



Fraunhofer

UMSICHT

FRAUNHOFER INSTITUTE FOR ENVIRONMENTAL, SAFETY, AND ENERGY TECHNOLOGY UMSICHT



ANNUAL
REPORT

2011 • 2012

»»A report for you about us, our products
and services and our responsibility for
the future.««





Content

On 112 pages we are reporting on our year 2011, our projects, the people behind the projects and the plans for 2012.

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PREFACE

Dear readers,

UMSICHT – this acronym has stood for environmental, safety and energy technology since the institute was founded in 1990. For our business partners as well as within the region, we have always been UMSICHTig – meaning prudent in German. In fact, we are somewhat proud of the fact that the institute's name has developed into a type of brand. We are UMSICHT, and we work, research and develop with UMSICHT, with prudence. The term can be used as a synonym for "sustainability", and both prudence and sustainability guide our work.

Fraunhofer UMSICHT is positioned broadly in its areas of work. We believe this to be one of our greatest strengths. We can quickly respond to new challenges and also have always space for "ideas that are somewhat different". For example, the project for tanning leather without generating wastewater and with fewer chemicals that was started years ago as a side project has meanwhile received the »Nicolaus August Otto Prize« for innovation from the city of Cologne.

We are setting strategic priorities despite the broad spectrum that is characteristic of us. Those challenges that deal with the shift in energy are at the forefront for us. The storage of energy is one of the most pressing issues that need to be addressed. As coordinator of the Fraunhofer Beyond Tomorrow Project "Hybrid urban energy storage," we are working on this. We have started operations of a large test lab for redox flow batteries. Another important topic of the future deals with our finite resources. The efficient use of biomass or the handling of rare earths and metals are just as important areas of work at Fraunhofer UMSICHT as the production of high-quality biofuels made of old fats and oil residues or the utilization of plastic waste or rubber residues as raw materials. Another overriding challenge is to reconcile food production and biomass utilization and to not create a utilization competition. We need to create compatible options for the supply of energy and raw materials and provide export technologies for a growing technology world market. With these objectives, we were able to bring to life a Fraunhofer innovation cluster, sponsored by businesses, the Fraunhofer-Gesellschaft and the German state of North Rhine-Westphalia. Read more regarding our current projects in the "Business Units" chapter, starting on page 16.



Left image *Prof. Dr.-Ing. Eckhard Weidner, Director of the institute.*

Right image *Prof. Dr.-Ing. Görgo Deerberg, Deputy Director of the institute.*

We implement the technological positioning of the institute in both our guiding principles and our key areas. Therefore, we consider neither the guiding principles nor the key areas to be static parameters, but rather look at them as dynamic processes. As a result, we started a process in 2011 that will help us to position ourselves more clearly. At the center of this process are two striking and provocative concepts about which you will be able to read more in the near future: "Producing without raw materials" and "Endless Energy".

Not only do we want to display technological and scientific excellence, but we also want to display responsibility in social, societal and cultural areas. For instance, Fraunhofer UMSICHT received the award as "Exemplary family-oriented business" from the city of Oberhausen, Germany for the second time in 2012. Flexible and family-friendly work structures allow family and work life to get along very well with one another. Another example is the interdisciplinary distance learning program "Environmental Sciences" (infernum), which the German UNESCO Commission once again recognized for the 2012/2013 period as "Project of the UN Decade of Education for Sustainable Development".

In 2011, we were able to award the Science Prize, which is donated by the UMSICHT Circle of Friends and Patrons, for the second time. In 2012, we will offer the prize in the areas of science and journalism for the third time to promote innovative activities and thinking as well as the cooperation of research and industry that is close to the market.

We are convinced that we are on the right path. "We" – that is, the whole institute. A big thank you to all our employees for accompanying us on this path.

We would also like to extend a big thank you to our friends and patrons, customers, and research partners for their trust.

Kind regards

Eckhard Weidner

Görgo Deerberg

Fraunhofer UMSICHT – guaranteed crisp ideas since 1990.
Our employees offer you:

Technology that pays!

ORGANIZATIONAL CHART PROFILE

DIRECTORATE

Director: **Prof. Dr.-Ing. Eckhard Weidner**

Deputy Director: **Prof. Dr.-Ing. Göрге Deerberg**

Business Units

Renewable Resources

Dr.-Ing. Stephan Kabasci

Deputy:
Dipl.-Ing. Thomas Wodke

- Bioplastics and Biomaterials
- Bio-based Monomers and Polymers
- Production and Utilization of Biogas

Process Technology

Prof. Dr.-Ing. Göрге Deerberg

Deputy: Dipl.-Ing. Josef Robert /
Dr. rer. nat. Stefano Bruzzano

- Downstream Processing
- Water- and Wastewater Technology
- Multiphase Reaction Technology

Biofuels

Dr.-Ing. Axel Kraft

Deputy:
N. N.

- Catalytic Processes
- Refinery Concepts
- Biofuel Processes

Materials and Interaction

Dipl.-Ing. Jürgen Bertling

Deputy: Dr. rer. nat. Holger Wack /
Dipl.-Ing. Marcus Rechberger

- Material and Product Design
- Processing Technology
- Biomimetics and Haptics

Information Technology in Process Engineering

Dipl.-Phys. Thorsten Wack

Deputy:
Dipl.-Ing. Andreas Schröder

- Information and Knowledge Management
- Environmental and Safety Law
- Server-based Computing

Energy and Recycling Materials

Dr. rer. nat. Thomas Marzi

Deputy:
Dr.-Ing. Barbara Zeidler-Fandrich

- Biogenous and Chemical Energy Media
- Recycling Technologies
- Thermochemical Storage

Energy Efficiency Technologies

Dr.-Ing. Christian Dötsch

Deputy: Dr.-Ing. Wilhelm Althaus /
Dipl.-Ing. Carsten Beier

- Electrical Energy Storage
- Polygeneration, Thermal Chiller
- Optimization of Energy Systems

Resources Management

Dr.-Ing. Hartmut Pflaum

Deputy:
Dr.-Ing. Markus Hiebel (MSc)

- Material Flow Management, Eco-Assessment
- Sustainability Management
- Innovation Processes

DEPARTMENTS

Administration

Dipl.-Betw. Andreas Weber

Deputy:
Dipl.-Region.-Wiss. Nina Junen

- Finances, Controlling, Contracts
- Human Resources Development

Public Relations

Dipl.-Chem. Iris Kumpmann

- Media and Public Relations
- Event Management
- Media Design for Digital and Print

Library

Dipl.-Bibl. Kerstin Hölscher

- Information Services
- Publication Support
- Archive

Central Technical Services

Dipl.-Ing. Richard Sprick

Deputy:
Dipl.-Ing. Joachim Hillers

- Facility Management
- Pilot Plant Stations and Workshops
- Construction, CAD

IT-Management

Dipl.-Ing. Andreas Schröder

Deputy:
Dipl.-Inform. Christian Knermann

- User Support
- Server and Network Management
- Data Lifecycle Management

Innovation Management/ Industrial Property Rights

Dr.-Ing. Hartmut Pflaum

- R&D Strategies
- Industrial Property Rights, Licensing
- International Projects, EU

Chemical Laboratory

Dr.-Ing. Edda Möhle

Deputy:
Dr. rer. nat. Anna Fastabend

- Anorganic Analysis
- Organic Analysis
- Development of Methods

Occupational Safety and Environmental Protection

Dr.-Ing. Ulrich Seifert

Deputy:
Dipl.-Ing. Jürgen Stein

- Consulting and Coordination
- Safety Analysis and Checks
- Approval Procedures

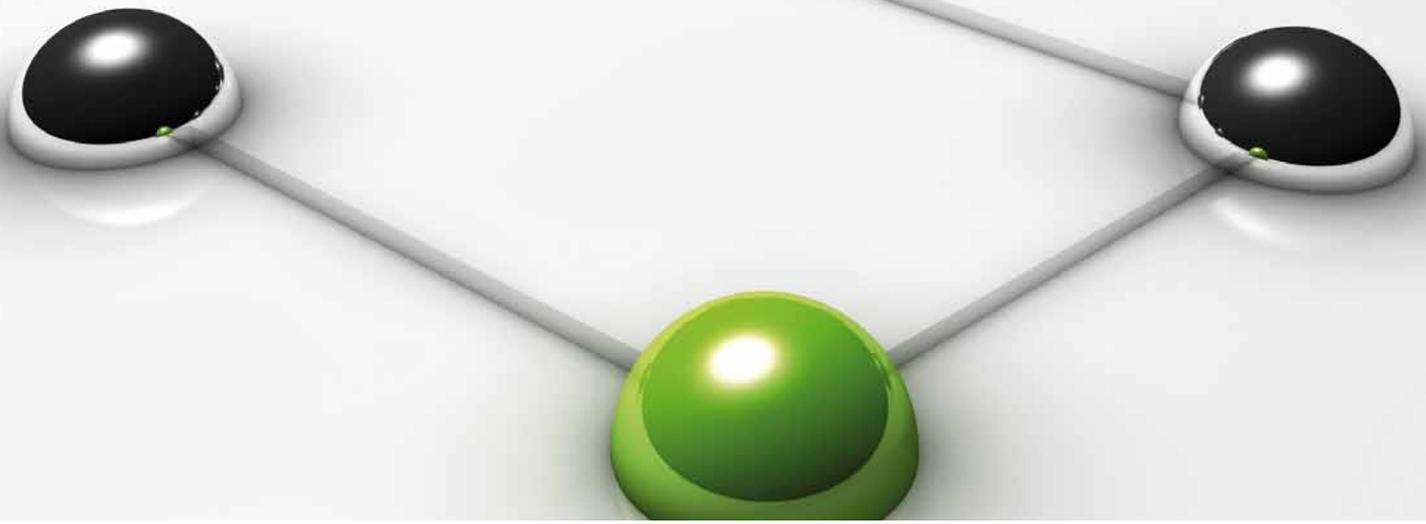


Image: Shutterstock

FRAUNHOFER UMSICHT IN PROFILE

FRAUNHOFER INSTITUTE FOR ENVIRONMENTAL, SAFETY, AND ENERGY TECHNOLOGY UMSICHT

Fraunhofer UMSICHT plays an active part in the shift in energy and materials supply. As a pioneer for technical innovations in the fields of environmental, materials science, process engineering and energy technology, Fraunhofer UMSICHT wants to encourage sustainable economic development and environmentally friendly technologies as well as innovative behavior to improve the quality of life for people and to support the innovation capacity of the national economy.

By our technological positioning, the profile of our institute is adapted to the rhythm of the economic and societal change focussing on promising new lines of research. Sustainability is the most crucial motivation for our acting.

Eight specialized business units represent the precisely tailored combination of products and R&D services responding to today's challenges of the market segments addressed. Modern project management methods are used to successfully realize sustainable innovation projects. They are supported by our technical infrastructure with a data center, library, workshops, technical shops and laboratories.

Together with industrial and public customers, the institute develops and researches new technologies and transfers them into industrial applications and marketable products. No matter whether the customer is a small or medium-sized enterprise, a major enterprise or a public institution, UMSICHT can guarantee a one-stop-shop service.

Starting from the project idea over proposal procedures to the development and market introduction, Fraunhofer UMSICHT offers its clients R&D expertise and thus provides them with competitive benefits and opens up international markets for them.

As a member of the Fraunhofer-Gesellschaft, the institute follows the tradition of applied, market-oriented research and development. Since its founding in 1990, Fraunhofer UMSICHT has been engaged in the structural change of the city and the region, acting as a catalyst for science and economy. This has been done through technology transfer, spin-offs and the set-up of R&D networks. The institute's international activities presently focus on European countries, but also in Africa, Asia and South America.

WILLICH BRANCH

At the Willich site, Fraunhofer UMSICHT offers comprehensive services in the areas of compounding and materials development, always customer-oriented and product-oriented. Biodegradable plastics, polymers from renewable resources, nanocomposites and recyclable plastics are being developed systematically and manufactured in pilot series and small batches. Process optimization, analytics and test engineering round out the portfolio of the Willich Branch. More information: chapter "Technical Shops, Laboratories" page 80.

TRAINING CENTER/FRAUNHOFER ACADEMY

We select qualified specialists and leaders with the objective to strengthen the innovative power of Germany. The interdisciplinary distance learning program for environmental sciences infernum imparts environmental expertise from more than 10 disciplines and qualifies its students, who are enrolled in the program parallel to their job, to think and act in interdisciplinary ways. The accredited Master's study program infernum is offered in cooperation with the FernUniversität in Hagen (distance learning university) and is part of the Fraunhofer Academy. More information: page 12 in this chapter.

With the Fraunhofer Talent School we offer talented teenagers from highschool an interesting insight into the researchers' day-to-day work and can meet young academics of tomorrow even today. More information: page 13 in this chapter.

COOPERATION WITH UNIVERSITIES

As an institute that, with its applications and market-oriented services, is acting at the intersection of research at the university and industrial practices and products, we are relying on strategic partnerships with universities and colleges in Germany and Europe. This is how we incorporate basic research into our projects. More information: chapter "Networks" on page 91.

COMPETENCE CENTER FOR HYDRAULIC TURBOMACHINERY "PUMP CENTER" BOCHUM

The first center of excellence for hydraulic turbomachines in Germany, supported by the Faculty of Mechanical Engineering of the Ruhr University Bochum and Fraunhofer UMSICHT, networks and bundles expertise from the fields of process engineering and energy technology, materials science, manufacturing technology, electrical drive engineering, water management, measurement and control technology and computer science. The objective is to establish the subject of hydraulic turbomachines as an attractive focal point of study in mechanical engineering and to support the market in the future with highly qualified people.

BOARD OF TRUSTEES/UMSICHT CIRCLE OF FRIENDS AND PATRONS

Fraunhofer UMSICHT is supported and consulted by a Board of Trustees and a Circle of Friends and Patrons. The Board of Trustees comprises members from the scientific community, industry, politics and administration. The Circle of Friends and Patrons intends to strengthen the role of the institute in the region. More information: chapter "Networks", pages 90 and 92.

SPIN-OFFS

Spin-offs of the institute bring successfully developed technologies in the market and strengthen the exchange with the industry. Fraunhofer Venture supports founders from the idea to a market launch by comprehensive support and consulting services. More info: chapter "Bibliography", page 103.



Image: sushi100/photocase.com

STAFF AT FRAUNHOFER UMSICHT

Permanent staff	198
Staff in scientific business units	144
Staff in infrastructure departments	54
Other staff	147
Trainees	15
Students (diploma, master, bachelor)	35
Students assistants and research assistants	86
Interns and persons in civilian service	11
Total staff	345

EXPENDITURES AND RETURNS 2011

	(in million €)	
Operational budget		24.8
Staff costs	11.3	
Other costs	13.5	
Investments		2.1

RETURNS OPERATIONAL BUDGET 2011

	(in million €)	
Basic funding	6.8	
Public returns	6.7	
Industrial returns	9.8	
Others	1.5	
Total returns		24.8

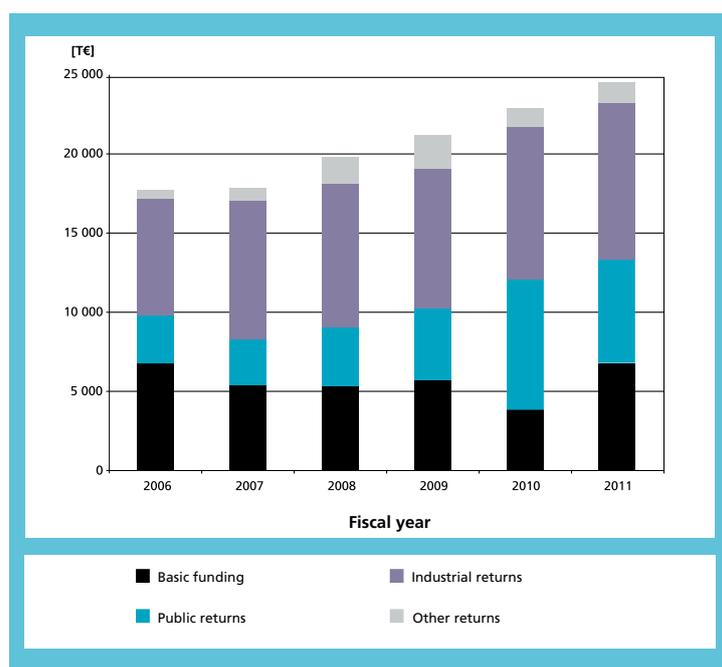




Image: Lucian Trutfofle.com

TRAINING CENTER/ FRAUNHOFER ACADEMY

MASTER'S STUDY PROGRAM INFERNUM

Today, life-long continuing education is a must. We select qualified specialists and leaders with the objective to strengthen the innovative power of Germany.

For more than ten years, the interdisciplinary distance learning program "Environmental Sciences" infernum has been on a course of success and offers future-oriented continuing education in the areas of environment and sustainability, in parallel to family and work life. The Master's study program, which is being offered jointly by Fraunhofer UMSICHT and the distance learning university in Hagen (FernUniversität in Hagen), started in November 2000 with 43 students. More than 600 students have registered since then. The numbers speak for the success of the study program; the teaching content and the academic structure show the reasons why.

In parallel to their jobs, infernum provides students with occupational knowledge about the environment that is gleaned from more than ten expert areas and enables them to think and act in interdisciplinary ways. People working in business, associations and science and administration, the self-employed and qualified newcomers to the environmental area obtain the latest specialized knowledge and interdisciplinary expertise. infernum thus creates the knowledge base for the integration of the ecological, economic and social aspects of sustainability. The Master's study program enables networked thinking and promotes creativity and the capacity for innovation. Graduates are qualified to realize sustainable solution approaches to complicated, scientific environmental tasks in companies and in society and to act as promoters with managerial responsibilities and strategic vision.

As a distance learning program, infernum supports its participants to work independently and in a structured way and in acquiring specific knowledge. The information is imparted by manageable learning modules in the form of course books (Studienbriefe) as well as internet-supported units. Classroom seminars and excursions supplement the teaching program with current research results and practical examples and intensify the contact between the participants and the supervising scientists.

After successfully completing the accredited program, graduates are awarded a Master of Science (M.Sc.) degree.

In October 2011, the German UNESCO Commission once again recognized the infernum study program for the 2012/2013 period as "Project of the UN Decade of Education for Sustainable Development." The recognition is awarded to initiatives that exemplarily implement the cause of the United Nations' worldwide education initiative and that teach sustainable thinking and activities. According to the jury's vote, infernum impressively shows what sustainable education can look like.

The infernum study program is a component of the Fraunhofer Academy that bundles the continuing education offers of the Fraunhofer-Gesellschaft under one roof. The latest findings from R&D are immediately reflected in the teaching content. This guarantees a unique transfer of knowledge from Fraunhofer research to companies.

www.umweltwissenschaften.de (only in German)

www.academy.fraunhofer.de (only in German)



FRAUNHOFER TALENT SCHOOL

The talents of today are the scientists of tomorrow. It is an important basis for our innovations to get into contact with creative, team-oriented and highly motivated young people today.

Since 2009, Fraunhofer UMSICHT has been participating in the Fraunhofer Talent School. The Talent School is a program for talented and technically interested teenagers from high school. In three-day workshops all students work committedly on interesting scientific topics, such as "Biomimetics", "Energy Supply of the Future" and "Biofuels". The workshops are complemented by an additional program offering interesting insights into the researchers' day-to-day work, as well as into international scientific life.

In 2011, Fraunhofer UMSICHT organised a Fraunhofer Talent School focusing on the issues environment and sustainability for the first time. In three workshops on the topics "Bionics", "Biofuels" and "Biomass – renewable energy", the participating teenagers were able to get a taste of the world of science, gain state-of-the art knowledge and develop ideas actively. In the years 2012 and 2013 Fraunhofer UMSICHT will offer a Talent School sponsored by the Deutsche Bundesstiftung Umwelt DBU (German Environment Foundation).

www.umsicht.fraunhofer.de/umwelt-talent-school
(only in German)

Left image Studying wherever and whenever you want to: Master's study program infernum.

Right image Teenagers from highschool participating in the Fraunhofer Talent School 2011.

Contact

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"With the help of the interdisciplinary work I have learned to look at problems from very different perspectives – of course, this principle can be transferred to other areas of life. Furthermore, the distance learning course advances self-discipline and working continuously. I have also left behind old thought patterns and existing knowledge and have dared to venture into new areas. This way I have looked beyond the rim of the teacup more than once".

*Sonja Hage, Volkswagen AG, Wolfsburg
Graduate of the study program infernum*

"I have already known for some time that the Talent School exists and I really wanted to participate once. When I heard that the workshop Bionics was offered I directly applied because I would like to work in this field later on. The topic totally caught me since you can work in an interdisciplinary way."

Johannes Wüllenweber, participant of the Talent School

² Business Units

This is what we do for you.

Main topics,
competencies,
service for research and development
as well as project examples.

Our eight business units

In the annual report we present an extract of all current projects of the business units.
You can find more project reports on the Internet on the business unit pages.

www.umsicht.fraunhofer.de/en/business-units.html



Dr.-Ing. Stephan Kabasci

RENEWABLE RESOURCES

»» INSPIRED BY
NATURE ««

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MAIN TOPICS

- Bioplastics and Biomaterials
- Bio-based Monomers and Polymers
- Production and Utilization of Biogas

INDUSTRIES AND TARGET GROUPS

- Plastics processing industry
- Chemical industry
- Adhesives industry
- Construction products industry
- Packaging industry
- Consumer goods and automotive industry
- Agriculture
- Biogas sector
- Food industry
- Energy industry
- Recycling and waste management industry



Climate protection, environmental relief and a careful use of finite raw material resources are important elements of a sustainable development. The production of energy and materials from renewable resources significantly contributes to this. We need to understand nature to protect it permanently and use its resources for innovative industrial processes and products.

OUR COMPETENCIES

We develop and optimize technical processes for producing materials and for generating energy. As basic materials we consider renewable raw materials and biogenous residues. By the use of biotechnological and chemical processes, functional chemicals and polymeric materials are made, or biogas as energy source is produced.

The focus of our application-oriented development of materials lies in bio-based plastics and their conversion to industrially successful products like films, injection molded parts or foams. Focal points of our biogas research are the optimization of technical processes and the technological system of production, purification, feed-in and utilization of biogas.

