaltigen Bioenergiestrategie (Detailstudie), Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 08/2012 – 07/2014.
- Mobilität Biogas Mexiko, Deutsches Zentrum für Luft- und Raumfahrt (DLR) / Bundesministerium für Bildung und Forschung (BMBF), 09/2011 – 12/2013.
- MONA: Monitoring des Biomethanproduktionsprozesses, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV)/ Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 05/2011 – 07/2014.
- Nachhaltige Bioökonomie, Marktprojekt, 12/2011 – 12/2014.
- Nachhaltigkeit der Biomassepotenziale – AP5, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV) AP, 03/2011 – 02/2014.
- Nachrüstung zum katalytischen Abbau von gasförmigen organischen Emissionen aus Kaminöfen, Deutsche Bundesstiftung Umwelt (DBU), 08/2013 – 01/2015.
- National Assessment of Actual Biomass Potentials for Energetic Use And Capacity Building for Monitoring of the Bioenergy Market in Serbia, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 11/2012 – 04/2015.
- NEKO – Neuartiger emissionsarmer Kaminofen, Deutsche Bundesstiftung Umwelt (DBU)/ Specht, 04/2013 – 03/2015.
- OptFlex Biogas – Ermittlung eines technisch-ökonomisch optimierten Betriebs von flexiblen Biogasanlagen, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 09/2012 – 12/2014.
- Optimierung einer ORC-Anlage, Marktprojekt, 10/2012 – 01/2013.
- Optimierungspotenziale von Biokraftstoffanlagen, Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (BMELV)/ Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 07/2012 – 06/2014.
- Perspektiven der Biogaseinspeisung und instrumentelle Weiterentwicklung des Förderrahmens, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), 06/2013 – 4/2015.
- Potenziale zur Steigerung der Leistungsfähigkeit von BGA – Energetische Effizienz von Repoweringmaßnahmen, Fachagentur Nachwachsende Rohstoffe e. V. (FNR), 01/2014 – 12/2015.
- Prognose des Bioenergieanlagenzubaues in einer Netzregion des Auftraggebers, Marktprojekt, 12/2012 – 12/2013.
- Prognose der Stromerzeugung aus Bioenergieanlagen für einen Netzbetreiber, Marktprojekt, 11/2013 – 10/2014.
- Prognose zur Stromerzeugung aus Biomasse, Marktprojekt, 08/2013 – 09/2015.
- Programmbegleitung (Service- und Begleitvorhaben) für das BMU-Förderprogramm zur Optimierung der energetischen Biomassenutzung, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 01/2014 – 12/2015.
- Rahmenvertrag zu Untersuchungen in BGA Westewitz, Marktprojekt, 08/2011 – 12/2013.
- Rahmenvertrag zur wissenschaftlichen Begleitung, Unterstützung und Beratung des BMVBS in den Bereichen Verkehr und Mobilität mit besonderem Fokus auf Kraftstoffen und Antriebstechnologien sowie Energie und Klima, Marktprojekt, 04/2012 – 01/2014.
- RegioBalance – Bioenergie-Flexibilisierung als regionale Ausgleichsoption im deutschen Stromnetz, Projektträger Jülich (PtJ), 08/2013 – 07/2015.
- REMISBIO: Maßnahmen zur Reduzierung von Emissionen von Biogasanlagen – Katalysator-test, Bundesministerium für Bildung und Forschung (BMBF)/ Projektträger Jülich (PtJ), 01/2011 – 12/2014.
- Rübenkonservierung für Biogasgewinnung, Marktprojekt, 08/2012 – 04/2013.
- SafePellets – Safety and quality assurance measures along the pellets supply chain, Marktprojekt, 01/2011 – 01/2014.
- Schaufenster Elektromobilität, VDI/VDE Innovation + Technik GmbH/ Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS), 12/2012 – 11/2015.
- SECTOR – Production of Solid Sustainable Energy Carriers from Biomass by Means of TORrefaction, EU-Projekt, 01/2012 – 06/2015.
- Service- und Begleitvorhaben für das BMU-Förderprogramm zur Optimierung der energetischen Biomassenutzung, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU)/ Projektträger Jülich (PtJ), 11/2008 – 12/2013.
- SolidStandards – Entwicklung und Durchführung von Trainings bezüglich der neuen EU-Normen für biogene Festbrennstoffe, EU-Projekt, 05/2011 – 04/2014.
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Figure 70: DBFZ is represented in a variety of trade magazines with its research topics.

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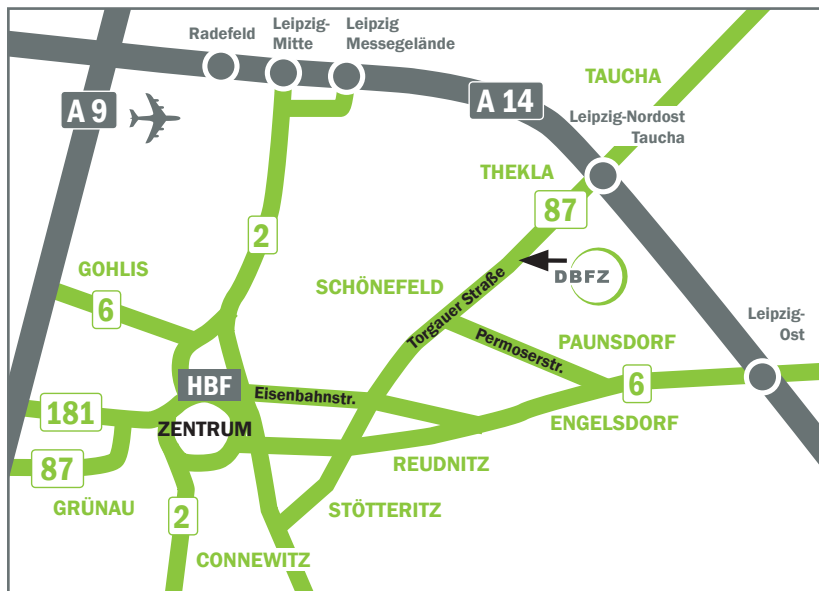
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