OUR R&D SERVICE

- Optimization and scientific consulting for biogas plants
- Purification, treatment and utilization of biogas
- Development and optimization of biotechnological processes, downstream processing
- Development of new bio-based monomers and polymers
- Development of bio-based materials and products
- Plastics processing development
- Pilot and small scale production of polymers and compounds
- Analysis of polymers and materials
- Certified testing of biodegradability of substances, materials and residues
- Market and feasibility studies, technology assessments



USING BIOWASTE MORE EFFICIENTLY

The utilization of biowaste for the generation of biogas contributes towards reducing greenhouse gas emissions. However, quite often the wastes in the biogas plants are not converted into biogas efficiently enough. One of the reasons for this is the severely varying composition of the waste mixtures. Fraunhofer UMSICHT researched the operation of three plants that utilize biogenous wastes in a project. The respective plant technology, the substrates used and the composition of the gas were recorded and systematized. This database serves to operate plants more efficiently in the future.

In Germany, great amounts of biowaste are still not used for generating energy. Instead they are either not collected or are solely processed at composting plants using a lot of energy. There are only approx. 100 fermentation facilities with a total capacity of 2.6 million tons per year for the treatment of biowaste. This is juxtaposed by a tenfold larger number of composting plants (approx. 1,000) that process 8.5 million tons of biowaste per year.* Severe fluctuations in the quality of the substrates used make the generation of biogas from waste and its options for utilization considerably more difficult. The varying composition of the residues leads to a situation where the fermentation process is constantly subject to changing conditions. The uncertain knowledge regarding this makes the plant operation inefficient. An exact knowledge of the properties of the residues instead allows for a good prognosis of the fermentation process and leads to a more efficient plant operation. Furthermore, the trace substances in the biogas from the waste products lead to acceptance problems with respect to feeding biogas into the natural gas grid.

To make the biological fermentation of waste products more operationally safe and more economical for plant operators, a systematized database regarding substrate composition, gas yields and gas qualities is necessary. The recording and systematization of the data is conducted by Fraunhofer UMSICHT in cooperation with the German Biomass Research Center (DBFZ – Deutsches BiomasseForschungsZentrum) for biological

residues from industry, retail and private households. During the two-year project, the researchers pursued a holistic utilization approach. They assessed the substrate input by quantitative analyses, investigated the actual fermentation process by means of online measurements and performed comprehensive biogas analyses. In this, over the course of the investigation period of one year, they observed three biogas plants with different fermentation processes and performed analyses once a week.

OPTIMIZED PLANT OPERATION AND HIGHER BIOGAS QUALITY

The objective was to obtain statistically verified results. For this, the whole analytic process was accompanied by quality assurance measures. These included all aspects of the measurement – from taking the sample to the transport of samples, all the way to the measurement and the analysis of the results. Tried and tested methods of analysis and sample taking techniques were adjusted on-site to the measuring task at hand and/or further developed.

The substrate catalog is intended to allow for a better prognosis of achievable gas qualities and to increase the process stability relative to the substrate's composition. For this, the researchers analyzed numerous parameters such as crude fat (CF), crude protein (CP), fiber content, neutral detergent fiber



(NDF) and acid detergent fiber (ADF) of the substrates based on a nutrition analysis and recorded all of the plants' relevant operational data. To optimize the process monitoring, all of the plant data and operational processes were investigated. Based on this, the interactions between different substrate characteristics and varying operating conditions were recorded and analyzed. By aligning the trace gas analytics with the substrate composition, a better prognosis of the gas properties shall be possible in the future based on the substrates used at a plant. Furthermore, parameters are identified that are essential to the sizing of the gas cleaning and development of new sensor systems.

The database contains all important process parameters through the change of which the operation of the plants can be optimized and the quality of the biogas improved. In addition, handling instructions for the operation of biogas plants still need to be created from the results. The project's results contribute towards increasing the use of organic residues for the generation of biogas and increasing the share of energy generated from residues due to more efficient plants.

* Source: Kern, M., Raussen, T.; Biogas Atlas 2011/2012; Witzenhausen-Institut für Abfall, Umwelt und Energie GmbH [Witzenhausen Institute for Waste, Environment and Energy]; Witzenhausen 2011

Funding note

The project was sponsored by the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU).

Project partner

*Deutsches BiomasseForschungsZentrum gGmbH
(German Biomass Research Center)*



Left image *Project researchers investigated the operation of three biogas plants that utilize biogenous residues.*

Right image *Wastes from industry, retail and private households are used in the biogas plants.*

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BIOGAS PLANT

Organic material, e.g. from biowaste, is decomposed by microorganisms in an oxygen-free environment at biogas plants. This process is called anaerobic decomposition or fermentation. In the process, biogas is generated which, for the most part, consists of energetically utilizable methane (also the main component of natural gas). Biogas, contrary to other renewable energy sources such as wind energy or solar energy, is constantly available and therefore represents an important component of the energy mix of renewable energies. In particular, biogas can in the future contribute towards attenuating the fluctuations in the generation of wind or solar energy. At present, more than 7,000 biogas plants are in operation in Germany, with an installed electric power capacity of approx. 2,800 MW.*

* Source: *Fachverband Biogas (Trade Association Biogas)*



BIO-BASED SOFTENERS AS ENVIRONMENTALLY FRIENDLY ALTERNATIVES

Plastics must be easy to process and optimally adapted to their respective application. Softeners help in achieving this. To date, phthalate-based softeners still dominate the marketplace. However, they are environmentally damaging and must not come in touch with foodstuffs. Fraunhofer UMSICHT is developing bio-based softeners for the bio-based plastic cellulose acetate. The objective is to increase the bio-based share of plastics and to improve the material's performance.

Softeners make plastics pliable and are among the most sold chemicals worldwide. The market research institute Ceresana Research expects worldwide demand for softeners to increase to 7.6 million tons per year by 2018. Phthalate-based softeners are market leaders, but they are harmful to the environment and not approved for direct contact with foodstuffs. Legal provisions and increasing environmental awareness increasingly demand the use of phthalate-free softeners. Even though phthalate have been mostly replaced in petro-chemically based plastics, they are still contained in bio-based plastics such as the wood-based cellulose acetate (CA).

Fraunhofer UMSICHT is developing bio-based plastics. Biograde® is a foodstuff-conformant, CA-based material recipe for injection molding that was developed to tap into new areas of application for the plastics in the foodstuffs sector. To increase the current bio-based share of CA of approx. 50 percent and to improve the properties of the material, Fraunhofer UMSICHT is currently researching alternative bio-based softeners and other functional additives.

CELLULOSE ACETATE

CA can replace some conventional technical plastics that are manufactured from fossil resources. Comparable to polystyrene (PS), acrylonitrile-butadiene-styrene (ABS) or technical polypropylene (PP) types, CA features a very good heat resistance and a high modulus of elasticity.

The surface feels pleasant, and the high density conveys a valuable impression. The processing into technical parts in an injection molding process is for the most part unproblematic and economical. In addition, the material displays a good potential for the manufacturing of foamed products.

BIO-BASED REPLACEMENT FOR PHTHALATES

Due to the chemical structure of CA consisting of glucose rings, the development of new softener systems for CA is complex. Not every softener is compatible with the bio-based plastics or displays the hoped for effect. In thermoplastic processing into an injection molded part, CA must be heated to become liquid so that it can be molded into a plastics part. The softener supports the melting. If its effect is insufficient, the material will burn. Another effect of non-suitable softeners is the quick embrittlement of the plastics parts. They break easily and have sharp edges at the fracture point.

Fraunhofer UMSICHT is investigating some known and some novel softener systems for CA. The focus of interest are, among others, the groups of citrate esters, phosphates and benzoates, since select softeners from these groups are non-toxic, biodegradable and between 50 to 100 percent bio-based. Furthermore, foodstuff conformity is assured in case of the citrate esters and benzoates.



Products made of CA can be found on the marketplace as household articles, IT products, and packaging. To be able to develop the optimal recipe for each application, the materials are subjected to comprehensive inspections and testing. Housing components (such as for keyboards, kitchen blenders or hair dryers) have to be dimensionally stable at elevated temperatures and extremely durable. In addition to the classic mechanical inspections with the tensile testing machine or the pendulum impact tester, injection-molded plastic components are stored for an extended period in climatic chambers and monitored for changes in the material's properties.

The flow properties of the material are also being examined to adjust the viscosity of the melt to the plastics engineering process. In particular in the case of the foaming process, the softeners used must be integrated into the CA so that they achieve the molding and flow properties for the foam extrusion and remain in the material during the foaming process and do not evaporate. No matter how manifold the challenges to material development and production engineering may be, the highly motivating objective is to develop sustainable plastics and to tap new areas of application for them.

Left image *Housing and components for IT products manufactured from cellulose acetate.*

Right image *Mechanical plastics testing on the tensile testing machine.*

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NEW AREAS OF APPLICATION FOR CA

As a result of improved material properties due to novel softener systems, CA are to advance into new areas of application.

Those include sophisticated technical components that are manufactured in an injection molding process and used in the most diverse areas as impact-resistant housings. The second largest area covers the manufacturing of extruded foams. There, thin and thick walled flat foam profiles can be distinguished, both based on the area of application and based on the manufacturing process used for them. As such, a multitude of development tasks result with respect to production engineering that need to be worked on in cooperation with industry partners.



Prof. Dr.-Ing. Göрге Deerberg

PROCESS TECHNOLOGY

»» OUR THEORY
IS PRACTICE ««

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MAIN TOPICS

- Downstream Processing
- Water- and Wastewater Technology
- Multiphase Reaction Technology

INDUSTRIES AND TARGET GROUPS

- Food industry
- Metal processing industry
- Pharmaceutical industry
- Chemical industry
- Agriculture
- Biotechnology
- Environmental technology
- Power engineering
- Water/wastewater technology



The sub-disciplines of production technology are becoming more and more interlinked. The call for integrated technologies and processes that solve not just one but various tasks at the same time is being voiced both for technical and economic reasons. Efficient overall processes are gaining importance in the context of the use of renewable resources and the change within energy supply.

OUR COMPETENCIES

We develop and realize system solutions for process technology based on demonstration plants at the laboratory and the technical shop as well as with the help of model-based simulation software. In this, we are looking at the process chain as a whole: from the process idea to the commercial process and from the raw material to the utilization of residues after the product has been used.

Our strengths are in membrane, separation and reaction as well as pipeline technology. Our expertise ranges from functionalized process additives as separation media, water cycle completion, wastewater treatment, recovery of materials from process flows and thermal process engineering to in-depth expertise in the areas of multiphase systems and the downstream processing for white biotechnology and biorefineries.

OUR R&D SERVICE

- Development of microsieve and membrane processes
- Process development for white biotechnology and biorefineries
- Process design for downstream processing
- Extraction of phyto-materials
- Energy-efficient water, wastewater and pipeline technology
- Structuring of surfaces for applications with flow profiles
- Reaction calorimetry
- Analysis, development and optimization
- of multiphase chemical syntheses
- Process modeling and simulation, computational fluid dynamics (CFD)
- Development of adsorbents
- Polymeric process additives
- Fluid process technology



CUSTOM DESIGN FILTERS ALLOW FOR PRECISE FILTRATION

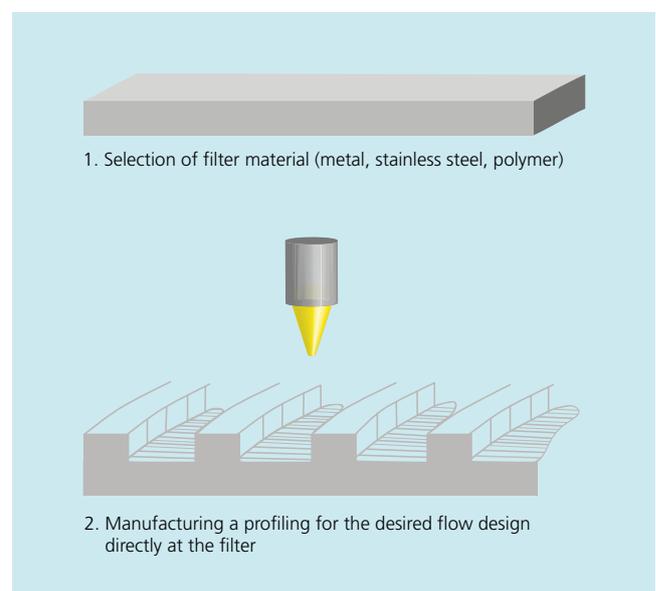
Microfilters are used in water, wastewater and food technology as well as in the chemical industry to clean waste and process water, or to recover recycling materials. The objective of the "MEF Designfilter" project of Fraunhofer UMSICHT is to manufacture tailor-made design filters from different materials for the most diverse applications that are very durable and precise and repel surface layers.

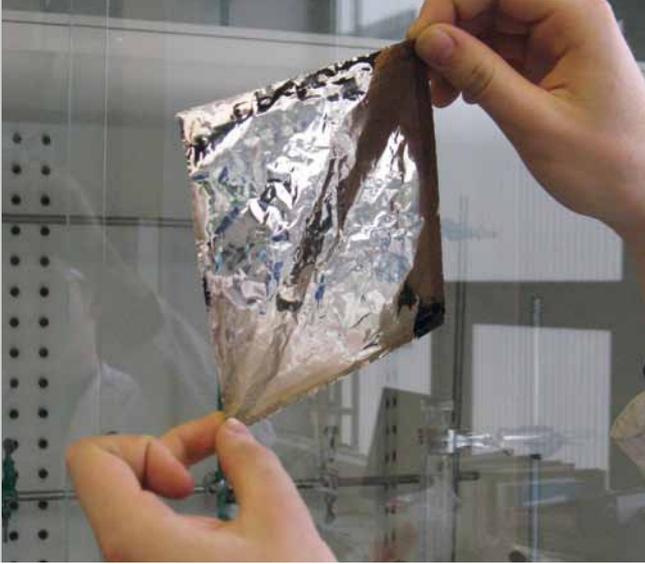
The objective of water technology is to close water cycles and provide drinking water. In the food industry ever cleaner or ever more tailor-made intermediate products are required. The chemical industry has to filter recycling materials from existing material flows. Fraunhofer UMSICHT is already developing membrane processes and metallic microsieves with nano-scaled coatings for solid separation in various industries, e.g. for decontaminating wastewater. The microsieves are, in particular, characterized by their even pore structure, which allows for a precise classification based on particle size.

However, in addition to the geometry of the pores and the material of the filter, the flow design in particular is important to the success of a separation process. A lot of filters tend to block when the feed perpendicularly flows against the filter. To prevent this, mostly complex module systems have been developed so far to render the membrane process suitable for industry. In the new project, Fraunhofer UMSICHT wants to develop design filters made of different materials which in a single manufacturing process receive both an even pore structure and a defined profiling.

These flow profiles assure that the desired flow and thereby an optimal filtration result is achieved for any application case. Flow channels that assure a high flow velocity are suitable to remove sticky fouling layers that occur, for example, in many

applications in the food industry. Slower flows can be configured for shear-sensitive products, such as from bioengineering. The filters can be manufactured from metal, stainless steel, plastic and even composite materials. Cleaner products can be achieved and a blockage of the filters can be prevented with the new design filters. In addition, the filter materials are even more durable and can be selected based on their respective use.





10,000 HOLES PER SECOND

Lasers are tools that can create both the microprofiles and the micropores effecting separation. In a first step, the flow channels are "milled" into films or pieces of sheet metal and the pores are created later. To determine the filter geometries suitable for the design filters, the researchers simulate the complex flows through micropores and microprofiles in advance. A filter is only manufactured once it theoretically features the desired characteristics.

At Fraunhofer UMSICHT, a laser laboratory with an ultra-short pulse laser is currently being built. The highly precise laser technology allows for the manufacturing of minimal pore sizes down to 1 μm with very low pore tolerances. In a fully automated process, the laser "drills" approx. 10,000 holes per second. The laser laboratory is suitable for processing areas of 64 x 44,5 cm. The design filter demonstrators are then tested with practice-relevant suspensions such as process water from the chemical or food industry.

The "Designfilter" project is intended to tap into a new research area at UMSICHT that deals with laser-supported micro-structuring of fluid-exposed components in process engineering, e.g. for creating surfaces with reduced friction.

Funding note

The MEF (research for small and medium-sized enterprises) project is financed internally by Fraunhofer and by the AiF working group of industrial research associations "Otto von Guericke" e. V. (AiF).

Left image *In water engineering, for example, microfilters are used to clean and disinfect wastewater.*

Right image *Metallic microsieves have an even pore structure that allow for a highly precise separation of materials.*

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ULTRA-SHORT PULSE LASERS

Ultra-short pulse lasers are increasingly finding use in research, science and industry.

The radiation sources send individual pulses with a duration of 10 pico seconds to 100 femto seconds. During this short pulse duration virtually no heat is transmitted into the material to be processed, since the duration of the pulse is below most interaction periods on the atomic level. This is referred to as cold processing since only the area that is immediately hit by the laser beam is heated and evaporated.

Ultra-short pulse lasers can be used for laser cutting, drilling, laser marking as well as for structuring the surfaces of the most diverse materials.



Image: seraphphotocase.com

INNOVATION CLUSTER BIOENERGY: NEW UTILIZATION CONCEPTS FOR BIOMASS

The material and energetic utilization of biomass reduces the emission of gases harmful to the climate, diversifies the raw materials supply and stabilizes it long-term. At the Fraunhofer Innovation Cluster Bioenergy in Oberhausen, Germany, industry and science as well as the German state of North Rhine-Westphalia are bundling their areas of expertise to develop new utilization concepts for biomass. The objective is to tap optimization potentials in collection, transport, storage and process management.

Immense amounts of wet biomass are generated worldwide. The spectrum ranges from grass and green waste via harvesting residues, processing scraps from agricultural and forestal production to biowastes from private households.

To date, wet biomass is utilized less intensely. The reason is its high water content which results in a low calorific value and makes its transport and storage more expensive. In addition, the inhomogeneity, the content of ash and partly lignocellulose as well as bad processability of wet biomass make its utilization considerably more difficult. Biogas plants are not efficient for their conversion, and other utilization concepts are often not available.

THE OBJECTIVE OF THE INNOVATION CLUSTER

Fraunhofer UMSICHT has initiated the Innovation Cluster Bioenergy with the objective of increasing the utilizable amount of biomass. Conversion technologies are to be developed over the course of four years that tap into the potentials of stalk-like as well as wet, lignocellulose-containing biomass. The overriding objective is to reconcile food production and biomass utilization and to not create a utilization competition. As such, agriculture should be leveraged to generate more efficiency and added value, and export technologies for the technology world market should be provided.

INTERMEDIATE PRODUCTS FOR VERTICALLY INTEGRATED PRODUCTION

The work focuses on two fractions of biomass that are generated constantly and in large quantities. They are stalk-like biomass that occurs when harvesting as well as residual material fractions from local and regional processing, e. g. from food production. The fractions are to be converted into carbon-rich intermediate products for the raw materials and energy supply and, where possible, be converted to final products by the existing infrastructure. Until this vertically integrated production process can be implemented, several process steps need to be optimized.

Untreated, wet biomass is non-storable and rots fast. The treatment has to take place close to harvesting. Concepts and technologies for efficient drying and fractioning of biomass are to be developed as part of the Innovation Cluster. In this step, products that can be utilized close to the field as well as products worth storing and transporting can be created. This may be dry press cake that is used as solid raw material in incinerations or for thermo-chemical utilization concepts. The press juice serves as a raw materials base for foodstuffs production, as an energy source or for chemical products.

The Innovation Cluster led by Fraunhofer UMSICHT is counting on the development of processing concepts in proximity to



the harvesting that convert the biomass decentralized, close to the field and semi-decentralized, in small stationary local conversion plants into energy-dense and sellable intermediate products for processing in the energy and chemical industry. Some intermediate products are coal-like products and bio crude oil. They can be created thermo-chemically through hydrothermal carbonization or pyrolysis.

Wet biomass is generated in a decentralized manner. To date, biomass is conditioned and primarily transported to centralized processing plants if it is converted to energy sources or used for material utilization. The expenses are enormous. The logistics necessary from the harvesting to the conversion generate up to 30 percent of the overall costs. While compaction measures such as comminution, baling or pelletizing are heading in the right direction, they are limited in their opportunities for reducing logistical costs and furthermore are quite cost-intensive.

If increasing the operating time of harvesting machines is successful and if the transport of water contained in the biomass can be avoided, then the process costs can be optimized. In addition, efficient biomass utilization contributes towards climate protection, to resource preservation with concurrent protection of fossil resources and to employment in the plant mechanical engineering sector.

Funding note

The Fraunhofer Innovation Cluster Bioenergy is financed by the Ministry for Innovation, Science, Research and Technology of the German state of North Rhine-Westphalia (MIWFT) with funds from the European Regional Development Fund (ERDF).



Left image *Stalk-like biomass is best processed directly on the field.*
Right image *Energy companies and the chemical industry process energy-dense intermediate products made of biomass.*

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PACT FOR RESEARCH AND INNOVATION

In the "Pact for Research and Innovation," the Fraunhofer-Gesellschaft has taken on the task of designing and implementing Innovation Clusters. The objective is to bundle the forces in one region and to activate them to solve challenging tasks.

With the site in North Rhine-Westphalia, the Innovation Cluster "Bioenergy" is located in a region that is characterized by agriculture, the energy industry and the (petro) chemical industry. Many well-known companies have their headquarters or a regional presence here. The dense network of universities and university institutions provides the best opportunities for access to innovative research.

Through the Innovation Cluster "Bioenergy," the region can develop itself as a regional Center of Excellence for the bioenergy sector.



Dr.-Ing. Axel Kraft

BIOFUELS

»» SUSTAINABLY MOBILE ««

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MAIN TOPICS

- Catalytic Processes
- Refinery Concepts
- Biofuel Processes

INDUSTRIES AND TARGET GROUPS

- Agriculture
- Energy industry
- Biofuel producers
- Chemical industry
- Automotive industry
- Plant construction



The discussion with respect to reducing CO₂ emissions and limited fossil raw material sources has triggered and intensified the search for economical ways of producing fuels from renewable resources and from bio-based residues. The latter may also be part of a multiple utilization of raw materials in cascades. Hence, one of the main objectives is the holistic utilization of the biomass used by including biofuel production in biorefinery concepts.

OUR COMPETENCIES

We develop and optimize technology for biofuels and bio-based chemicals, e. g. biodiesel, second generation bio-based diesel and higher alcohols. Raw materials are fats and oils, sugars and other renewable resources of different purity.

We point out strategies for the future on how to produce fuels, energy and chemicals in a sustainable and competitive way and also engage ourselves in the European Biofuels Technology Platform.

Our service portfolio ranges from fundamental research to initial process engineering designs and cost estimates. Our work is hinged on a broad knowledge in the area of catalytic synthesis of fuels and chemical products from renewable resources.

OUR R&D SERVICE

- Chemical process development on mini plant and pilot plant scale (also under pressure)
- Catalyst screening and catalyst prototype development
- Development of holistic utilization concepts for biofuels (refinery and biorefinery)
- Economic feasibility studies
- Optimization of reaction engineering and separation processes for biofuels and related by-products
- Development of analytic methods (chromatographic and wet-chemical methods)
- Preparation of proposals and cooperation in European networks (e. g., as part of the EU's Seventh Framework Program for Research and Technological Development)



BIO-BASED FUEL FOR AIRCRAFTS

Researchers worldwide are searching for alternatives to fossil fuels due to resource depletion and climate warming. Fraunhofer UMSICHT developed a process to create high-quality fuels such as diesel or gasoline from bio-based residues of oils and fats. However, there are currently no sustainable alternatives for the aircraft fuel kerosene. The researchers at UMSICHT counted on and developed biokerosene based on oleic acid from sunflower oil.

Biodiesel, electromobility, solar or hydrogen propulsion – for the automotive area there are numerous research approaches to develop alternatives to crude oil as an energy source. For air traffic, most of these solutions are not usable due to their huge weight, for example in the case of rechargeable batteries.

The only option for a regenerative energy source in air traffic is liquid biofuel, the use of which the first airlines are already testing. There are, however, not enough alternative raw materials that can be planted and utilized sustainably and economically.

Even though biokerosene based on palm oil can be manufactured at present, it is not ecological, because the habitats of animals and plants in the rain forests are destroyed through the mass production of palm oil. The jatropha plant, which can grow even under arid conditions, also stands in competition with food cultivation in case of increased demand. Algae as potential fuel suppliers live in water and grow fast, but the product yield is currently still too low to efficiently utilize them as fuel suppliers.

Therefore, alternative energy plants have to be found for a sustainable solution. Fraunhofer UMSICHT already developed the greasoline process to produce biofuel which resulted in a spin-off last year for marketing purposes.

SUNFLOWER OIL CONTAINS A HIGH PERCENTAGE OF OLEIC ACID

It is now possible to create kerosene using the same process. The researchers determined that this is best achieved with oleic acid. Since the oil of special sunflowers that are not genetically modified has an oleic acid content of more than 90 percent, this is the ideal raw material.

Furthermore, when manufacturing biokerosene, specific properties of the kerosene have to be taken into consideration. Among other things, it must evaporate in a narrower temperature range than gasoline or diesel, and it must still remain liquid at minus 39 degrees Celsius.

In the waste-to-fuels process, high quality liquid fuels are generated from plant-derived oils by means of catalytic cracking. No hydrogen is needed for this, and, instead of a conventional catalyst, activated carbon is used which is easily regenerable. The reactor operates at ambient pressure and 450 to 500 degrees Celsius. Inside the reactor, the fats and oils are split and the oxygen is separated from the molecules. This way, the long-chained hydrocarbons are generated as can be found in fossil diesel fuel.

Furthermore, the process allows for generating smaller components from larger chains, not only arbitrarily,



but also targeted for the generation of hydrocarbon chains or even rings such as they occur in jet fuel. This can be achieved with unsaturated fatty acids that feature predetermined breaking points, such as oleic acid. Also positive in terms of the new raw material, the cultivation of sunflowers is unproblematic since this is possible within Europe and even previously unused land areas can be used for this.

For aviation it will become increasingly important in the future to minimize the climate footprint. Since the beginning of this year, airlines have to participate in the EU emission trading scheme and have to purchase additional certificates for their CO₂ emissions. In addition, they have voluntarily agreed to the objectives of the IATA (International Air Transport Association) to no longer cause any additional CO₂ emissions starting in 2020.

In the year 2050, the total emissions of the world's air traffic is to be reduced to 50 percent of the original value from the reference year 2005.

Left image *Air traffic has to considerably reduce its CO₂ footprint in the future.*

Right image *The researchers were able to develop a bio-based intermediate product for manufacturing kerosene, the components of which also can be found in fossil fuels.*

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SPIN-OFF FOUNDED

On August 2, 2011, the Fraunhofer UMSICHT project turned into a spin-off: Greasoline GmbH (a limited liability company) with its managing director, Dr. Peter Haug. The waste-to-fuels process is to be successfully marketed by the company. Potential customers include the technical industry as well as plant construction and petroleum companies that can install the technology in existing refineries.

With greasoline[®], residues are to be used whose cultivation do not negatively change the land use. Two liters of fuel can be produced per hour in the existing technical shop facility at Fraunhofer UMSICHT. An important next step is the scaling up.

greasoline[®] is a registered trademark in Germany only.



RENEWABLE ENERGIES FOR ALL

Access to energy is unevenly distributed across the world. This situation will be aggravated by increasing energy demand. Knowledge of the interaction of energy, poverty, environmental protection and sustainable development is the key to the development of solutions. As part of the EU project "Energizing Development," Fraunhofer UMSICHT is illustrating and internationally sensitizing the link between environmental and development questions taking the debate on energy safety and biofuels as an example.

"Without a bold change of policy direction, the world will lock itself into an insecure, inefficient and high-carbon energy system." That is how the Organisation for Economic Cooperation and Development (OECD) in November 2011 began the press release with which it introduced the World Energy Outlook 2011 (WEO) of the International Energy Agency (IEA). The report came to the conclusion that the leeway in energy policy is becoming smaller and smaller. Industrialized countries already consume more than 50 percent of the total energy, while the poorest countries consume only a fraction of that. 1.6 billion people do not have any access to electricity and more than 2 billion people depend on biomass ovens for heating and cooking.

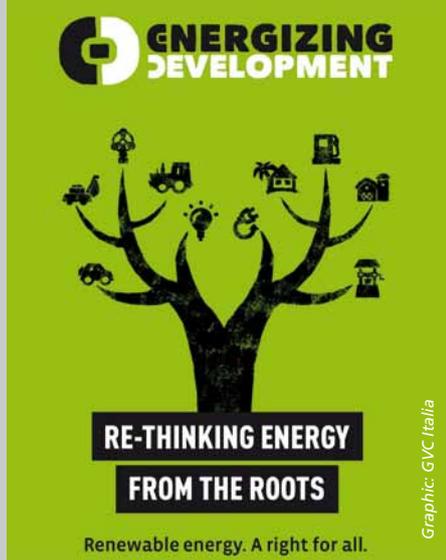
PRIMARY ENERGY CONSUMPTION IN THE YEAR 2035

The WEO's team of authors estimates that the growing world population and upcoming industrialized countries will lead to a one-third increase in primary energy demand between 2010 and 2035. Of this, 90 percent alone account for non-OECD countries. While the share of fossil energy in worldwide primary energy consumption is going to drop from the current rate of 81 to 75 percent, the share of renewable energies will increase from 13 to 18 percent by 2035. Oil consumption will increase from 87 to 99 million barrels per day by 2035. The largest share of this will go to the transport sector of the developing and emerging countries, according to the estimates of the experts of the International Energy Agency.

This scenario illustrates how important it will be to work out solutions for monitoring the impact of the global climate change to create the foundation so that in the future all people will have access to renewable energies. This is where the EU project "Energizing Development" comes into play. This project, which is supported by non-governmental organizations and scientific institutions from four member states of the European Union (Italy, Germany, Portugal and Romania), focuses on broad dissemination of knowledge.

HANDBOOK FOR BIOFUELS

The advantages and disadvantages of biofuels are pointed out as examples for developing countries. The objective is to inform and raise the awareness for topics which are connected to development, environmental protection and the reduction of poverty. The "Handbook on Biofuels and Family Agriculture in Developing Countries" was published as the central element of the project. The book provides an overview of oils and bio-diesel produced from tropical oleaginous plants and serves as teaching material. It covers a broad basic knowledge, from cultivation and harvesting techniques to process technology of plant oil refining and biofuel production to social, environmental and economic aspects. An international team of 20 figures from non-governmental organizations was trained for five days in Lisbon, Portugal. The trained people are to pass on the acquired knowledge in national training sessions in Italy,



Portugal and Romania. The implementability of this "Train the Trainers" concept is currently in the testing phase.

To promote synergies between society, local authorities and institutions in Europe and developing countries, the "Energizing Development" project was presented at "Green Week" in Brussels, Belgium and at "KeyEnergy" in Rimini, Italy. In addition, Fraunhofer UMSICHT organized an international workshop in Oberhausen, Germany in September 2011 that focused on the certification of biofuels from the point of view of small and medium-sized companies.

It will only be permanently possible to force energy policy to be re-thought from the roots through constant information. In this way the basis for the right to renewable energies will not just remain a wish but will become a reality in the long term. The "Energizing Development" project is a step in this direction.

Funding note



The "Energizing Development" project was co-financed by the European program "Development and Cooperation" - EuropeAid.

Project partners

GVC - Gruppo Volontariato Civile, Italy (coordination)
 ALMA MATER STUDIORUM - Università di Bologna, Italy
 ALMA RO and TERRA Mileniul III, Transilvania Ecological Club, all Romania
 FETRAF - Federação dos Trabalhadores na Agricultura Familiar, Brazil
 Fraunhofer UMSICHT for the Fraunhofer-Gesellschaft, Germany
 OIKOS - Cooperação e Desenvolvimento, Portugal
 Province of Santa Fé (Secretary for Family Agriculture), Brazil
 The handbook can be downloaded from the project website free of charge: <http://edeng.gvc-italia.org/Documents/Handbook-on-Biofuels-and-Family-Agriculture-in-Developing-Countries>

Left image Fresh *jatropha* seeds, Mozambique – the oil can be utilized as fuel.

Center image Information about the project is provided in this brochure.

Right image Boy with a basket of manioc at a farm close to Bilibiza, Mozambique.

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MILLENNIUM DECLARATION

One hundred and eighty nine states signed the Millennium Declaration in September 2000. It defines four areas of action for international politics.

Eight development objectives were derived from the declaration that are to be implemented by 2015, including the elimination of hunger and extreme poverty, elementary school education for all children, gender equality and empowerment of women, reducing child mortality, improving maternal health, combating HIV/AIDS, malaria and other communicable diseases, assuring ecological sustainability and creating a global development partnership. Even though the topic of energy is not explicitly mentioned, its contribution towards solving the worldwide problems is apparent.



Dipl.-Ing. Jürgen Bertling

MATERIALS AND INTERACTION

»» FROM THE IDEA
TO PERCEPTION ««

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MAIN TOPICS

- Material and Product Design
- Processing Technology
- Biomimetics and Haptics

INDUSTRIES AND TARGET GROUPS

- Plastic processors
- Product developers, industrial designers
- Materials and additives manufacturers
- Sealing and surface technology companies
- Manufacturers of processing technologies



Modern materials can be customized in various ways. By chemical or structural modification, the characteristics can be optimized or multiple functions can be implemented. Here, the environmentally and at the same time user-friendly formulation of the materials systems sets an important task for the future.

OUR COMPETENCIES

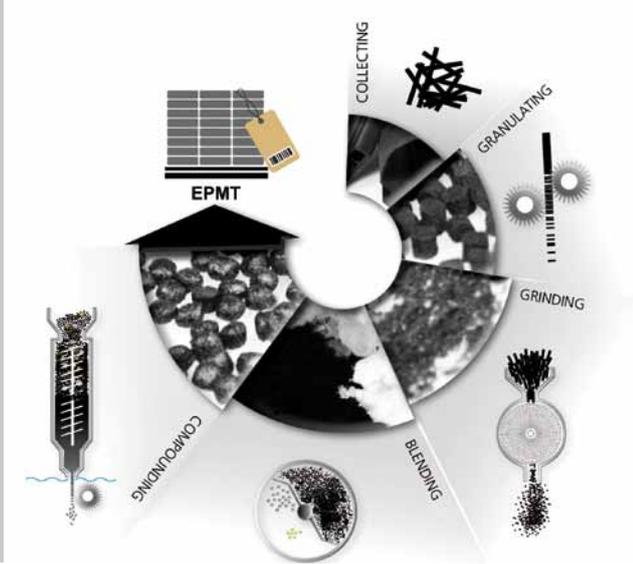
We regard ourselves as an experimentation laboratory for innovative materials, products and process technologies but as well as for radical new concepts that contradict established views.

Our distinguishing features are a broad practical experience and the industry-oriented equipment of our laboratories and technical shops as well as our enthusiasm for unconventional ideas and new resource efficient and environmentally compatible solutions.

Currently we are developing self-healing, adaptive and recyclable plastics and elastomers, weather-resistant local timber, tanning processes without wastewater, self-sharpening blades, bionic systems for dental cleaning, applications for microencapsulation and innovative greening for building facades. We are interested in what a person feels when touching materials and products and what we can learn from biology for the development of materials.

OUR R&D SERVICE

- Strategies for biomimetic and sustainable material innovations
- Development of additive, particle, and material systems
- Product development and industrial design (building construction, automotive, consumer products)
- Component design and rapid prototyping
- Production of samples and process optimization in the areas of compounding, comminution, microencapsulation, impregnation, spray processes and generative manufacturing
- Utilization of supercritical fluids as auxiliary process agents
- Simulation, test and analysis of plastics, wood, leather and functional materials



on process that turns rubber residues into elastomer powder is, among other things, responsible for the desired mechanical properties of the compounds. In case of the EPMT®, important functions such as impact absorption, e. g. for engine mounts, or transfer of friction, e. g. for tire materials, can be adjusted.

NEW MARKET PERSPECTIVES THROUGH RECYCLING

The recycling of elastomers increases the added value and opens up new market perspectives. Production waste, e. g. from rubber processors, no longer has to be disposed of but rather can be recycled. As such, elastomer residues remain in the production cycle much longer. At present, 60 to 80 percent of elastomeric powder by mass can be worked into the thermoplastic matrixes. EPMT® can be used cost-effectively, are easily processed in injection molding or extrusion machines, and are themselves also recyclable.

Processors of thermoplastic elastomers can now, on the one hand, obtain EPMT® and further process it into products, whereby they lower the raw material costs since recycled EPMT® is cheaper than new material. But industry customers who incur elastomer residues can recycle these, too, by manufacturing EPMT® from them, integrating it into products and thereby closing materials cycles.

Funding note

Financed by the German Federal Ministry for Economics and Technology (BMWi) as part of the EXIST research transfer program



Left image *Elastomeric powder modified thermoplastics (EPMT®) as soft prototype. Elastomeric powder – "comminuted rubber residues" – can now be used in high quality materials and not just in secondary products.*

Right image *From rubber residue to EPMT®: the processing steps from elastomeric residue to EPMT® material.*

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EPMT® MATERIAL GRADES

Three grades of material are currently available, classified based on their values of Shore hardness A.

EPMT® SOFT covers the Shore hardness range of approx. 60 Sh A. EPMT® MEDIUM covers the range of 85 ShA, and EPMT® HARD is in the range of approx. 45 ShD.

The materials are analyzed in-depth. EPMT® SOFT, for example, displays mechanical characteristics of approx. 425 percent for breaking elongation and a tensile strength of 11 MPa; characteristics that are in the range of properties of thermoplastic elastomers (TPEs) available on the market.



UTILIZING MOSSES FOR REDUCING FINE DUST IN CENTERS OF POPULATION

Mosses are the oldest land plants. They successfully occupy biological niches. They have developed interesting survival strategies for this. Special aspects of the physiology of mosses such as their ion exchange capacity, anti-bacterial and anti-fungal effect are moving them into the interest of research. Fraunhofer UMSICHT is researching the potential of mosses for absorbing fine dust. One objective is to reduce fine dust in densely populated regions through the vertical mossification of facades.

"The air in Germany was loaded too much with fine dust and nitrogen dioxide in 2011 as well. The fine dust values on average were above the level of the preceding four years. In terms of nitrogen dioxide, the load remained unchangedly high." The press release of the German Federal Environment Agency (UBA) from February 2012 regarding the initial analysis of preliminary measurement data of the German states and UBA regarding the air quality in Germany is clear; something has to be done to reduce fine dust in densely populated areas. The establishment of environmental zones, the implementation of the most modern exhaust standard (EURO 6) and the tightening of the regulation for small combustion systems are important steps.

Fraunhofer UMSICHT wants more and is developing solutions to targetedly absorb fine dust and to remove it from the air.

MOSSES PHYSIOLOGICALLY INTERESTING

Mosses appear to be promising candidates. The physiology of mosses (bryophytes) is in many ways different from that of higher plants (cormophytes). Special physiological aspects of the mosses raise hope for a high potential for technical applications; fine dust absorption, ion exchange capacity, anti-bacterial and anti-fungal effect as well as moisture management are only some of these aspects.

Since roof areas are favored for other concepts such as solar systems or lately for building-integrated agriculture, the work of Fraunhofer UMSICHT concentrates on the vertical cultivation of mosses. The long-term perspective consists of mossifying large facade areas and having a significant impact on the microclimate and the fine dust concentration in urban areas.

RESILIENT MEASUREMENT OF THE FINE DUST REMOVAL PERFORMANCE OF MOSSES

However, to date qualitative and quantitative statements regarding the assessment of fine dust reduction by mosses are only available to a very limited extent. Only very few, in part contradicting values regarding the absorption capacity of mosses can be found in the literature. There are no known values regarding the actual adsorption of aerosol particles by mosses. It is, however, assumed that due to the large leaf surface area of mosses far more particles are becoming attached than are actually metabolized.

Fraunhofer UMSICHT wants to put the impact of mosses with respect to the absorption and adsorption of aerosol particles on a scientific basis and is working out methods for quantification. Further work packages focus on the development of a vertically acting watering system and the development of a moss-specific water recycling system.



LIVING FACADES

However, far more than pure technology is necessary to let mosses grow in cities on technical surfaces made of concrete and steel and to turn them into living, biological areas.

A rethinking process is required that shifts the acceptance from technical surfaces to naturally designed surfaces with irregularities, niches, and indentations, because mosses, which in nature grow on vertical stone surfaces (epipetric mosses) or trees (epiphytic mosses), need nature-like surfaces.

Another area of work of the project is therefore to determine which properties the technical surfaces need to be populated by mosses. Once inoculated with mosses, such facades ideally develop on their own and change over the course of time. This can be utilized as an exciting design element in cities.

In the course of the project to date, vertical test surfaces were installed with epipetric mosses and the growth of the mosses was examined. A special material system for moisture management as well as nutrient solutions for optimal growth rates were developed. Test and analysis routines for the fine dust removal performance of mosses are undergoing trials. The practical trial is in the planning stage.

Left image *Close-up of a test surface for vertical moss cultivation.*

Right image *Test surface for vertical moss cultivation.*

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AIR QUALITY IN GERMANY

The threshold values for fine dust and nitrogen dioxide are exceeded too often, especially in direct proximity to roads. In 2011, approx. 20 percent of all measuring stations in Germany exceeded the maximum allowed daily threshold value for fine dust on more than 35 days. Said value allows for 35 days [per year] with more than 50 micrograms of fine dust (PM10) per cubic meter of air ($\mu\text{g}/\text{m}^3$) averaged across the day. Fine dust is generated by burning fuel and by the incineration processes in industry and households as well as by emissions from agriculture. Another factor is the weather. The air is intermixed only to a very limited extent in high-pressure weather conditions with limited exchange of air. As a result, the air itself then worsens, since the fine dust emissions remain the same. There were several such weather conditions in 2011.

Source: www.umweltbundesamt.de



Dipl.-Phys. Thorsten Wack

INFORMATION TECHNOLOGY IN PROCESS ENGINEERING

»» USING INFORMATION INTELLIGENTLY ««

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MAIN TOPICS

- Information and Knowledge Management
- Environmental and Occupational Safety Law
- Server-based Computing

INDUSTRIES AND TARGET GROUPS

- Operators of waste treatment plants
- Operators of wastewater treatment plants
- Manufacturing companies
- Chemical industry



The knowledge available worldwide doubles every five years. Intelligent, target-group-specific information management aids in promptly separating valuable from unnecessary information and occupies a central role in today's production value adding chains.

OUR COMPETENCIES

According to projections of the EU commission, 80 percent of the technologies in use today will be replaced by new ones within the next ten years.

Value adding chains in companies are closely connected to making information available. Optimizations cannot be carried out without having a sufficient data base available.

The close interlinking of the operative processes with specific, organizational and technical information closes, in connection with ergonomic user interfaces, any existing information gaps. To achieve this, service-oriented architectures (SOA) are being created and made available as application services (ASP) independently of location and client.

OUR R&D SERVICE

- Data extraction
- Data consolidation
- Data visualization
- Customer-specific system analysis and software development
- IT mapping of organizational structures and workflow management



"GREEN" SERVER ROOM THANKS TO KNOWLEDGE PLATFORM

The constant and site-independent availability of information is becoming more and more important in day-to-day business. Developments such as cloud computing and mobile terminal devices promise more freedom but are also responsible for the growth of the infrastructure in the server rooms and/or computing centers. One result is increased energy consumption. To counteract this, Fraunhofer UMSICHT, in unison with the Fraunhofer-Gesellschaft, is developing the internal "GreenDataCenter" knowledge portal which will be used to help optimize the energy utilization at computing centers.

The Fraunhofer-Gesellschaft (FhG) has more than 80 research institutions, among them 60 Fraunhofer Institutes all over Germany. In total, these sites are equipped with approx. 100 server rooms. A central objective is to improve the efficiency of the energy utilization – the so-called Power Usage Effectiveness (PUE) – in the server rooms to a value of 1.5. On the one hand, this pays off financially since savings in the operating costs are possible, on the other it pays off ecologically since CO₂ emissions are avoided.

"GreenDataCenter" provides the IT decision makers at the Institutes with basic information, practical examples and tips for reducing the energy consumption of a server room or for planning a new one on an informed basis. To support determining the status quo in the server room, a questionnaire is provided that takes into account the constructional prerequisites, important influencing factors and their interactions, and as such allows for an assessment of the existing systems. The results are displayed with the help of a matrix of measures based on which, in combination with best practice examples, each IT manager is provided with the necessary basics to improve the PUE of their own server room. The portal is based on a Wiki structure, since the users at the Institutes are to be provided with information that is as comprehensive as possible, in combination with the IT managers' experiences.

BECOMING A "GREEN" SERVER ROOM IN THREE PHASES

The project is structured into three stages. Phase 1 includes determining the state of science and technology with respect to the energy-efficient operation of server rooms. It concludes with compiling the necessary basic knowledge, a questionnaire for determining the status quo, an initial matrix of measure and suitable examples from practice. The developed approach for energetic optimization will be verified at a representative Fraunhofer sites in phase 2. One of the sites to be looked at will be Fraunhofer UMSICHT, since the Institute has two differently equipped server rooms and also provides central services for the FhG that require a special IT infrastructure. In the final phase, the results are combined as a knowledge platform and are expected to be provided to the Institutes at the end of 2012.

It is planned to continuously maintain the portal after the project ends and to expand on its content. The feedback from experiential knowledge from optimizations conducted at the Institutes will play an important role in this. Setting up an in-house benchmark system at Fraunhofer is also intended to support the continuous improvement of the energy efficiency in the server rooms.

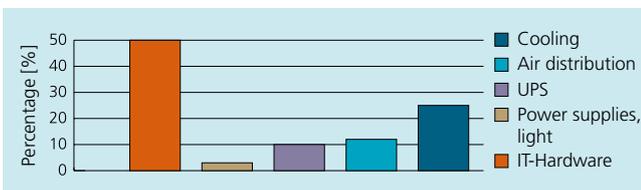


Image: Shutterstock

FHG SUSTAINABILITY STRATEGY

Capturing and assessing additional parameters is paramount for a comprehensive analysis and optimization of the sustainability of the server operation. Therefore, in a next step, assessment parameters such as Carbon Usage Effectiveness (CUE™) [ratio of the sum of the CO₂ emissions of operation relative to the energy consumption] and the Water Usage Effectiveness (WUE™) [ratio of the annual water consumption relative to the energy consumption] are to be assessed with respect to their applicability. The impact on the environment of operating the server rooms is directly reflected in these indicators.

The "GreenDataCenter" project supports the sustainability strategy of the FhG with the development of the knowledge platform and assessing various key data. The initiative builds on the activities of the Fraunhofer Sustainability Network, which was officially founded in December 2009. The network strives to increase the alignment of research and technological development within the FhG with the principle of "sustainability".



Funding note

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.

Fraunhofer Sustainability Network
www.nachhaltigkeit.fraunhofer.de



Left image The objective of the "GreenDataCenter" project is to improve the PUE in the server rooms to a value of 1.5.

Graphic Energy consumption in a server room.

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POWER USAGE EFFECTIVENESS

Power Usage Effectiveness (PUE) is an indicator developed by "The Green Grid" consortium that indicates how energy-efficient a server room is working. It consists of the ratio of:

$$\text{PUE} = \frac{\text{overall energy consumption of the server room}}{\text{energy consumption of the IT systems}}$$

The overall energy consumption consists of the energy consumption of the infrastructure (lighting, cooling, uninterruptible power supply, etc.) as well as the energy consumption of the IT components. The lower the PUE, the more efficient the energy utilization within the server room. In this, a value below 2 is considered to be efficient and a value below 1.5 very efficient. At present, the PUE indicator is considered to be the globally recognized indicator for assessing the energy efficiency of computing centers.

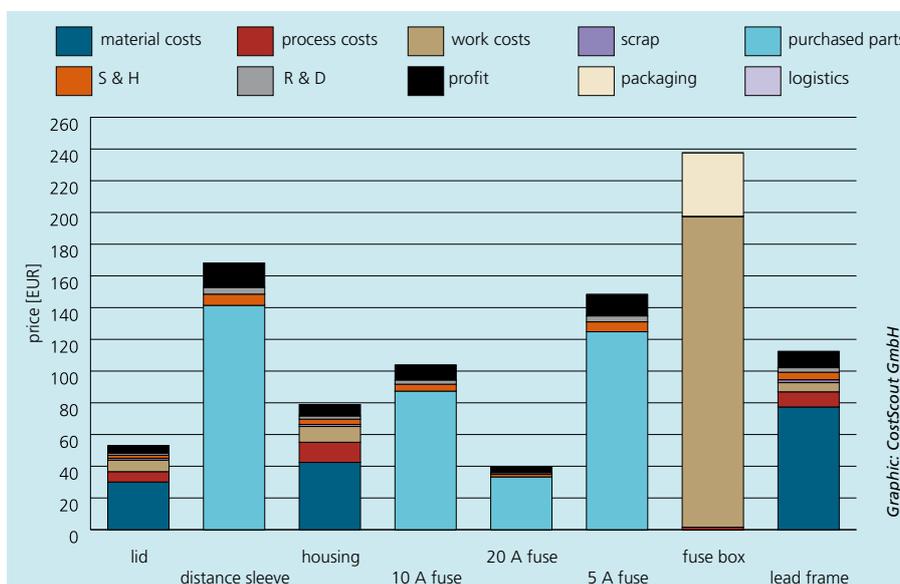


NEW SOFTWARE MAKES PURCHASING COSTS MORE TRANSPARENT FOR COMPANIES

A lot of companies depend on purchasing construction elements for their products from supplier companies. The reason is the cheaper conditions of the supplier as opposed to in-house production. The costs for purchasing of materials quite often amount to more than 60 percent of the revenue. Fraunhofer UMSICHT developed the software CostScout ONE in cooperation with CostScout GmbH. It assists small to medium-sized enterprises in the systematical calculation of purchasing costs which then can save up to 20 percent of the expenses.

In the increasingly tougher global competition, only those companies that focus on their core competencies stand a chance. As a result, a lot of companies no longer produce a majority of the elements they need themselves, but rather purchase them. The requirements posed to the purchasing organization therefore increase immensely. Reducing costs is still the main focus in a lot of companies. A detailed calculation of the purchasing costs quite often does not take place, since the purchasing department does not have the resources or the know-how.

Fraunhofer UMSICHT developed an innovative tool for CostScout GmbH that was sponsored through an innovation voucher of the German state of North Rhine-Westphalia. Fraunhofer UMSICHT acted as both an R&D partner and as a consultant in this project. After intensively conducting market research, the consulting component included, among other things, the design and structuring of the software with respect to competing products, functionality and software architecture. In the consulting component, the Institute developed the software and implemented it after eight months.



INTUITIVE OPERATING CONCEPT

The newly developed software helps non-experts to perform the calculation of purchased parts easily, quickly, and in a structured way.

It is characterized by an intuitive operating concept. Complex components and assemblies can be modeled based on a process cost calculation in differing levels of detail – from a simple estimate to a very precise calculation.

A view at the level of the individual manufacturing processes allows for



Image: Shutterstock

identifying cost drivers. Different scenarios, e. g. moving the production site, using alternative materials or manufacturing processes, can be assessed and compared. Price and revenue developments can be presented across the product's life cycle and production capacities can be checked.

INDIVIDUALLY CONFIGURABLE ANALYSIS TOOLS

The user can easily calculate the costs for any products with the help of a database based on relevant information such as labor, site and machine costs. The option to prepare comparative calculations is of particular interest. What, for instance, changes if a company produces products in a different country? Or what impact does the use of other materials or an alternative manufacturing technique have on costs?

The developers paid particular attention to configuration options of the databases, analysis tools and reports which can be individually customized for each company. These allow the customer to integrate their own specific cost information. As such, the software not only provides for the necessary transparency in purchasing, but also provides the company with important cost information throughout the entire product life cycle. The tool can therefore be used anywhere from the calculation accompanying the development to controlling, up to proposal preparation in sales.

Funding note

Sponsored by an innovation voucher of the German state of North Rhine-Westphalia

Graphic *Example of a cost distribution of the sales price created with the new software.*

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INNOVATION VOUCHER

The German state of North Rhine-Westphalia offers innovation vouchers for small and medium-sized enterprises that the companies can use to be reimbursed for the costs of external consulting, research and development services at European universities and institutes.

The voucher offers an up to 50 percent discount on the use of know-how and infrastructure for the development of new products, processes and services.

To date, 489 vouchers have been handed out (as of January 2012).



Dr. rer. nat. Thomas Marzi

ENERGY AND RECYCLING MATERIALS

»» RESOURCES FOR OUR FUTURE ««

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MAIN TOPICS

- Biogenous and Chemical Energy Media
- Recycling Technologies
- Thermochemical Storage

INDUSTRIES AND TARGET GROUPS

- Energy supply
- Recycling and waste management industry
- Plant construction
- Chemical industry
- Sewage treatment plants, landfill sites, fermentation plants
- Municipalities
- Small and medium-sized enterprises (SMEs)



Population growth and the growth of the economy, increasing prosperity and global competition result in energy and resources becoming scarcer and more expensive. In the future, it will be necessary to utilize fuels more efficiently and to use regenerative energies. It is also of equal importance to make energy storable or to find alternatives made from recycled materials.

OUR COMPETENCIES

The goal of our work is application-oriented development of processes for efficient energy and material conversion. Our expertise includes opening up new sources of energy and recycling materials.

Our technical expertise is in the areas of biomass and syngas, sorption technology, catalytic processes, chemical heat storage, fuel characterization and GIS (geographic information systems) applications.

Sorptive and catalytic gas processing, catalytic conversion of biogases and syngases as well as the development of processes for chemical energy storage and for the recycling of "critical materials" are focal points of our work.

OUR R&D SERVICE

- Biomass to energy/waste to energy
 - Mechanical processing of biomass and alternative energy sources
 - Thermochemical conversion (combustion, gasification, pyrolysis)
 - Biogenous gases (analysis, processing, feed-in and utilization)
 - Sampling and analysis of biomass, wastes, residues and slags
 - Characterization of fuels
- Catalytic processes
 - Cleaning and chemical conversion of syngas
 - Preparation and cleaning of biogenous gases
- Thermochemical storage
 - Product and process development
- Development of recycling systems
 - Process development and assessment



RECOVERY OF HIGH-TECH METALS USING IONIC LIQUIDS

High-tech devices are extremely fast-paced. On average, a cellular phone is obsolete after two years. Forty-nine thousand tons of cobalt are needed worldwide each year to manufacture rechargeable batteries. This is equivalent to eight percent of the total annual cobalt production. The problem in the case of metals such as cobalt, niobium and tantalum is that the EU depends up to 100 percent on imports. Efficient recycling methods can contribute towards replacing a portion of these imports with recycled material. Fraunhofer UMSICHT is researching the use of ionic liquids (IL) for the recovery of high-tech metals.

In general, recycling processes for high-tech metals consist of a combination of mechanical, thermal (e. g. pyrometallurgical) as well as hydrometallurgical treatment steps.

The low concentration of the precious metals in waste products initially requires a concentration in individual material flows. These are then targetedly processed further. An important process step of hydrometallurgical processes is the liquid/liquid extraction, the so-called solvent extraction. In this step, dissolved metals are selectively separated from other components from an aqueous solution by an organic, water-insoluble extraction agent. In the process, the metal ions bind with the extraction agent and can then be reclaimed at high purity.

Extraction agents currently in use are diluted with flammable organic solvents such as kerosene so that large quantities of compounds with environmental and safety concerns are handled in the solvent extraction.

Fraunhofer UMSICHT is researching alternative extraction agents that combine the function of solvent and extraction agent and can thus contribute to the process intensification in the solvent extraction.

IONIC LIQUIDS AS ALTERNATIVE EXTRACTION AGENTS

Ionic liquids are also among this group of functional liquids. In initial laboratory tests, an already commercially available ionic liquid, Aliquat® 336, was modified with respect to the selective separation of two metals. By replacing the chloride ion with an organic anion, an extraction agent based on Aliquat® 336 was synthesized with which cobalt and nickel can be selectively extracted from an aqueous solution. Furthermore, in additional test series, the extraction capability for iron was investigated and the successful synthesis of the ionic fluids was proved.

The results of the initial laboratory tests will be used for the further development of the synthesis and the selective extraction capabilities of synthesized ionic liquids. Building upon preliminary tests, the objective of the RECUPERO project is to synthesize two ionic liquids at laboratory scale and subsequently extract select high-tech metals with these ionic liquids. Fundamental extraction parameters (temperature, pH value, etc.) are to be identified in the process at laboratory scale. In addition, the reversal of the extraction process, meaning the dissolution of the metal IL complex, is to be considered.



A second project is starting in 2012 as part of a cooperation project with European research institutions. Different questions of raw material supply, substitution and reclamation options of precious raw materials from waste products will be reviewed in the project. Different processes of the whole process chain (mechanical, chemical, pyrometallurgical) will be developed and, among others, compared with respect to the quality of the reclaimed metals. The most promising reclamation processes are then to be further developed.

Left image Different ionic liquids that were synthesized using Aliquat® 336 as starting material.

Right image Extraction of iron at differing pH values in comparison to the aqueous solution.

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IONIC LIQUIDS

Ionic liquids (IL) consist exclusively of ions.

Contrary to typical inorganic salts (such as table salt), they have a melting point of below 100 °C, whereby they occur as liquids. In general, they are not flammable, feature a low vapor pressure and can dissolve a multitude of chemical bonds.

Through the targeted combination of cations and anions, IL can be synthesized with custom-made properties for specific separation tasks. The Task-Specific Ionic Liquids (TSIL) obtained this way combine the characteristics of the extraction agent and the organic solvent into one molecule.



BIOETHANOL 2.0: ETHANOL FROM SYNGAS

Bioethanol is popular both as fuel and as chemical raw material. Until now it has been manufactured through the fermentation of sugar and starch. Fraunhofer UMSICHT wants to produce bioethanol from syngas that is generated from lignocellulosic biomass – for example wood and straw. The objective is to develop the catalysts necessary for this. The advantages are that the raw materials do not compete with food, and in addition, electricity and heat are produced. This is environmentally friendly and protects the climate.

In 2010, 604,000 tons of bioethanol were produced in Germany. Almost 1.16 million tons were consumed. According to the Federal Association of the German Bioethanol Industry (Bundesverbandes der deutschen Bioethanolwirtschaft e. V.), the additional demand was covered by imports. Ethanol*, as first generation biofuel, is primarily produced by fermentation of biomass containing sugar and starch. Biomass based on lignocellulose can, to date, not be used for ethanol synthesis, because the material bond of cellulose, polyoses and lignin, which serves as structural substance for the plants, can hardly be broken down through fermentation without chemical pre-treatment.

Fraunhofer UMSICHT is researching how ethanol can be produced from lignocellulosic biomass in the future. This avoids a competition with foodstuff production which is controversially discussed in the case of ethanol production through fermentation. If biomass is not fermented but rather gasified, syngas – a mixture of carbon monoxide (CO) and hydrogen (H₂) – is created. In the process, the lignocellulose percentage is also converted, which is not the case with fermentation. The objective is to develop a process for the catalytic manufacturing of ethanol from syngas that is economical and implementable on an industrial scale. As second generation fuel, ethanol from lignocellulosic biomass combines the demand for a high CO₂ reduction potential with an effective raw material utilization and preserves resources, the environment and the climate.

NEW CATALYTIC PROCESS NEEDED

Syngas, from which ethanol will be produced, is generated from wood, straw and non-fermentable residues. The process engineering advantage is that syngas from wood gasification already features the correct H₂/CO ratio for ethanol synthesis. This, as calculations show, makes its production economical.

Adapted catalytic processes with new catalysts are required for this. Catalysts lower the activation energy of a reaction, accelerate it, and improve its selectivity so that the product yield is optimized. The catalyst systems must feature a high activity and ethanol selectivity and work at a pressure level that is as low as possible. However, no catalysts for generating ethanol from syngas are commercially available at present. Therefore, a core task is to optimize catalyst systems known from literature and/or to develop completely new systems and to adapt them to the requirements of biomass gasification.

The catalysts will be tested in a continuously operated laboratory system and optimal process conditions for a possible scale-up (meaning a transfer to industrial scale systems) will be worked out. The reaction speed and ethanol yield in interaction with the different catalyst systems will be investigated in different types of reactor under different reaction conditions.



Safety aspects, energy costs and the removal of the heat of the reaction will also be examined. Since syngas from biomass gasification contains impurities such as tar, polyaromatic hydrocarbons and sulphurous substances, it must be researched how these affect ethanol synthesis. Tolerance levels for these substances are to be derived from this as a foundation for the planning of industrial scale gas cleaning.

POLYGENERATION

The process offers opportunities for improvement of the energetic and economical efficiency through the polygeneration of ethanol, electricity and heat. Polygeneration is an integrated process that can concurrently provide different energetic products such as electricity, heat, gas and liquid fuels. Specifically, the syngas generated by the gasification of biomass can not only be refined into a high quality fuel, but can also be used for power and heat generation in gas and steam turbine power plants. The combination of both strategies leads to a flexible production of individual target products and constitutes the bases of an expanded value added chain.

* In the remainder of the text, bioethanol will be referred to as ethanol

Funding note

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Project partners

UHDE GmbH (ThyssenKrupp), Ruhr University in Bochum

Left image *Bioethanol is used as a fuel additive.*

Right image *To date, biomass that contains lignocellulose is not suitable for ethanol production.*

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BIOETHANOL PRODUCTION

As the worldwide leader in ethanol production, the United States of America relies on grain, while Brazil, the world's second largest producer, derives ethanol from sugar cane. In 2011, approx. two thirds of Germany's bioethanol was obtained from feed grain and almost one third was from sugar. All these raw materials are in direct competition with foodstuffs and feedstuffs.

In 2011, the bioethanol plants in Germany produced 576,828 tons of bioethanol. That is 4.4 percent less than in the year prior, 2010. In this, the share of sugar as raw material for bioethanol was declining and dropped from 33 percent to 28 percent. Just like in the first half of 2011, the relatively high prices for sugar on the world market had an impact.

Source: www.bdbe.de



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ENERGY EFFICIENCY TECHNOLOGIES

»» SMART ENERGY SUPPLY ««

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MAIN TOPICS

- Electrical Energy Storage
- Polygeneration, Thermal Chiller
- Optimization of Energy Systems

INDUSTRIES AND TARGET GROUPS

- Energy supply companies
- Operators of renewable energy plants
- Complex energy-intensive consumers
- Producing industry
- Companies in the innovative process
- Architects, building planners, technical building services equipment



Our objective is the development of new technologies to increase energy efficiency and their integration into existing energy systems. To achieve this, we combine the experience and research results we obtained from our laboratories and test benches using simulated tools – always focusing on the market and the addition of value.

OUR COMPETENCIES

Our technical focal areas are electrical energy storage devices that are required to balance the fluctuating consumption levels and discontinuous feed of renewable energies into the grid; Organic-Rankine-Cycle (ORC) plants that currently turn unused waste heat, such as from biogas plants into usable and profitable power; thermal chillers that provide cold from solar heat or waste heat, from the single-family home to the remote cooling grid.

In addition to these technological focus areas, the entire power supply concept is being optimized systemically, where we develop the supply structures for electricity, heat and cold as well as the operations management as well as possible.

OUR R&D SERVICE

- Electrical energy storage
Development of redox flow batteries, testing of lithium batteries as well as optimization of CAES systems, integration and usage optimization of storage devices in the grid
- Polygeneration/ORC
Development, optimization and construction of ORC plants for biogas facilities, solar ORC or wood ORC in the output class of 50-200 kWel
- Thermal cold production/storage
Steam Jet Ejector Chiller (SJEC) technology (waste heat, solar) and absorption cold; solar cooling, cold storage (PCM/PCS)
- Optimization of Energy Systems
Modeling and optimization of central and decentralized energy systems for the supply of electricity, heat, cold; LowEx



USING CITIES AS ENERGY STORAGE

The shift in energy requires an expansion of solar and wind power. The performance of energy from sun and wind fluctuates, but the power grids only operate robustly when, at any given point in time, exactly that amount of electricity is produced that is also being consumed. In addition to expanding the grid, energy storage will play an important role in assuring the energy supply. Fraunhofer UMSICHT is researching how cities could be used as energy storage in the future.

The addition of renewable energies, especially from the sun and wind, will make it more difficult to robustly operate power grids in the future. High installed generation capacity with severely fluctuating feeds will increasingly lead to situations where significantly more power is generated in the short term than is needed. On the other hand, there may be no sufficient electric generation available, e. g. in case of prolonged lulls in the wind. In addition to the temporal need for balancing, there might also be a large geographic one. The surplus energy from wind power plants in the north of Germany mismatches the energy hunger of the densely populated areas in the west and south of Germany. In the south, the increased installation of photovoltaic systems in single family home developments is also leading to an overload of the low voltage grids that can no longer store the generated power.

The energy system of the future has to be able to permanently balance energy supply and demand both temporally and geographically. For this, essentially two development paths are being pursued: the expansion of the power generation and grid capacities as well as energy storage and intelligent control of consumers and producers. While the grid expansion primarily is a question of choice of routes, acceptance and costs, in the case of energy storage, the development of new technologies, intelligent concepts and operating strategies are in the foreground. This is where the Fraunhofer project, "Hybrid urban energy storage", which is coordinated by Fraunhofer UMSICHT, comes into play. The objective is to

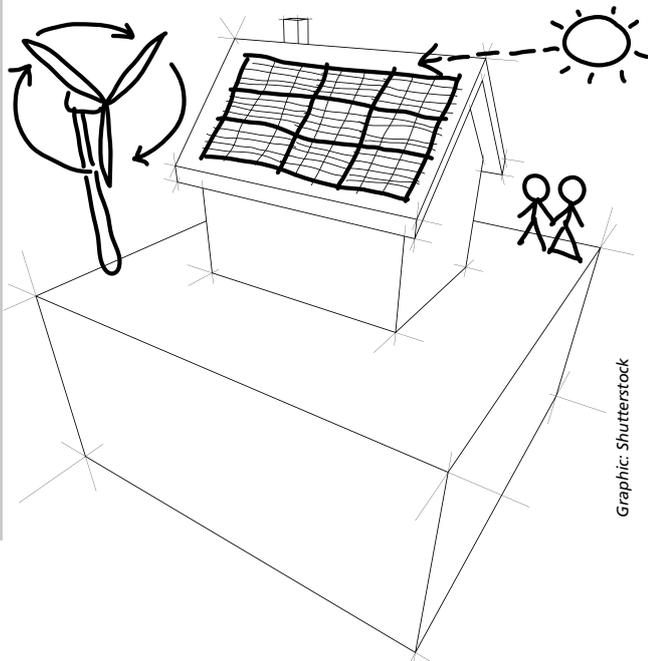
minimize the expansion of grid and producer capacities and the costs associated with them through optimized use of power balancing options in cities.

FUNCTION OF HYBRID URBAN ENERGY STORAGE

Cities feature an enormous (indirect) potential for storing electric energy. The combination of different types of energy balancing into a novel system with new storage options turns cities into hybrid storage systems.

For instance, electricity does not necessarily have to be stored directly in electrical storage systems. Buildings can also act as a buffer for the electric grid. Heat pumps and electrical water heaters use electricity to provide heat to buildings. Combined heat and power plants in addition to heat also provide electricity. By using cheaper, in part existing heat storage, power generation and consumption of these systems can be adjusted to the grid's requirements. As such, an electricity gap can be compensated for by the preferred use of a mini CHP plant while the generated heat is stored. Similarly, in case of a power surplus, heat pumps can be used for preferred heat generation. The buffered heat will then be retrieved from the loaded storage as needed at a later point in time. Both are variants for load or supply shifting.

Real electric storage systems are further components of hybrid urban energy storage. These can be larger, centrally



located batteries or smaller ones in individual homes that are combined for compensating large amounts of energy. For extremely short-term consumption or production peaks in the grid or at times during which no shiftable producers and loads are available, emergency backup CHP plants at hospitals and computing centers can spring into action on short notice. In addition, on the consumer side, large surplus capacities in the grid can be switched into operation on short notice for the heating of local and district heating grids.

The motivation of the Fraunhofer Day-after-Tomorrow project "Hybrid urban energy storage" is to support the safe, economical and environmentally friendly supply of power in the future. The objective is to store surplus energy in hybrid urban energy storage systems in a cost-optimized and intelligent manner. To do this, the participating Fraunhofer Institutes, under the coordination of Fraunhofer UMSICHT, are developing decentralized electrical and thermal storage technologies as well as an intelligent control technology.

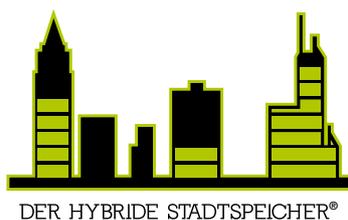
Project partners

Fraunhofer UMSICHT (coordination)

Fraunhofer ISE

Fraunhofer IOSB-AST

Fraunhofer ISIT



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Left image Buildings can also act as a buffer for the electric grid.

Graphic The addition of solar and wind energy poses a challenge for the electrical grids.

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HYBRID URBAN ENERGY STORAGE

Hybrid urban energy storage can flexibly and dynamically balance power production and demand.

Since the power balancing already takes place in the local grid, the necessary expansion of net controlling power capacity is reduced. In addition, hybrid urban energy storage systems have a lot of systems such as heat pumps, combined heat and power plants (CHPs) and hot water boilers that have already been installed and can be redesigned with small measures (such as additional heat storage) and therefore lower costs for using them to store electrical energy.



REDOX FLOW BATTERIES STORE ELECTRICITY FROM RENEWABLE SOURCES

In the future, the increasing amounts of solar and wind power must be stored for the night time or times with lulls in the wind. One solution are redox flow batteries. Fraunhofer UMSICHT operates one of the largest test laboratories for redox flow batteries in Europe in Oberhausen, Germany. Individual cells and large stacks are set up and tested here. The objective is to develop large redox flow batteries in the Fraunhofer Consortium with up to 2 megawatts of power that can provide electricity to approx. 2,000 households.

Already today, renewable energies are the second most important source in the field of electricity generation in Germany. By 2020, their share of the electricity generation is to be more than doubled from the current 20 percent. By 2050, Germany is supposed to be completely converted to renewable energies, as per the objective of Germany's federal government, but the current energy supply system can be overloaded if high shares of electricity from renewable energies are fed into it. Redox flow batteries which store electricity in the range of a few 10 kilowatts (kW) to several 10 megawatts (MW) in the longer term may be a solution.

REDOX FLOW BATTERIES FOR THE 10 KW TO 10 MW OUTPUT CLASS

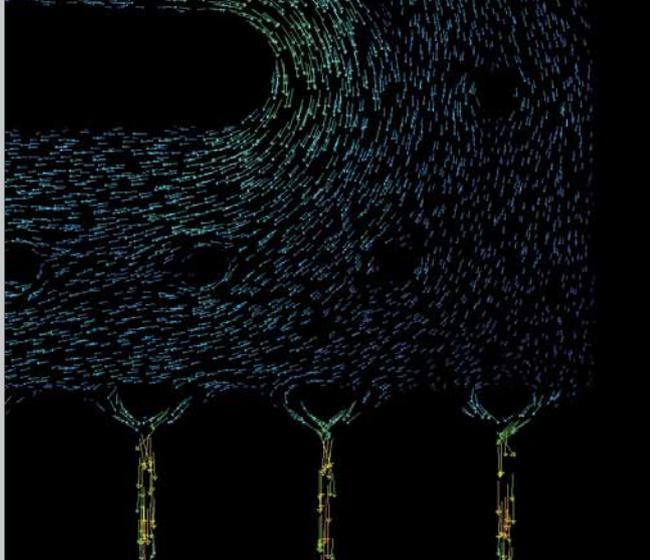
However, no redox flow batteries in this output class are currently commercially available on the market. A Fraunhofer consortium wants to change that. The objective is to achieve high efficiencies through technical innovation, to simplify the structure of the battery, and to use more cost-effective materials. This is the only way that the high system costs can be reduced, which presently amount to approx. 100,000 Euros for small outputs (10 kW/100 kW). As one of the first research institutes in Germany, Fraunhofer UMSICHT is intensely researching electrical energy storage systems. Redox flow batteries are their main focus, since their output is individually adjustable and retrievable and they represent the energy storage system with the potentially lowest storage costs.

Redox flow batteries with up to 80 kilowatts can be tested in the battery laboratory.

FUNCTIONAL PRINCIPLE

Redox flow batteries store energy in electrolyte solutions. The electrolytes are separated by an ion exchange membrane. The most common is the vanadium redox flow battery. Vanadium occurs in different oxidation levels (V^{2+}/V^{3+} and V^{5+}/V^{4+}) here. Since only vanadium compounds are used and not, like in other systems, two different chemical compounds, the cross-contamination of both electrolytes is prevented. Very robust and long-lasting batteries can therefore be constructed and manufactured.

The charging and discharging of the vanadium electrolytes takes place in a so-called stack. This stack is the core component of the battery and the power generation unit of the storage system. These stacks consist of multiple individual cells that are connected electrically in series. This increases the output voltage and power of the battery. The storage of the electrolyte takes place in external tanks; therefore the storage size determines the battery capacity. Compared to conventional batteries, the Redox flow battery has the advantage that power (kW) and storage capacity (kWh) can be individually adjusted to the application. At the same time, the storage tank is comparatively cost-efficient so that especially large storage capacities provide economic advantages.



PROJECT SPECIFICS

The consortium is testing and developing new membrane materials and battery designs and is researching both stacks for small outputs and battery operation management. The operating principle of the Redox flow battery was demonstrated at the Hanover Fair using a 2 kW system.

The challenge consists of the scale-up, making the system larger. Flow simulations help to improve the construction of the cells and let the electrolytes evenly flow through the cells. Based on these insights, the development of a 35 kW stack is planned. Three of these stacks will be combined into a 100 kW battery. The 35 kW stacks will be developed at Fraunhofer UMSICHT in Oberhausen, Germany and will be tested at the battery laboratory. The laboratory provides the foundation for developing larger system with up to 2 megawatts. This contributes towards robustly operating the power grid with fluctuating energy sources and is an important contribution toward assuring supply safety.

For information regarding the laboratory equipment, see pages 84/85.

Funding note

Contribution from the German Federal Budget, fiscal year 2010 for the project: "Development of a 1 MWh/100kW redox flow battery storage system for integration of fluctuating regenerative energies into the power grid"

Partner

Fraunhofer ICT

Fraunhofer ISE

Fraunhofer UMSICHT



battery-lab.umsicht.fraunhofer.de

Left image *View of the test environment of the redox flow laboratory with electrolyte containers and heat exchangers in the background.*

Right image *Simulation of the flow within a stack.*

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ENERGY STORAGE SYSTEM

As recently as 2004, hardly anybody in Germany was looking into energy storage systems. Coal and nuclear power plants were providing a quite constant output. Plannable and controllable power plants as well as pump storage power plants kept the power grid in balance and took care of keeping the amount of power fed into and retrieved from the grid virtually identical.

The expansion of renewable energies changed this. The output of solar and wind power plants fluctuates and requires the expansion of the storage capacity. However, there are hardly any suitable sites for building pump storage power plants.

Electric energy storage systems can be a solution and level the path for the shift in energy.



Dr.-Ing. Hartmut Pflaum

RESOURCES MANAGEMENT

»» UTILIZING POTENTIALS ««

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MAIN TOPICS

- Material Flow Management, Eco-Assessment
- Sustainability Management
- Innovation Processes

INDUSTRIES AND TARGET GROUPS

- Waste management industry
- Energy industry
- Water and wastewater industry
- Process industry and manufacturing industry
- Public administration (planning authorities, federal and state governments, municipalities)
- Banks and insurance companies, investors
- Groups and associations, politics



Resources find their way into products and services which we need to live, which increase our quality of life and which form the foundation for the future. Resources – be they limited or renewable – must be used in a sustainable and economical way. We offer you suitable tools and services to control materials and energies, knowledge and ideas in an optimized way.

OUR COMPETENCIES

We examine the use and effects of materials, energy, goods and knowledge in processes, process chains and value added networks. We optimize them according to economic, ecological and technical-infrastructure criteria. The focus of our R&D services is on production systems, locations and regions. Our objective is to use resources in such a way that they lead to progress and innovation.

We combine modern management instruments with expertise regarding resources and technologies. The results enter into strategic studies and consulting services. For you and your customers, we calculate the contributions for the sustainable development of products, processes, services and company sites as a whole.

OUR R&D SERVICE

Research, development, optimization and implementation in the following sectors:

- Resources Management
(e. g. CO₂-balances, carbon footprints and ecological balances, life cycle management; resource efficiency)
- Material flow systems
(e. g. analyses of energy potentials, bio-energy plants)
- GIS applications for planning and analyses
(e. g. utilization of renewable energies, site development)
- Roadmaps for strategic decision-making
(e. g. research agendas, climate protection concepts)
- Management of R&D projects
(on an international, national and EU level)
- Targeted innovation and knowledge management
(e. g. technology integration, trend analyses, strategies)



EFFICIENT AND SUSTAINABLE ENERGY PLANNING IN THE REGIONS

Regional planning instruments are indispensable so that cities and municipalities can sustainably use biomass. As part of the three year EU project "BEn", Fraunhofer UMSICHT developed a user-friendly web-based instrument for local energy planning: the biomass energy register. It helps in site planning by bundling basic data regarding energy-generating biomass utilization in regions and bringing participants together.

By 2020, the share of renewable energies of the overall energy consumption is to increase to 20 percent within the EU compared to 1990. By using biomass as an energy source, municipalities, in particular, can secure a sustainable energy supply source, achieve climate protection objectives, increase the regional value generation, and thereby contribute to achieving the objective of the Europe 2020 strategy. An essential pre-requisite for this is that cities and municipalities can rely on a well-founded and joint knowledge base.

This exact process is supported by the BEn (Biomass energy register for sustainable site development for European Regions) project which equips municipalities with an easily applicable instrument for local energy planning. Seven European partners from five countries developed a biomass energy register under the leadership of Fraunhofer UMSICHT. It contains data about biomass sources and potentials, sites for existing plants, including best practice examples, data about energy sinks as well as a comprehensive collection of participants and networks. For this, all relevant data was collected for four different model regions and combined within a WebGIS system (geographic information system). This way, the status quo of the region with respect to the energetic utilization of biomass can be represented.

ACCESSIBLE, TRANSFERABLE AND EXPANDABLE WORLDWIDE

The system contains additional information such as guidelines regarding the management and financing of biomass energy investments or calculation aids. Among other things, the database serves as a foundation for the regions to develop master plans for bioenergy planning. The user has different tools available, such as measuring functions, for data retrieval and analysis. By listing relevant participants and contacts from the biomass area, networks can be rebuilt or existing ones can be expanded. It is a knowledge and communications platform and therefore the foundation for cooperations. The biomass energy register is available as a first point of contact for investors and project developers. It serves for political decision-making and compiles the existing competencies of the region in the subject matter of bioenergy.

An important advantage of the system is its open source character. The data is available worldwide, openly accessible and expandable, e. g. for the integration of additional renewable energies and data from new regions. The BEn platform was tested and successfully applied in the following four regions: Northeast England/United Kingdom, Emscher-Lippe Region/Germany, Umbria/ Italy, and the Gostynin Lake District/Poland.



INITIAL RESULTS IN THE FOUR REGIONS

For the Emscher-Lippe Region, the biomass energy register is very useful for illustrating the supply and demand, since the region is characterized by close proximity of urban areas to rural areas. Over the course of the project's duration, it was possible to increase the installed output by approx. 15 MW. A logistics infrastructure for the utilization of biomass will be setup in northeast England. The BEn project helped in collecting relevant information and best practice examples and this will allow sustainable development for the future. In Poland, regional participants networked with the help of the BEn project and joint regional study trips were organized. Heterogeneously available data were processed and transferred into a joint data pool for the region. Based on the BEn project, participants attended training measures so that they would be sensitized for the later implementation of activities. In the Umbria Region, important biomass projects were triggered by this project, based on the result and data of the energy register.

Funding note

The BEn project was co-funded by the European Commission – Executive Agency for Competitiveness and Innovation (EACI) under the program Intelligent Energy Europe (IEE).

Project partners

WiN Emscher-Lippe Association for Structural Improvement (Germany), Rural Development Initiatives (UK), European Center for Renewable Energies (Austria), Biomass Research Center (Italy), Institute for Ecology of Industrial Areas (Poland), Gostynin Lake District Tourist Communes Associations (Poland)



www.ben-project.eu

Left image The biomass energy register is accessible worldwide via the Internet.

Right image The register features an interactive map application with comprehensive GIS functionalities.

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MODEL REGION

The examined regions displayed different characteristics. In the area of the Polish Gostynin Lake District there are predominantly residues from agriculture and wood, whereas in the Emscher-Lippe Region there are huge potentials in the waste product area. Northeast England features residues from the area of wood, whereas the Umbria Region displays different potentials in the wood sector but also residues from wine production. The energy register provides a good overview of the biomass potentials based on different substrates: agricultural and forestal products, especially cultivated energy plants, forest and residual wood, straw from grains, waste products as well as by-products and plant waste. The register is transferable to other regions.





BIOCOUPLE – COUPLING MATERIAL AND ENERGETIC UTILIZATION OF BIOMASS

On the one hand, scarce fossil resources can be replaced by biomass, while, on the other hand, the utilization of biomass quite often poses competition to food and feed production. Furthermore, the coupled energetic and material utilization of biomass competes with the exclusive energetic or material utilization of these organic substances. In the BioCouple project, Fraunhofer UMSICHT investigated the coupled material and energetic utilization of biomass as well as the possibility of integrating them into existing energy scenarios.

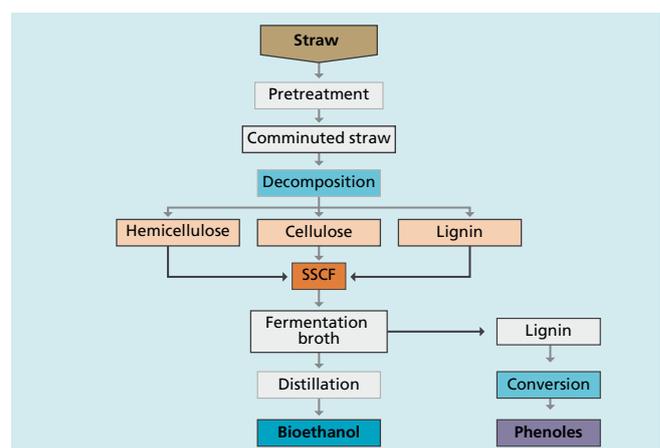
The German Federal Government presented an ambitious package with the "Integrated Energy and Climate Program" in 2007 with 14 projects for expanding the utilization of renewable energies. The share of renewable energies, in particular, plays a decisive role in this context. With the help of the "Biorefinery Research Portal," 92 European research projects involved with biorefinery were identified in 2010. The cluster showed that the focus of the activities is on the concrete assessment and optimization of individual biogenous raw materials, product spectrums, processing techniques or process chains. In the BioCouple project, scheduled for a duration of one and a half years, UMSICHT checked to what extent the concept of biorefinery is suitable to provide bio-energy, energy as well as substances/materials coupled and efficiently and how it can be optimally integrated into existing energy systems.

EXAMINATION OF FIVE GENERIC BIOREFINERY CONCEPTS

Due to the project's strategic focus with respect to the integration of biorefineries into the German energy system, the reviewed biorefinery concepts had to fulfill the following criteria: technologies available short to mid-term and relevant markets for the main and by-products had to exist as well as a particularly advantageous geographic location. Biorefineries whose raw materials could not be obtained within Germany for economic or technical reasons were not taken into consideration.

The focus was on the following biorefinery concepts (types):

- Type I Single platform biorefinery for bioethanol and animal feed made from grains containing starch
- Type II Single platform biorefinery for biodiesel, animal feed and glycerin made from plant seeds containing oil
- Type III Single platform biorefinery for synthetic biofuels, electricity and naphtha made from residual wood/SRF*
- Type IV Three platform biorefinery for bioethanol and chemical made from straw
- Type V Two platform "green" biorefinery for electricity, insulating materials, fiber-reinforced plastics and fertilizers made from grass





In addition to technical/economic analyses, these generic biorefinery types were assessed with respect to different environmental aspects such as climatic effectiveness, preservation of fossil resources, and acidification potential. Furthermore, the project team determined corresponding indicators for reference systems that each provide the same product spectrum and were compared to the biorefinery types. Based on these results, an extrapolation of the absolute savings potential for Germany arrives at 14 million tons of CO₂ equivalents in 2030.

SUCCESS FACTORS FOR BIOREFINERIES

The analyses have shown that a concept for coupled production of material and energetic products, meaning "the" biorefinery, can not yet be spoken of. The generically reviewed biorefineries are at different stages of development and/or commercialization. While the processes of the types I, II and V are already fully deployable and available on the market, types III and IV are concepts that are not yet commercially developed. Accordingly, there is an individual need for optimization for each system. Strategically, the following factors can be derived which are of considerable importance to the success of biorefineries: the availability of the biomass, the selection of a suitable site, and the marketability of the produced products. The mid- and long-term objective in the area of biorefinery is the further development of new bio-based products that utilize nature's synthesis performance.

* Short Rotation Forestry

Funding note

German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU)

Project partners

Öko-Institut e. V. (Eco Institute)

Wuppertal Institut für Klima, Umwelt, Energie GmbH

(Wuppertal Institute for Climate, Environment, Energy)

Left image BioCouple studied the possibilities and perspectives of different biorefinery concepts up to the year 2030.

Right image In the future, biomass is to be coupled, meaning to be used both energetically and materially.

Graphic Exemplary path to a three-platform refinery for bioethanol and chemicals made from straw.

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BIOMASS STRATEGIES

Currently, two strategies for the development of biorefineries are being discussed:

- The conversion of biomass into basic chemical compounds which subsequently are further processed in existing synthesis routes into conventional products.
- The development of new synthesis paths which directly use the complex molecular structures of the biomass and build on them.

The development of new bio-based products requires additional research, new infrastructures and, where applicable, new markets, but provides the perspective of a more efficient production in the long term.

3 People

Research has lots of human factors: behind our work, there are people; we would like to introduce some of them to you, since without them we would be nothing.

Nermin Adrovic · Sabine Ajeti-Althoff · Bersedan Ali · Wilhelm Althaus · Thiemo Ansorge · Clemens Backhaus · René Bauer · Nushin Behzadifar · Carsten Beier · Teresa Belkot · Anja Bergmann · Sascha Berthold · Jürgen Bertling · Ralf Bertling · Siegfried Bleche · Jan Blömer · Pia Borelbach · Julia Borkes · Klaas Breitzkreuz · Inna Bretz · Karlheinz Bretz · Birgit Brosowski · Michaela Bruisten · Stefano Bruzzano · Christian Brzoska · Tobias Buchholz · Jörg Buck · Martin Buckermann · Marcus Budt · Björn Bülden · Daniela Buschmann · Leonardo Canello · Petra Corbeck · Philipp Danz · Joachim Danzig · Stephan Deckert · Görgo Deerberg · Christina Demmer · Martin Distelhoff · Christian Dötsch · Sebastian Drabben · Boris Dresen · Tim Drews · Günter Drißen · Anja Drnovsek · Andreas Dudlik · Mona Duhme · Bärbel Egenolf-Jonkmanns · Ulrike Ehrenstein · Marie Eingrieber · Thomas Eisenburger · Christina Eloo · Arif Emini · Christoph Epping · Rene Dirk Eppler · Rafael Erdmann · Anna Fastabend · Klaus Feja · Matthias Fischer · Walter Fischer · Jasmin Folly · Jane Garstka · Ilka Gehrke · Anja Gerstenmeier · Andrea Gerstner · Ute Gessner · Kai Girod · Markus Gläßer · Christoph Glasner · Patrycja Gondek · Jürgen Grän-Heedfeld · Anna Grevé · Johannes Grob · Sofian Bastian Guetari · Miriam Hansen · Erika Heiken · Ernst Heiken · Volker Heil · Torsten Hennig · Markus Hiebel · Joachim Hillers · Sabine Hillesheim · Damian Hintemann · Kerstin Hölscher · Nils Hohmann · Björn Hunstock · Aylin Hustermeier · Michael Jandewerth · Georg Janicki · Hilke Janssen **Erich Jelen** Alisa Jovic · Nina Junen · Stephan Kabasci **Stefan Kaluza** Christel Kang · Annedore Kanngießer · Tobias Kappels · Sabine Kareth · Nicole Karow · Ulrich Kern · Anneliese Kesselring · Volkmar Keuter · Marvin Kicha · Andreas Kilzer · Thomas Klein · Uwe Kleinwegen · Kerstin Klocke · Thomas Klose · Nina Kloster · Volker Knappertsbusch · Christian Knermann · Christian Knoll · Sabine Köhler · Hans-Jürgen Körner · Rodion Kopitzky · Axel Kraft · Joachim Krassowski · Simone Krause · Burkhard Krüger · Peter Krüger · Iris Kumpmann · Joanna Kurek · Jan Lang · Kay-Uwe Laux · Bernd Lehrke · Frank Letzner · Heiko Lohmann · Daniela Lucke · Hildegard Lyko · Daniel Maga · Thomas Marzi · Karl Meller · Andreas Menne · Stefan-Mario Menning **Ute Merrettig-Bruns** Michael Metz · Gertrud Michels · Edda Möhle · Gerhard Mrosek · Asja Mrotzek **Christine Mühleib** Ralf Müller · Torsten Müller · Judith Mundt · Sandra Naumann · Nicole Neugebauer · Anke Nellesen · Helen Niemeyer · Nicole Nowara · Rasit Oezgüec · Thomas Ombeck · Gabriela Ortmann · Katrin Ortmann · Eva Otter · Frank Pape · Ralf Paucker · Sebastian Pfeifer · Hartmut Pflaum · Udo Piontek · Astrid Pohlig · Clemens Pollerberg · Sascha Pott · Henry Rübiger · Svenja Raschke · Marcus Rechberger · Andre Reinecke · Manfred Renner · Jens Reschke · Manuela Rettweiler · Thorsten Ricker · Josef Robert · Hendrik Roch · Susanne Rölleke · Iris Romeike **Jorge Iván Salazar Gómez** Olga Salijow-Samus · Kenny Saul · Bettina Sayder · Elisabeth Schaberg · Bianca Schacht · Florian Schellhase · Peter Scheuern · Eva Schieferstein · Dennis Schlehuber · Stefan Schlüter · Uwe Schnell · Nick Schöwe · Sabrina Schreiner · Andreas Schröder · Stefan Schroer · Anita Schulze · Tim Schulzke · Kerstin Schwarze-Benning · Peter Schwerdt · Ulrich Seifert · Thorsten Seipp · Andreas Sengespeick · Annette Somborn-Schulz · Martin Spitz · Richard Sprick · Esther Stahl · Jürgen Stein · Sabine Strauch · Simone Taube · Peter Timmermann · Christoph Unger · Barbara Vatter · Max von Tapavicza · Holger Wack · Thorsten Wack · Andreas Weber · Stephanie Wehr · Eckhard Weidner · Katharina Weßling · Andrea Paula Wilmsen · Michael Winkel · Thomas Wodke · Daniel Wolf · Patrick Wrobel · Heike Wünnenberg · Barbara Zeidler-Fandrich · Stefan Zepnik



UTE MERRETTIG-BRUNS HOT ON THE TRAIL OF TRACE ELEMENTS AND BACTERIA

Dr. Ute-Merrettig Bruns (52) is a biologist. She studied in Braunschweig, Germany and completed her doctoral thesis in Dortmund, Germany. She then came to UMSICHT and started working in the biotechnological laboratory. That was 20 years ago. She told the UMSICHT editors what she does at the laboratory, why trace elements and bacteria are so important, and why she loves her job.

WHAT DO YOU DO IN UMSICHT'S BIOTECHNOLOGICAL LABORATORY?

Environmental biotechnology is one important subject area that we are dealing with in the biotechnological laboratory. For one, there is the biological treatment of waste products, meaning in particular the fermentation of substances. In this area, the biogas topic crops up a lot in our lab. We are investigating the processes of biogas production. In addition, we are researching the biodegradability and compostability of materials, in particular of plastics. We are working closely together with the Renewable Resources business unit on this. Another topic is the biotechnological production of materials, in particular the fermentative production of succinic acid.

WHAT DO YOU USE TO CONDUCT ANALYSES?

We have more than 50 test units to perform fermentation tests, temperature-controlled rooms for incubation, a 30 liter laboratory biogas reactor, laboratory systems on which we can also test biological compostability under realistic conditions, two respirometers for assessing biodegradability, and various fermenters for the production of biomaterials. Our laboratory is a DIN CERTCO-certified test laboratory (page 83), and we have also performed a lot of work in the past two years for external customers, in addition to our research activities. We perform fermentation tests as well as microbiological analyses and conduct feasibility studies, e. g. for decomposition processes of new materials for biogas production when the materials are not as easily degradable and thereby fermentable.

WHAT DO YOU LIKE THE MOST ABOUT YOUR JOB?

I like that I can organize my work independently. My work is self-determined, and I can introduce my own ideas. For me, it is always a very nice blend of office work at my desk and laboratory work. This is particularly appealing since I need the close contact to the laboratory. I cannot sit at my desk all day long.

WHAT ARE YOU CURRENTLY RESEARCHING?

Last year's main project was a research project from the biogas area which was scheduled for a duration of two years. It dealt with the significance of trace elements in the biogas process. Bacteria need certain trace elements for an optimal biogas production. We have developed a test method to be able to quickly and precisely analyze the biological activity in the biogas fermenters. We received the Biogas Innovation Prize for our results (page 105). I am very happy about that!

WHY IS THIS SO DIFFICULT AND/OR WHY IS THE TEST SO SPECIAL?

The metabolic activity of the bacteria in the fermenters of biogas plants is still a little bit of a black box. We roughly know when it is taking place, but the exact biological activity is not known. However, the better the bacteria are at turning organic matter into biogas, the higher the biogas yield is going to be. Therefore, our test contributes towards operating biogas plants more efficiently. We developed this ORGA test jointly with the Universities of Göttingen and Rostock (Germany).



We inspect samples of the fermenter broth and then see how fast the substrates are converted into biogas within five days. We then know if it is optimal or if it has deficits.

WHAT DO YOU DO THEN?

Newer research projects are currently dealing with the question of how we can influence biogas production. That is a highly complex topic. There are many different groups of bacteria that are active here and that build on one another. They work like a food chain such as the ones we are familiar with like in the ocean: from plankton to algae and fish all the way up to humans. We first need to research how these can be influenced.

ON THE TOPIC OF BIOGAS: ARE YOU ONLY IN THE LABORATORY OR ALSO DIRECTLY ONSITE AT PLANTS?

We work very close to the application – even in biology. Therefore, it clearly makes sense for us to work together with plant operators. In our current project, in particular, we studied biogas fermenter samples that we obtained directly from the plants. All in all, we have sampled more than 30 biogas plants together with our project partners. At the end of the project we worked together with the operators of a large-scale plant who added trace elements based on our recommendations.

IS BIOLOGY ALSO THE FOCUS OF YOUR LEISURE TIME?

At a minimum, I am also quite interested in biology during my leisure time. I like to explore the lower Rhine fauna and flora by bicycle because I can observe wild geese among other things here. But I also really enjoy reading, especially mysteries and crime fiction, and enjoy many sports such as skiing, horseback riding and tennis, and of course spend a lot of time with my husband and my 21-year-old son.

Left image Ute Merrettig-Bruns takes a reading of the biogas volume produced in the gas collection tube at regular intervals and records the values during a fermentation test.

Center image The biological decomposition of plastics in the composting system is studied under controlled conditions in compost reactors.

Right image Ute Merrettig-Bruns performing experiments at the fermenter plant. The substrate additives are recorded and the measured values are checked at the continuously operated biogas plant.

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ERICH JELEN PROTECTING WORKS OF ART AND CULTURAL ASSETS

Many museum pieces or even monuments that are part of our cultural heritage are at risk of being lost for posterity. Hylotox 59, an agent enriched with the insecticide dichloro-diphenyl-trichlorethane (DDT) that was used in the former Eastern Germany (GDR) for wood treatment, is to blame, among other agents.

Fraunhofer UMSICHT employee Dipl.-Ing. Erich Jelen from the Materials and Interaction business unit knows exactly how the agent, which was originally intended to protect wood, is causing the damage and what can be done about it:

"Contamination from DDT is more than apparent to the naked eye. That is because there is a layer of white crystals on wood treated with a paint or spray process and/or in impregnation baths. This happens because DDT, due to its chemical and physical properties under normal climatic conditions, only rarely shifts into the gas phase and can crystallize on the surface." Hylotox was banned in most European countries approximately twenty years ago.

Sculptures, roof beams, as well as instruments were treated, sometimes numerous times, and are therefore so highly contaminated that people must wear protective clothing as well as a breathing mask in their vicinity. Unfortunately a lot of treated works of art and cultural assets end up in the back corner of some warehouse. In worst case scenarios, museums and churches have to remain completely closed until they have been renovated. "To counteract this, I offer a complete package for the preservation of historical monuments. This means I do not only provide different processes for non-destructive decontamination of the affected cultural assets, but I also offer analyses and consulting as well as information regarding environmental medicine," claims the 48-year-old.

ERICH JELEN – SPECIALIST ON MANY LEVELS

The fact that the father of three school-aged children can involve himself so versatilely is due to his broad education. The scientist from the Ruhr Area started studying chemistry in college after he finished high school. He supplemented this education with an apprenticeship as a furniture carpenter. "After spending a few years in the carpenter profession, I then thought: 'OK, that cannot be all that there is to do,' and then started studying ecological biology through distance learning in parallel to my work. I then added a degree in chemical engineering with a focus on environmental technology at the University of Applied Sciences in Münster."

Erich Jelen has been dealing with the subject of decontamination at UMSICHT since 2000. He was introduced to it back then through a customer's interest in a controllable high-pressure system that can be used for decontaminating wood with compressed carbon dioxide. Since the engineer, according to one of his colleagues back then, "was the only one who knew what a piece of wood actually looks like," he was chosen to join him in the meeting. "After the meeting, my former colleague, chemist Andreas Weber, and I then further developed the system so that at the end of a project it was actually possible to decontaminate five figures from the 16th century with the help of supercritical carbon dioxide. The thing that made it special was that all colors remained intact."



It was possible to remove up to 99 percent of the organo-chlorine pesticides with the decontamination process using supercritical carbon dioxide, which received multiple awards.

COLOR PRESERVATION PLUS DECONTAMINATION THROUGH SUPERCRITICAL CARBON DIOXIDE

In the workshop series "UMSICHT: On Topic!" (UMSICHT: Zur Sache!), Erich Jelen informed together with other speakers in early 2012 about the importance of the protection of cultural assets and the necessity of decontamination. Experts in the renovation and preservation of historical monuments as well as newcomers to the area were able to receive training in the areas of material characteristics and occupational safety and learn new research approaches at the same time.

In addition to the decontamination process with supercritical carbon dioxide, Erich Jelen is currently cooperating with museums and other Fraunhofer Institutes on another process for decontamination and surface cleaning.

He is also active in several panels such as the German Construction Technology Platform (Focus Area Cultural Heritage), the Research Alliance for the Protection of Cultural Heritage (Forschungsallianz Kulturerbe) as well as the Scientific & Technological Working Group for the Restoration of Buildings and Preservation of Monuments (Wissenschaftlich-Technische Arbeitsgemeinschaft für Bauwerkserhaltung und Denkmalpflege).

Left image Erich Jelen measures the quality of the surfaces with the 3D confocal microscope after decontamination.

Center image Erich Jelen (right) with a colleague from the former Messer Griesheim AG during a decontamination test of works in high pressure containers with a volume of approx. 200 liters.

Right image DDT-contaminated sculpture before cleaning.

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CHRISTINE MÜHLEIB IT IS ONLY ONE OF THE MANY PIECES OF THE PUZZLE

Anything is possible. That is kind of Christine Mühleib's life's maxim – both professionally and privately, because the 30-year-old IT specialist has a pretty tight daytime schedule and is active in a lot of different areas. In 2002, she started her cooperative education as an informatics specialist for application development at Fraunhofer UMSICHT. She also has a degree in Business Information Systems and is the mother of a 3-year-old daughter. She has also been the equal opportunities officer at the institute for the past two years.

"I always enjoy having a lot to do and like to combine different activities. It keeps things interesting," stated Christine Mühleib while justifying her varied activities. As an employee in the Information Technology in Process Engineering business unit, she usually works on a lot of projects at once: a piece of hardware has to be ordered, a software tested or adapted, support is needed for various services or quarterly invoices need to be sent out. Christine Mühleib has increasingly been working in a team on the ViP project – the virtualization platform of the Fraunhofer-Gesellschaft – for about a year now. With this project UMSICHT is creating a concept for the roll-out and the operation of a virtualization platform at Fraunhofer-Gesellschaft Institutes. "In my work, I have contact with a lot of different interfaces within the participating institutes and the Fraunhofer-Gesellschaft. I am working in the technical area and also keep an eye on the commercial and business aspects. I really enjoy it." Most of the time she works on ten different things at once. There is no chaos, because she has everything under control. If anything, multitasking stimulates her.

FLEXIBLE WORK HOURS HELP IN ORGANIZING

The end of her work day is precisely coordinated with her family, because Christine Mühleib's 3-year-old daughter Charlotte needs to be picked up from the day care sitter. "Charlotte is the best thing that ever happened to me, and I always look forward to my time with her. But at the same time I also definitely wanted to keep working full-time."

Child and career – she is managing to balance this pretty well with her husband. "Of course we always have to plan everything precisely, but once everything has been organized, things work like a charm." UMSICHT's flexible work time models also contribute to this and they offer a solution for emergencies: "If Charlotte gets sick or if the day care sitter is not available, I can bring her to work with me. UMSICHT has the MiKi ("Mit-Kind", meaning with Child) office for this," she explains. UMSICHT recently received the prize from the city of Oberhausen (page 105) for its family-friendliness and for its flexible flextime arrangements, telework (work from home) options and counseling through the family service offered for children, but also for relatives in need of care.

Looking back: Christine Mühleib has always been thrilled by technical things. "Computers were simply exciting to me. That might have been in part due to my three big brothers. When I was 17 I received a book as a gift that was somewhat trend-setting: 'How to learn programming based on the hamster model'," she laughingly remembers. After she completed her training at UMSICHT, she determined, "Actually, I would like to learn more. And in particular, I would like to also include the business side in addition to the technical aspects." She therefore decided to take advantage of the cooperative course of study for a degree in Business Information Systems at the FOM*. But this by far was not the final station for Christine Mühleib, she is always a bit restless and enjoys learning something new.



"I look at my career a little bit like a puzzle. And there are always parts that are missing."

ENERGY THROUGH ACTIVITY

That is why she takes advantage of opportunities to broaden her horizons. Christine Mühleib is participating in the Fraunhofer Mentoring Program. Here, as a mentee, she exchanges ideas with her mentor, the IT strategist of the Fraunhofer-Gesellschaft, as well as with other mentees. She also likes to dedicate herself to social issues and has been the equal opportunities officer at UMSICHT for the past two years. During this time, she organized school vacation childcare for employees' children together with her colleague Astrid Pohlig. "This is a cooperation with the University of Duisburg-Essen, where the caretaking of the children occurs. The vacation programs are designed with a lot of variety built in, and all of the children who have attended before want to attend again during the next vacations." The best part about it is that the parents simply come to work as usual, because a shuttle bus picks the UMSICHT employees' children up at the institute and takes them back at the end of the work day.

Time to breathe? "That's something I don't necessarily need. Most of the time I recharge my batteries by simply having a lot to do, being busy and learning a lot of new things. Of course there may occasionally be an hour in which I just soak it all in. But activity is better," admits the resident of Duisburg, Germany. In addition to her diverse job and her family, which keep her on her toes, she also get some exercise from her hobby – twice a week she heads to the riding stables to tend to her horse.

* University of Economics and Management in Essen, Germany

Left image Christine Mühleib really enjoys her varied job in the IT sector.

Center image UMSICHT received the "Exemplary family-friendly company 2012" award from the city of Oberhausen.

Right image If the daycare sitter is not available, parents can conveniently bring their children with them to the Mit-Kind office at UMSICHT.

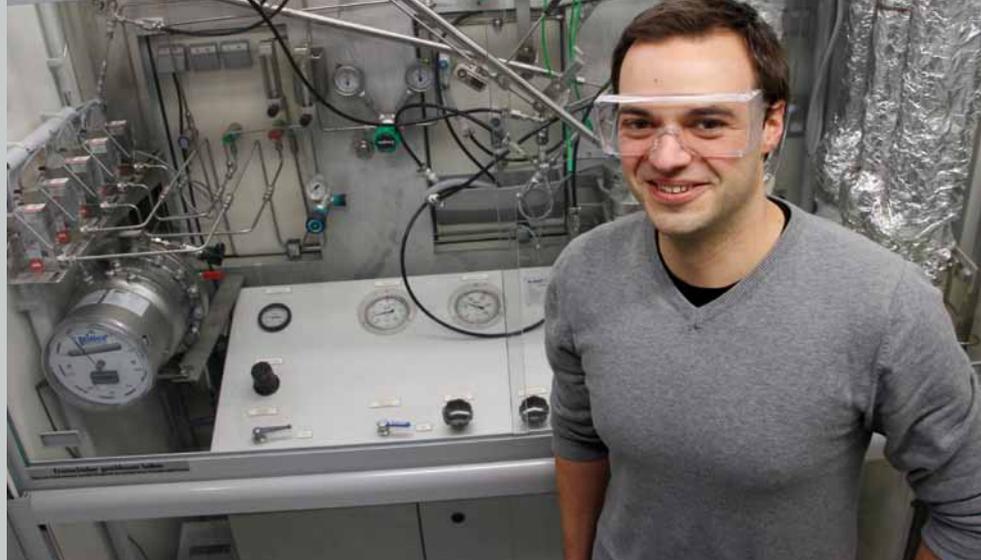
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STEFAN KALUZA "FRAUNHOFER ATTRACT" PROMOTES HETEROGENEOUS CATALYSIS

Dr. rer. nat. Stefan Kaluza started working at Fraunhofer UMSICHT on February 1, 2012. Supported by the "Fraunhofer Attract" sponsorship program for application-oriented further development of ideas of young scientists, the 31-year-old studies heterogeneous catalysis. Stefan Kaluza used to be the head of the catalysis group at the Ruhr University in Bochum. In the interview, he explains why he decided to join Fraunhofer UMSICHT, why he is fascinated by chemistry and whom he would like to meet.

YOUR FIELD OF WORK IS HETEROGENEOUS CATALYSIS. WHAT'S THAT?

Catalysis is used in chemical processes. If, for example, very high pressures or temperatures are needed for conducting such a process, it makes sense to use a catalyst. It functions as an aid and lets the reaction take place at lower temperatures and pressures. In this case, heterogeneous means that the catalyst and the reaction medium are present in different phases, for example, you have a solid catalyst and a gas phase reaction. Interestingly, the heterogeneous catalysis has not been intensely pursued at Fraunhofer until now.

WHAT DO YOUR PROJECTS REGARDING HETEROGENEOUS CATALYSIS AT FRAUNHOFER UMSICHT LOOK LIKE?

Since the beginning of last year, I have been working on a project for the preparation of higher alcohols from syngas. We would like to be able to make CO₂ materially usable in the future, meaning to turn CO₂ into an energy source or even into a valuable chemical material.

We are dealing with the preparation of methylal in cooperation with the Max-Planck-Institut für Kohlenforschung (Institute for Carbon Research) in Mülheim, Germany. We recently had a kick-off meeting with our partners for a project sponsored by the Federal Ministry of Education and Research (BMBF). The latter will also deal with the preparation of dimethyl ether from syngas.

YOU LEFT UNIVERSITY TO WORK FOR FRAUNHOFER UMSICHT. WHAT WAS SO ENTICING FOR YOU AT FRAUNHOFER UMSICHT?

I am very interested in industrial applications research. I like that you can see that what you are doing will also be applied. But at the same time, I want to understand things down to the smallest of details, which virtually is the academic value. This also explains why I studied at the university for so long. When I received the offer from UMSICHT, I realized that the opportunities for application-oriented research are significantly better here.

WHY DID YOU DECIDE ON CHEMISTRY AS FIELD OF STUDY?

Almost everyone in my family has worked at a chemical park. When I was still little, they held an open house there, so I went and thought it would be great to be able to understand all those pipes and systems. When we then had chemistry as a class at school, I was immediately fascinated by it. After passing my Abitur – German school leaving examination – I was sure that I wanted to intensify this with university degree studies.

HOW DID YOU MANAGE TO EARN YOUR DOCTORATE AT AGE 28?

I had the good fortune that my parents supported me a lot financially. Unfortunately, I also saw with a lot of my fellow



Image: Carsten Jünger/pixelio.de



students who were working on the side how much that was delaying them time-wise. Chemistry is a very time-consuming field of study. Lectures in the morning, laboratory in the afternoon.

WHAT DO YOU ASSOCIATE WITH SUSTAINABILITY?

That I could do a whole lot more. For instance, I drive every day from Bochum to Oberhausen. That is not sustainable at all. Sustainability is dealing very responsibly with the resources one has available. It begins with little things such as simply turning the light off or lowering the heat when you aren't home.

WHAT ELSE DO YOU HAVE PLANNED PROFESSIONALLY?

A very good aspect of "Fraunhofer Attract" is that it offers a whole lot of leeway in further career planning. Of course, Fraunhofer is interested that its employees gain a foothold in an institute and that a new business unit may arise from an Attract group. But I also still have the option to pursue a post-doc degree. Many people who started in the Attract program also end up in industry. The versatility is simply very appealing. I have to say that even though I have only been with UMSICHT for a short period of time, I already feel very comfortable at the institute. At the moment I would like to intensify my work here and would like to stay. The opportunity to conduct application-oriented work is very appealing to me.

IS THERE ANYBODY WHOM YOU WOULD LIKE TO MEET?

The person I am already looking forward to meeting is Ferdi Schüth, director of the Max-Planck-Institut für Kohlenforschung in Mülheim. We have established a cooperation with him. I have already attended several of his lectures in Bochum. He is an incredibly brilliant man who does not have his head in the clouds, and you can really see that he simply enjoys what he is doing. Let's just say I'm a fan.

Left image *Applying a theory is ideal for Stefan Kaluza.*

Right image *Stefan Kaluza earned his doctorate in chemistry at the age of 28.*

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"FRAUNHOFER ATTRACT"

The "Fraunhofer Attract" sponsorship program provides extraordinary external scientists with the opportunity to drive their ideas forward market-oriented towards application within an optimally equipped Fraunhofer Institute.

Over the course of five years, the scientist is given a budget of max. 2.5 million euros to establish and lead a group.



JORGE IVÁN SALAZAR GÓMEZ

"COOKING IS LIKE CHEMISTRY"

Red, yellow, green. They come in all colors. No wonder that UMSICHT employee PhD Chem. Proc. Ing. Jorge Iván Salazar Gómez misses his tasty delicacies. Fruit from Columbia. Even the names amaze: Guanábana, Curuba, Lulo, Chirimoya, Granadilla or Mamey Zapote. Not to mention the flavor. "If I find such a fruit here at a supermarket at all, then it is usually still green," explains Jorge Iván Salazar Gómez, almost disappointed. Around here, you'll never find them as ripe and juicy as in his native Columbia.

Jorge Iván Salazar Gómez has been living in Oberhausen, Germany since 2005. He decided to move to this country without knowing a single word of German. The reason was his love for his German wife.

After two years of intense language training, he started to work for Fraunhofer UMSICHT in the Energy and Recycling Materials business unit in 2007. At the institute, he primarily deals with quantitative analytics of biogenous gases and, recently, the development and characterization of materials for so-called thermo-chemical heat storage. Biogenous sources represent valuable energy sources that have been increasingly utilized in recent years, e.g. directly on-site at gas engine combined heat and power plants or can even be fed into the natural gas network after suitable processing. It is important to know the gas composition of the biogases in order to determine the area of use. The storage of heat is a market with a huge potential, since the energy supply of the future will be primarily ensured through decentralized provisioning.

DIFFERENT COUNTRIES, DIFFERENT CUSTOMS

Jorge Iván Salazar Gómez enjoys his work a lot, and the small prejudices he used to have against Germans have completely been wiped away. "I thought that Germans were very strict and overly precise, but everyone is very open and friendly. Especially the people in the Ruhr Area," says the 34-year-old, revising his opinion.

Despite the Southern temper they are said to have, Columbians are very conservative at work. That is why he prefers the friendly and familial atmosphere at Fraunhofer UMSICHT. In addition, he has picked up what he considers to be a typical German characteristic: doing handicrafts. "In my home country, almost no one ever does handicrafts. Here, people do it all the time. Whether it's making birthday cards or other small gifts. I do this now, too," raves Jorge Iván Salazar Gómez.

He does not experience a lot of homesickness for Columbia, but that might also be due to the fact that he has been gone from his hometown of Medellín for so long. He left Columbia ten years ago. He first went to Scotland, where he wrote his doctoral thesis at the University of Strathclyde in Glasgow on the "Manufacturing, cleaning and characterization of carbon nano tubes for hydrogen storage." He earned his doctorate in chemical engineering and process engineering. His family initially could not believe that he wanted to study chemistry. "Why not study law? Or civil engineering?" he was asked. But chemistry is what had always fascinated Jorge Iván Salazar Gómez, so nobody was able to change his mind. Unlike physics, chemistry was something tangible to him, for example while cooking. "To me cooking very clearly reflects chemical processes. For example, adding salt to food changes the osmotic pressure. When searing onion, processes such as caramelization can be observed, among others." Cooking is one of Jorge Iván Salazar Gómez's favorite hobbies. In his opinion, Indian cuisine is particularly exciting and delicious due to its



Image: Klaus-Uwe Gerhardt/pixie.jp.de

numerous essential oils such as the terpenes. He got to know and appreciate Indian food during his doctoral dissertation in Glasgow. One of his favorite dishes is "Chicken Tikka Masala." He only prepares typical Columbian dishes, such as "Sopa de Patacón" – a soup that contains boiled pieces of banana that are pressed and then crisp fried, when he really has a lot of time. By the way, his favorite German dish is beef roulades.

"GARCÍA MÁRQUEZ TALKS ABOUT THE REAL COLUMBIA"

When Jorge Iván Salazar Gómez is not in the kitchen in his free time, he is usually exercising. He typically goes to the gym or swims. In the past, however, he practiced martial arts such as Aikido and Kung Fu. He finds relaxation in reading. The books "One Hundred Years of Solitude" and "Love in the Time of Cholera" by Columbian author Gabriel García Márquez are particularly appealing to him – not necessarily because of the story they tell but rather because they really reflect both the current Columbia and its history. "In the books, nothing is played down. They showcase the harsh reality of the country. I am glad that a lot of German know these books. That way I can talk with them about my home country." Nevertheless, he would not call the author his idol, but he would not mind discussing Columbia with him some day over a coffee.

Left image Jorge Iván Salazar Gómez measures the main components and trace components in biogases by means of gas chromatography.

Center image During vacations in his home country, the Columbian always looks forward to the tasty supply of tropical fruit.

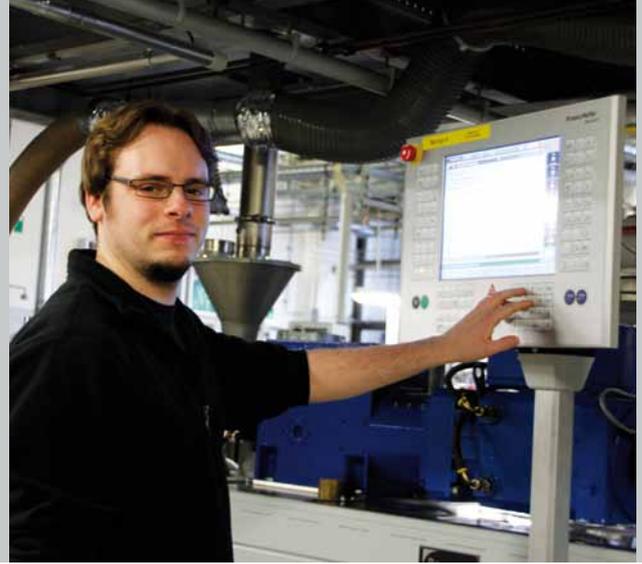
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EDUCATIONAL OPPORTUNITIES AT FRAUNHOFER UMSICHT

With twelve different training programs, Fraunhofer UMSICHT provides a good start into a professional career to qualified school graduates. A dual study program to become a chemical laboratory technician is offered for those who would like to combine university studies and a job-training. The training programs are not held every year in every career path. Marie Eingrieber, Sebastian Drabben, René Bauer, Stephan Deckert and Tobias Buchholz started their training in 2011. The complete portfolio includes a career path in natural science and technical, in commercial/business and administration, and in the IT sector.

Images from left to right Started their cooperative education in 2011: Marie Eingrieber – specialist for media and information services, Sebastian Drabben – process engineering technician for plastics and rubber technology, René Bauer – chemical technician, Stephan Deckert – chemical laboratory technician, Tobias Buchholz – IT application development specialist.

Prize-winning degree:

In September 2011, Florian Schellhase received the Heinz Nixdorf Prize from the Chamber of Industry and Commerce of Essen, Germany and the Heinz Nixdorf Foundation as the best trainee in the IT sector of his graduation year. In his final project, Florian Schellhase developed an antivirus solution for the data servers at Fraunhofer UMSICHT. Florian Schellhase received a cooperative education to become an IT specialist for system integration at UMSICHT.

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Current information for pupils and students

www.umsicht.fraunhofer.de/en/students.html

FOCAL POINT IN NATURAL SCIENCES

Chemical laboratory technicians prepare and conduct chemical experiments and/or investigations. They log and analyze the test results. In addition, they prepare chemical substances. The training to become a chemical laboratory technician takes three and a half years; the dual course of study takes four years.

Fraunhofer UMSICHT offers the training to become a chemical laboratory technician in two ways. For one, trainees may receive the formation the traditional way, meaning a cooperative training at school and in the business. Alternatively, there is the option for a dual course of study that includes both a bachelor's degree at a university and a job training.

Chemical technicians control and monitor machines and system for manufacturing, filling and packaging of chemical products. (Duration of the training: three and a half years).

Physics laboratory technicians conduct physical measurements and series of experiments. They set up testing plants, and prepare, conduct and document measurements and/or experiments. (Duration of the training: three and a half years).



FOCAL POINT IN TECHNOLOGY

Building and infrastructure systems electronics technicians maintain, monitor and optimize technical building infrastructure systems such as air, heat, electrical and security systems. They receive disruption reports, diagnose disruptions and fix defects. (Duration of the training: three and a half years).

Industrial mechanics manufacture, commission or convert devices, machines and production systems. They monitor and optimize manufacturing processes and take on repair and maintenance tasks. (Duration of the training: three and a half years).

Technical product assistants develop products with the help of various software programs on a PC. They supplement the work of development engineers with respect to design specifications, technical feasibility and safeguarding all the way to the final virtual product. (Duration of the training: three years).

Technical system planners for steel and metal construction technology implement the specifications of designers for steel and metal components in parts and general arrangement drawings. In addition, they are responsible for the accompanying technical documents. (Duration of the training: three and a half years).

Process engineering technicians for plastics and rubber technology manufacture molded parts, components, or laminated rubber parts as well as semi-finished products, fiber-reinforced composites or plastic windows. They operate and control machines and systems that are for the most part automated. (Duration of the training: three years).

FOCAL POINT IN IT

IT specialists for application development develop and program software based on customers' requests. They test existing applications, adapt them and develop user interfaces suitable for the application. (Duration of the training: three years).

IT specialists for system integration realize customer-specific information and communication solutions. In doing this, they network hardware and software components into complex systems. (Duration of the training: three years).

FOCAL POINT IN ADMINISTRATIVE TASKS

Specialists for office communications assume subject area-related business and administrative activities and handle internal secretarial and assistant tasks. (Duration of the training: three years).

Specialists for media and information services specializing in library work on the building-up and the maintenance of the library stock. They provide customers with relevant media and information. (Duration of the training: three years).

⁴ Technical shops/laboratories

Overview of our technical equipment.

We are making available more than 4,500 square meters for our technical shops and laboratories.

Research requires space.

TECHNICAL SHOPS

Fraunhofer UMSICHT makes an expansive technical infrastructure available for the performance area of product and application-oriented research and development that is closely intertwined with the laboratory areas of the institute. Here, we are presenting the portfolio of the technical shops, the test, pilot and demonstration installations on a selected excerpt basis. If you have any questions concerning applications, please do not hesitate to contact the specialist for that field.

PLASTICS TECHNICAL SHOP

At the Willich site, Fraunhofer UMSICHT offers comprehensive services in the areas of plastics and recycling technologies, always customer-oriented and product-oriented. Biodegradable plastics, polymers from renewable resources, resource-friendly materials, nanocomposites and recyclable plastics are being developed systematically and manufactured in pilot series and small batches. Process optimization, analytics and test engineering, recycling concepts, market and feasibility studies round out the portfolio of the plastics technical shop.

The plastics technical shop is separated into a material laboratory, a compounding technical shop and a testing laboratory.

After the development and the optimization of the compounds in the materials laboratory, larger sample amounts can be produced in the industry-like compounding technical shop. Six twin screw extruders with a throughput performance of 10 to 600 kg/h are available for this. The short development times that can be achieved when up-scaling offer our clients an advantage in the market when launching products. Concurrent with the development of processes and materials, mechanical and tribological material indicators are determined in the test laboratory, and analyses on the rheology are carried out, as well as on the thermal behavior, the chemical composition and the structure.

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MEMBRANE TECHNICAL SHOP

Membrane processes are an ecological and economical alternative to the traditional cleaning and recovery processes. Very often, laboratory and pilot tests are required to evaluate the separation behavior of the membrane. Test stations and installations for microfiltration, ultrafiltration and nanofiltration, and installations for reverse osmosis as well as microsieve filtration are available for on-site operations. Suitable processes were selected based on preliminary examinations, on the basis of which membrane processes are being developed for obtaining recycled materials, for the recycling of water and for downstream processing. Systems engineering to produce microsieves, membranes and membrane modules complete the technical infrastructure.

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PARTICLE TECHNICAL SHOP

The market for customer-specific, powdered substances with defined distribution of particle sizes is growing all the time. Temperature-sensitive, visco-elastic and fibrous materials can be shredded only with a great expenditure of energy and costs. In its particle technical shop Fraunhofer UMSICHT uses innovative chilling technology to develop suitable solutions.

The range of the R&D goes from test grinding and sample batch production to ten tons, from classification, feasibility



and profitability studies to cryogenic fragmentation (including process development) to the development, planning, construction and optimization of customer-specific grinding installations.

A sintering station as well as a sintering test station are completing the particle technical shop.

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HIGH PRESSURE TECHNICAL SHOP

In its high pressure technical shop, Fraunhofer UMSICHT has facilities for the impregnation as well as processing of plastics and for atomization by means of super-critical carbon dioxide. In the high pressure technical shop, pressures up to 500 bar and temperatures of up to 250 degrees Celsius can be achieved. Through-puts of up to 100 kg/h can be realized for high-pressure compounding and high-pressure spraying. The high-pressure facilities can work with sample sizes of 63 milliliters to 1,700 liters. The portfolio of facilities includes, among other things, a semi-industrial research and production facility to generate particles according to the PGSS® and the CPF process.

The high pressure shop is working on the following projects:

- Tanning of leather under the influence of carbon dioxide
- Production of polymer powders using high-pressure spray processes
- Optimization of the mixing effect and wetting during the melt-mixing
- Impregnation and modification of polymer materials and components
- Process-integrated separation of residual monomers and solvents

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BIOMASS TECHNICAL SHOP

A central task of research consists of finding and tapping into alternative energy sources and to make them usable with suitable technologies. Important to mention is the material and energetic utilization of biomass. The inclusion of biogenic energy carriers and raw materials into the existing structure for supplying energy and resources is an important step to a power and resources supply system that is geared towards sustainability and future capability.

For the mechanical and thermal preparation of biomass, the thermal conversion of herbaceous and timber-based biomass as well as for the mechanical preparation of various types of biomass Fraunhofer UMSICHT keeps devices available. They comprise installations for flash pyrolysis, rotary kilns for biomass conversion, grinders and shredders for cutting and a briquetting press and a pelletizing press for molding. The accompanying analytics of all educts, intermediates and end products take place in the laboratories of the institute.

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TEST STATIONS

- for cutting plastics,
- to stimulate powders to vibration,
- for impact crushing,
- for measuring swelling pressure,
- for biogenic sulfuric acid corrosion (BSK),
- for the examination of haptic perception of plastic surfaces,
- for the characterization of fuels,
- for testing the flight performance of refuse derived fuels,
- for the separation of impurities from refuse derived fuels or from cohesive bulk materials using fluidized bed

round out the portfolio of the technical infrastructure.

LABORATORIES

Fraunhofer UMSICHT has a widely varied laboratory infrastructure, in which cross-functional teams from science and technology are working.

CHEMICAL ANALYSIS LABORATORY

Having an analysis that is precise and reliable is a prerequisite for working on environmental and process-engineering problems. The institute has a well-equipped laboratory available for this, it also includes the latest analytical system combinations. The broad range of the services on offer include standard procedures as well as, in particular, the development of innovative, custom-tailored methods. Examples from our analysis portfolio include:

- Chromatographic methods: HPLC, GC, IC, GPC with different detectors: FID, MS, ECD, DAD, RI
Analysis examples: organic acids, alcohols, sugars, hormones, PFT, siloxanes, PAK
- Element analytics with ICP-OES
- Elementary analysis, released carbon (TOC), calorimetry, BET
- The focus is on characterizing fuels and biobased oils, greases and fossil fuels.

The validation of the results of the measurement is carried out, among others, by comparing them with those of outside laboratories (round robin tests).

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Image: Shutterstock

BIOTECHNOLOGY LABORATORY

The biotechnological laboratory handles tasks regarding the cleaning of polluted media (water, soil, air), examines biological decomposition and production potentials and develops novel microbiological processes, from a laboratory scale to a technical shop scale.

As an approved testing laboratory in the federal association of compost quality standards (Bundesgütegemeinschaft Kompost) and an approved testing laboratory of DIN CERTCO for the compostability according to the industrial standards DIN EN 13432, DIN EN 14995, and ASTM 6400, we offer:

- Microbiological analyses in accordance with DIN, ISO and OECD processes
- Testing of biological degradability under aerobic and anaerobic conditions (e. g., AT4 and GB21 as per regulations governing waste disposal)
- Development of biotechnological production processes
- Fermentation tests in accordance with VDI guideline 4630

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PHYSICS LABORATORY

The portfolio for the characterization of materials for material-scientific questions includes:

- Particle size and shape
(among others, static and dynamic dispersion of light, sieving, microscopy)
- Interface properties and structure of pores
(among others, tensiometry, electrophoresis, gas sorption)
- Composition, structure and phase transformations
(among others, thermoanalysis, rotational rheometry, IR spectroscopy)
- Determination of mechanical parameters
(among others, tensile tests, impact bending tests, tribological measurements)
- Thermoanalytical methods: DSC, TG (to 1,000 °C) and STA (to 1,600 °C)
- Spectroscopic methods: IR (reflection and transmission, inline-/online coupling, TG-IR coupling, film press), UV/VIS, IR databases

Contact

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CHEMICAL LABORATORY

The chemical laboratory includes:

- Parallel vessel systems, reaction calorimeter
- Biofuels: small technical installations to produce and clean biofuels (mini-installation to produce biodiesel, short path distillation)
- Small technical installations for the cleaning and concentration of product streams (rectification, extraction, crystallization)
- Chemical synthesis, protective gas and vacuum installations as well as pressure vessels, utilization of special gases

Contact

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HIGH PRESSURE LABORATORY

The high pressure laboratory consists of four test facilities equipped with modern measuring and automation technology:

- Two fixed bed reactor systems that are laid out for different throughputs,
- a discontinuous stirred tank reactor and
- a plant for the chemical conversion of biogenous synthesis gases.

The fixed bed reactors and the stirred tank reactor are fully automated and therefore can be operated around the clock. An IR device with sensors that is suited for high pressures and temperatures is available for online monitoring.

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ENERGY STORAGE LABORATORY

battery-lab.umsicht.fraunhofer.de



Lithium battery test laboratory

Fraunhofer UMSICHT operates a testing set-up for lithium batteries with which they can be examined and tested independently in a selectable test environment.

Range of R&D:

- Testing of lithium battery packs for mobile and stationary applications
- Performance and durability tests
- Testing with standardized or freely selectable test cycles
- Impedance spectroscopy
- Development of battery models

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Redox flow battery test laboratory

Fraunhofer UMSICHT operates one of the largest testing laboratories in Europe for redox flow batteries in which it is possible to not only test individual cells but also large stacks and which can be tested separately from the selectable test environment.

Range of R&D:

- Development, design and construction of redox flow battery stacks



- Measuring of redox flow batteries
- Selectable operating parameters
- Reproducible test environment
- Impedance spectroscopy
- Development of battery models

Contact

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A parallel reactor system for quick catalyst screening as well as the expansion of the characterization infrastructure (powder X-ray diffractometry, physisorption and chemisorption, temperature-programmed methods) will supplement the laboratory portfolio in the medium term.

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CATALYSIS LABORATORY

Fraunhofer UMSICHT is expanding its expertise in the area of heterogeneous catalysis. To do this, it is creating a network of catalyst synthesis and characterization, up-scaling and testing.

The objective is to establish a new approach for the development of innovative catalysts. The focus is on catalysts for the manufacturing of energy source and basic chemicals from regeneratively generated syngas. In cooperation with partners from basic research, plant engineering as well as the chemical industry, catalysts from basic research are being prepared, tested and further developed for industrial scale use.

At the catalyst laboratory, catalyst tests can be conducted under near real-life conditions, the results of which flow into an optimized catalyst and/or process development.

The catalyst laboratory includes the following systems:

- Synthesis system at technical shop scale for testing large catalyst quantities in the fixed bed or slurry reactor
- Preparation units (some fully automated) for conducting catalyst syntheses at laboratory and semi-industrial scale
- Laboratory synthesis system for flexible testing of catalysts at high temperatures and pressures in the fixed bed reactor

5 Network

Fraunhofer, Board of Trustees,
UMSICHT Circle of Friends and Patrons,
Involvement with Universities

We construct networks, link into existing networks, work in cooperation with partners, friends and patrons. We are happy to introduce some of them to you.

Luckily, we are not alone in the world.



FRAUNHOFER-GESELLSCHAFT

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

THE FRAUNHOFER-GESELLSCHAFT

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units in Germany, including 60 Fraunhofer Institutes. The majority of the more than 20,000 staff are qualified scientists and engineers, who work with an annual research budget of € 1.8 billion. Of this sum, more than € 1.5 billion is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated international research centers and representative offices provide contact with the regions of greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to

reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.



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GROUP FOR PRODUCTION/ ALLIANCES AND NETWORKS

The institutes of the Fraunhofer-Gesellschaft work together among each other. They cooperate in alliances or bundle different competencies according to the specifications in flexible structures. Thus, they ensure their prominent position for the development of system solutions and the realization of holistic innovations.

GROUP FOR PRODUCTION

Fraunhofer UMSICHT is a member in the Fraunhofer Group for Production. Seven Fraunhofer Institutes have joined together with the goal of jointly working on production-oriented research and development to be able to offer the customers in industry, trade and the service sector comprehensive holistic solutions to problems from one source by bundling the manifold expertise and experience of the individual institutes.

By using the latest findings from production and engineering and computer sciences, the Fraunhofer Group for Production is offering a range of services that comprises the entire production cycle and/or the entire value added chain.

Focus of the group:

- Product development
- Manufacturing technologies
- Production systems
- Production processes
- Production organization
- Logistics

FRAUNHOFER ALLIANCES

In addition, UMSICHT is participating in seven Fraunhofer Alliances. These alliances have joined together with the intention to jointly work on a business segment or to market it.

They consist of institutes or departments of institutes that have different competencies. In its work, UMSICHT concentrates on the following alliances.

- AutoMOBILE production | www.automobil.fraunhofer.de/english/index.html
- Construction | www.bau.fraunhofer.de/en
- Energy | www.energie.fraunhofer.de (German version only)
- Generative production | www.generativ.fraunhofer.de (German version only)
- Lightweight construction | www.fraunhofer.de/en/institutes-research-establishments/groups-alliances/lightweight-construction.html
- SysWater | www.syswasser.de/en.html
- Cultural heritage | www.forschungsallianz-kulturerbe.de (German version only)

FRAUNHOFER-NETWORKS

- Batteries | www.batterien.fraunhofer.de/EN
- Energy storage systems and grids | www.energie.fraunhofer.de (German version only)
- Intelligent energy grids | www.energie.fraunhofer.de (German version only)
- Sustainability | www.nachhaltigkeit.fraunhofer.de (German version only)
- inHaus Center | www.inhaus.fraunhofer.de/en
- Academy | www.academy.fraunhofer.de (German version only)



BOARD OF TRUSTEES

The Executive Board of Fraunhofer appoints trustees for the institutes. They consist of representatives of the science sector, the industry and the public sector and consult the heads of the institutes and entities of the Fraunhofer-Gesellschaft. Since December 2002 Fraunhofer UMSICHT has been advised by a board of trustees.

CHAIR

Ernst Gerlach
Chairman of the Board of Trustees
Managing Director of the Verband der kommunalen RWE-Aktionäre GmbH (VKA) (Association of the local shareholder of RWE)

Hubert Loick
Deputy Chairman of the Board of Trustees
Loick AG for renewable resources, Chairman of the Board

Left image *Prof. Pilz during his farewell ceremony in 2011.*

In 2011 some trustees resigned from their position and retired.

Many thanks to:

Dr. Jochen Hamatschek

formerly Westfalia Separator Food Tec GmbH, Managing Director

Udo Völker

MAN Ferrostaal AG, Chief Representative

Prof. Dr. Volker Pilz

formerly Bayer AG, Safety Director

Prof. em. Dr. Thomas Melin

RWTH Aachen, Director of the Institute for Process

MEMBERS

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Burkhard Drescher Consulting (BDC)

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Weihenstephan College in Triesdorf, Germany

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Bayer Schering Pharma AG, Plant Manager

Dr.-Ing. Andreas Schütte
Fachagentur Nachwachsende Rohstoffe e. V. (FNR), Managing Director

Dr.-Ing. Gunnar Still
ThyssenKrupp Steel AG, Environmental Protection Directorate, Senior Vice President



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INVOLVEMENT WITH UNIVERSITIES

The market for research and development is fast moving. As an institute that, with its applications and market-oriented services, is acting at the intersection of research at the university and industrial practices and products, we are relying on strategic partnerships with universities and colleges in Germany and Europe. This is how we incorporate basic research into our projects.

TEACHING AND RESEARCH

Prof. Dr.-Ing. Eckhard Weidner manages both Fraunhofer UMSICHT and teaching as the professor for "Process Engineering Transport Processes" at the Ruhr University Bochum. This provides the institute with a direct connection to the university and strengthens the scientific network of both research facilities.

Prof. Dr.-Ing. Görgo Deerberg, Deputy Director of Fraunhofer UMSICHT, has been adjunct professor at the mechanical engineering faculty for "Environmental and Process Engineering" since January 2011 at Ruhr University Bochum. This expands the involvement with the Ruhr University.

There is a lively exchange between universities, students and Fraunhofer UMSICHT. In addition to common projects, a lot of employees teach at universities in the region.

INVOLVEMENT WITH UNIVERSITIES

- Ruhr University Bochum
- TU Dortmund
- University of Duisburg-Essen
- FernUniversität in Hagen
- Hochschule Niederrhein – University of Applied Sciences
- Fachhochschule Gelsenkirchen – University of Applied Sciences
- Hochschule Ruhr West – University of Applied Sciences
- Folkwang University of the Arts
- TU Bergakademie Freiberg – the University of Resources
- University of Rostock
- Unidad de Desarrollo Tecnológico (UDT), Aninstitut der Universidad de Concepción, Chile
- Hochschule Karlsruhe – University of Applied Sciences
- RWTH Aachen University
- University of Michigan, USA
- University of Assiut, Egypt
- University of Bayreuth
- Chinese Academy Of Sciences (CAS)
- Münster University of Applied Sciences, Site Steinfurt
- HAWK – University of Applied Sciences and Arts, Hildesheim/Holzminden/Göttingen
- TU Dresden
- TU Berlin
- Heinrich Heine University Düsseldorf



UMSICHT CIRCLE OF FRIENDS AND PATRONS

The "Association for the promotion of environmental, safety and energy technology (UMSICHT Circle of Friends and Patrons)" works in the area of applied research in the areas of environment, safety and energy technology.

Center image *Prof. Dietrich Grönemeyer, patron of the UMSICHT Science Prize.*

Right image *Prize winner of the UMSICHT Science Prize 2011.*

We, the members, want to establish the prerequisites so that good ideas become innovations and the region's job engine is stimulated through education, research and development.

Dr. Thomas Mathenia

Chairman of the UMSICHT Circle of Friends and Patrons

The focus of the UMSICHT Circle of Friends and Patrons is the exchange of experiences and knowledge with universities, industry, the R&D network of the Fraunhofer-Gesellschaft and within its membership. This promotes innovative thinking and actions and contributes towards being able to promote research and at the same time generate value for their own activities from this.

Dr. Susanne Raedeker

Deputy Chairwoman of the UMSICHT Circle of Friends and Patrons

The objective of the Circle of Friends and Patrons is to kick off innovative research and development project already at a very early stage both ideally and materially and to open up access to future-capable and sustainable technology developments for North Rhine-Westphalia – and in particular the Ruhr Area.

Prof. Dr.-Ing. Göрге Deerberg

Managing Director of the UMSICHT Circle of Friends and Patrons

The UMSICHT Circle of Friends and Patrons flanks the measures that strengthen the role of Fraunhofer UMSICHT in the region and on the market for applied research. The coal and steel-producing areas of North Rhine-Westphalia that are subject to structural changes in particular can thus access the future-capable and sustainable developments in technology. The members of the UMSICHT Circle of Friends and Patrons utilize the R&D network of the Fraunhofer-Gesellschaft. They are informed in a timely manner about promising future trends, they can initiate their own research projects and contribute to establishing important fields of research in the region.

WE INVITE YOU TO BECOME A MEMBER AS WELL.

The UMSICHT Circle of Friends and Patrons is open to new members! They promote research and development, strengthen their scientific-technical reputation and invest in the upcoming generation of managers in industry. They utilize services that Fraunhofer UMSICHT offers exclusively to the members of the Circle of Friends and Patrons.

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Image: Ilka Drnovsek



Image: Ulla Emig

UMSICHT SCIENCE PRIZE

The Association for the promotion of environmental, safety and energy technology (Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik) has awarded the second UMSICHT Science Prize for research contributions and for publications in the field of environmental, safety and energy technology. The prize is awarded in the category of science for industry and market-oriented works of research, in the field of journalism for the understandable presentation of scientific and practice-relevant topics. The patron, Prof. Dr. med. Dietrich Grönemeyer, Chairman of the Wissenschaftsforum Ruhr e. V. (Science Forum Ruhr) awarded the prizes on July 6, 2011

The UMSICHT Science Prize is intended to motivate and promote innovative thinking and acting in the fields of environment, safety and energy. It is intended to show that education, research and development in tandem with an entrepreneurial mindset provide added value for one's own actions and is fun. The prize money is split into a prize in the science category valued at 10,000 euros and two prizes in the journalism category valued at 2,500 euros each.

PERFLUORINATED TENSIDES (PFT)

The prize winner in the science category was Prof. Dr. Andreas Fath. He received the prize for his work on the electrochemical decomposition of perfluorinated tensides (PFT). In 2006, increased concentrations of the compound were confirmed in various bodies of surface water. With the newly developed electrochemical process, it is possible to mineralize PFT in fluorine acid, water and carbon dioxide so that no harmful residues remain.

"Don't hesitate, innovate! This 'don't hesitate' also applies to handing in your projects, given that an innovation in your desk's drawer or inside your head not helping anybody," Fath says to encourage new contestants.

WATER FOR METROPOLISES

Dr. Arndt Reuning received the prize in the journalism category. His radio feature broaches the issue of the water supply of metropolises and how it is threatened by two

developments: the increase in population and climate change. The broadcast points out technical solutions that could help to secure the water supply of metropolises in the future and discusses options for political action.

"The UMSICHT Science Prize, with its unique profile, is directing the view onto topics of decisive importance to our society. It is worthwhile to be a part of it," says Reuning.

FOCAL POINT IN ENERGY

Dr. Barbara Kruse, on behalf of the editorial team of the science magazine RUBIN of the Ruhr University Bochum, accepted the Science Prize in the journalism category for a special edition on the topic of energy. The editorial team was able to bring high-quality scientific contents and their background closer to readers who did not necessarily have specialized knowledge.

"People who work in science and journalism are united by curiosity, enthusiasm for a topic, and increasingly also by the interest and joy of bringing difficult issues closer to a broader public," states Kruse to sum things up.

THE SUCCESSFUL CONCEPT THAT WILL CONTINUE

The competition for the award will continue.

For additional information, see (German version only):

www.umsicht-foerderverein.de

The "Innovation" sculpture was exclusively designed for the prize by Hans-Dieter Godolt of Godolt copper atelier in Alpen, Germany.



⁶ Bibliography

»The most useful books are those of which readers themselves
compose half.« Voltaire (1694-1778), Philosophical Dictionary

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Open Access

The full texts of the underlined publications are available online with open access.

Fraunhofer publications can be found online at:
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 In: Journal of chemical technology and biotechnology : JCTB 86 (2011), No. 4, pp. 519-524
<http://dx.doi.org/10.1002/jctb.2544>

Wack, H.; Hintemann, D.; Michael, H. et al.:
Preparation and properties of swellable thermoplastic elastomer alloys based on elastomeric powder, polypropylene, and superabsorbent polymer
 In: Journal of applied polymer science 120 (2011), No. 3, pp. 1290-1296
<http://dx.doi.org/10.1002/app.33160>

Fraunhofer UMSICHT successfully cooperates with customers from all industrial sectors and with companies of all sizes. The following excerpt from the institute's reference list is an overview on project and cooperation partners and customers. For reasons of clarity we refrained from listing the partners from the Fraunhofer R&D network separately.

A

A. & E. Lindenberg GmbH, Bergisch-Gladbach
 Abfallentsorgungsanlage Linkenbach, Linkenbach
 AdFiS Products GmbH, Teterow
 AGIT Aachener Ges. für Innovation und Technologietransfer mbH, Aachen
 AHK China, Beijing, China
 AiF Arbeitsgem. industrieller Forschungsvereinigungen Otto von Guericke e. V., Berlin
 ALBA Group, Köln
 Assiut University, Assiut, Ägypten
 A-TEC Anlagentechnik GmbH, Moers

B

Babcock Borsig Service GmbH, Oberhausen
 Babcock Noell GmbH, Würzburg
 Balance VNG, Leipzig
 BASF SE, Ludwigshafen
 BAYERNOIL Raffineriegesellschaft mbH, Neustadt a. d. Donau
 Bernd Josef Wenning, Rhede
 Berufsgenossenschaft Rohstoffe und chemische Industrie (BG RCI), Heidelberg
 BFR, Büro für Regionalanalyse, Dortmund
 Bioenergie Neuhof GmbH & Co. KG, Neuhof
 Biomassekraftwerk Lünen GmbH, Lünen
 BKV Beteiligungs- und Kunststoffverwertungsgesellschaft mbH, Frankfurt am Main
 Bundesinstitut für Bau-, Stadt- und Raumforschung, Bonn
 Bundesministerium für Bildung und Forschung, Berlin
 Bundesministerium für Wirtschaft und Technologie, Berlin
 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin

C

CETIAT, Lyon, Frankreich
 Claas Selbstfahrende Erntemaschinen GmbH, Harsewinkel
 Clariant GmbH, Hürth
 Colortech Farbpasten GmbH, Mannheim
 Cornelsen Umwelttechnologie GmbH, Essen
 Cornpack GmbH & Co. KG, Teterow
 CTAG Centro Tecnológico de Automación de Galicia, Porrino, Spanien
 CUT Membrane Technology, Erkrath

D

Daikin Europe N.V., Brüssel, Belgien
 DBI – Gastecnologisches Institut gGmbH, Freiberg
 DBU – Deutsche Bundesstiftung Umwelt, Osnabrück
 Deckert Management Consultants GmbH, Düsseldorf
 DELU AG, Dorsten-Rhade
 Deutsche Energie-Agentur GmbH (dena), Berlin
 Deutsches BiomasseForschungszentrum gGmbH (DBFZ), Leipzig
 DiMatteo Förderanlagen GmbH, Beckum
 DIN Deutsches Institut für Normung e. V., Berlin
 Dürr Cyplan Ltd., Bietigheim-Bissingen
 DVGW-Forschungsstelle am Engler-Bunte-Institut des KIT, Karlsruhe
 DVGW Deutscher Verein d. Gas- u. Wasserfaches e. V. technisch wissenschaftlicher Verein, Karlsruhe

E

ecoprog GmbH, Köln
 E&E Verfahrenstechnik GmbH, Warendorf
 Elastogran GmbH, Lemförde
 ENAGRA GmbH & Co KG, Monzelfeld
 Entsorgungsgesellschaft Steinfurt mbH, Altenberge
 EnviTec Biogas AG, Saerbeck
 E.ON Energie AG, München
 E.ON Ruhrgas AG, Essen
 EPC – Eimer Projekt Consulting, Berlin, Bochum
 Evonik Degussa GmbH, Hanau
 EWG – Essener Wirtschaftsförderungsgesellschaft mbH, Essen

F

Fachagentur Nachwachsende Rohstoffe e. V. (FNR), Gülzow

FernUniversität in Hagen, Hagen
 FESTEL CAPITAL, Fürigen, Schweiz
 FH Gelsenkirchen, Gelsenkirchen
 FH Münster - Labor für Abfallwirtschaft, Siedlungswasserwirtschaft, Umweltchemie LASU, Münster
 FKUR Kunststoff GmbH, Willich
 Forschungszentrum Jülich GmbH, Jülich und Berlin

G

Gelsenwasser AG, Gelsenkirchen
 Gemeinschaftskraftwerk Schweinfurt GmbH, Schweinfurt
 Georg Fischer JRG AG, Sissach, Schweiz
 GKU Standortentwicklung GmbH, Berlin
 Grontmij GmbH, Köln

H

HAWK Hochschule für angewandte Wissenschaft und Kunst, Fachgebiet Nachhaltige Energie- und Umwelttechnik NEUTec, Göttingen
 Hitachi Power Europe GmbH, Duisburg
 Hochschule Bremen, Fakultät 5 - Natur und Technik, Fachrichtung BIONIK

I

IfW GmbH, Schwerte
 imat-uve GmbH & KG, Mönchengladbach
 Immanuel Kant Baltic Federal University, Kaliningrad, Russland
 Inde Plastik Betriebsgesellschaft mbH, Aldenhoven
 Infracor GmbH, Marl
 InnovationCity Management GmbH, Bottrop
 Institut für Energie- und Umwelttechnik e.V. (IUTA), Duisburg
 Institut für Nichtklassische Chemie e.V., Leipzig
 IZEG – Informationszentrum Entwässerungstechnik Guss e.V., Bonn

J

Jowat AG, Detmold

K

Kayser Automotive Systems, Einbek
 Karlsruher Institut für Technologie, Karlsruhe
 Kompetenzzentrum Hessen Rohstoffe (HERO) e. V., Witzenhausen

- L**
Leibniz-Institut für Agrartechnik e.V., Bornim
Logo tape GmbH & Co. KG, Harrislee
Loick AG für nachwachsende Rohstoffe,
Dorsten
- M**
Max-Planck-Institut für Kohlenforschung,
Mülheim an der Ruhr
Mahler AGS GmbH, Stuttgart
MedEcon Ruhr GmbH, Bochum
Meibes System-Technik GmbH, Gerichshain
Meotec, Mülheim an der Ruhr
Ministerium für Wirtschaft, Energie, Bauen,
Wohnen und Verkehr des Landes Nord-
rhein-Westfalen, Düsseldorf
- N**
NANO-X GmbH, Saarbrücken
N.E.ST Neue Energien Steinfurt GmbH,
Steinfurt
Niederrheinische Fettschmelze Kalkar,
Wöllstadt
Nockemann & Klein GmbH & Co KG,
Marienheide
Novamelt GmbH Klebstofftechnologie, Wehr
nova-Institut GmbH, Hürth
- O**
Oschatz GmbH, Essen
- P**
Pilot Pflanzenöltechnik Magdeburg e. V.,
Magdeburg
Phytowelt GreenTechnologies GmbH, Nettetal
Pentair Haffmans BV, Venlo, Niederlande
PlanET Biogas mbH, Vreden
Polyplast Müller GmbH, Straelen
Purac, Gorinchem, Niederlande
- R**
Ralf Hacker Anlagenbau, Lübbecke
r.e Bioenergie GmbH, Regensburg
Regionale Planungsgemeinschaft Havelland-
Fläming, Teltow
Reisner AG, Holzwickede
Rheinisch-Westfälische Technische Hoch-
schule Aachen, E.ON Energy Research
Center, Aachen
- Rheinisch-Westfälische Technische Hoch-
schule Aachen, Institut für Kunststoff-
verarbeitung (IKV), Aachen
Rhein-Main-Deponienachsorge GmbH,
Flörsheim
Ritter-Pen GmbH, Brensbach
Ritter Solar, Karlsbad
rmp rapid product manufacturing GmbH,
Helmstedt
Ruhr-Universität Bochum, Lehrstuhl für Energie-
anlagen und Energieprozesstechnik LEAT,
Bochum
RWE Deutschland AG, Essen
RWE Energiedienstleistungen GmbH, Essen
RWE Service GmbH, Essen
- S**
Sasol Germany GmbH, Marl
Schwelm Anlagentechnik GmbH, Schwelm
Sennergie GmbH, Bielefeld
Silcarbon Aktivkohle GmbH, Kirchhundem
Siloxxa Engineering AG, Essen
SOLID Composites GmbH, Voerde
Solvay Fluor GmbH, Hannover und Zug
Stadt Bochum, Bochum
Stadt Dorsten, Dorsten
Stadtwerke Bochum, Bochum
Stadtwerke Duisburg, Duisburg
Stadt und Stadtwerke Witzenhausen,
Witzenhausen
STEAG New Energies GmbH, Saarbrücken
Steinberg Leuchtmittelwerke GmbH,
Geesthacht
Süd-Chemie AG, München
Süd-Chemie AG Corporate Research &
Development, Bruckmühl
- T**
Taros Chemicals GmbH & Co. KG, Dortmund
ThyssenKrupp Polysius AG, Beckum
ThyssenKrupp Uhde GmbH, Dortmund
Technische Universität Berlin, Berlin
Technische Universität Dortmund, Institut
für Energiesysteme, Energieeffizienz und
Energiewirtschaft
Technische Universität Dresden, Dresden
Technische Universität München, München
Technische Universität Kaiserslautern,
Kaiserslautern
Treevolution.de GmbH, Sontra-Blankenbach
- U**
Universität des Saarlandes, Forschungsgruppe
Umweltpsychologie, Saarbrücken
Universität Dortmund, Lehrstuhl für
Thermodynamik
Universität Rostock, Institut für Umwelt-
ingenieurwesen, Rostock
Universität Siegen – Institut für Fluid- und
Thermodynamik, Siegen
University of Manchester, Manchester,
Großbritannien
- V**
VDI Technologiezentrum GmbH, Düsseldorf
VDMA – Fachverbund Druck und Papier-
technik, Frankfurt am Main
Verein Deutscher Ingenieure (VDI), Düsseldorf
Viega GmbH & Co. KG, Attendorf
VSM Solar, Bangalore, Indien
VTT Technical Research Centre of Finland,
Finland
- W**
WAGRO Systemdichtungen GmbH,
Dortmund
WETEC Elektrotechnik GmbH, Moers
WiN Emscher-Lippe GmbH, Herten
Wuppertal Institut für Klima, Umwelt,
Energie GmbH, Wuppertal
- X**
Xervon Energy GmbH, Duisburg

INVOLVEMENT WITH UNIVERSITIES

Ruhr University Bochum
 TU Dortmund
 University of Duisburg-Essen
 FernUniversität in Hagen
 Hochschule Niederrhein – University of Applied Sciences
 Fachhochschule Gelsenkirchen – University of Applied Sciences
 Hochschule Ruhr West – University of Applied Sciences
 Folkwang University of the Arts
 TU Bergakademie Freiberg – the University of Resources
 University of Rostock
 Unidad de Desarrollo Tecnológico (UDT), Aninstitut der Universidad de Concepción, Chile
 Hochschule Karlsruhe – University of Applied Sciences
 RWTH Aachen University
 University of Michigan, USA
 University of Assiut, Egypt
 University of Bayreuth
 Chinese Academy Of Sciences (CAS)
 Münster University of Applied Sciences, Site Steinfurt
 HAWK – University of Applied Sciences and Arts, Hildesheim/Holzminden/Göttingen
 TU Dresden
 TU Berlin
 Heinrich Heine University Düsseldorf

SPIN-OFFS

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 Systems for oxygenation
www.airox.de

A-TEC Anlagentechnik GmbH, Duisburg
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www.atec.de

Carbon-TF B.V., Venlo, Netherlands
 Emissions trading
www.carbon-tf.com

Catfish Solutions UG (limited liability), Oberhausen
 IT-Consulting
www.catfishsolutions.com

DataPool Engineering GmbH, Oberhausen
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www.dp-e.de

design4science GbR, Dortmund
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www.design4science.eu

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 Emissions trading
www.emissions-trader.de

FKuR Kunststoff GmbH, Willich
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www.greasoline.com

SOLid Composites GmbH, Voerde
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www.solidcomposites.de

VSM Solar Private Ltd., Bangalore, India
 Solarthermally driven cooling for buildings
www.vsmsolar.com

WAGRO Systemdichtungen GmbH, Dortmund
 Swellable polymere seals; sewer and building refurbishment; consultation, planning, and implementation; development and production of sealing systems (area of application: engineering and pipeline construction)
www.wagro-systemdichtungen.de

PATENTS

Issued Patents

Process for tanning of animal skins
(Geihlsler, Renner, Weidner) - Germany

Registered Trademarks

BioSX (word trademark, Germany)
BryoEngineering (word trademark, Germany)
HYBRID URBAN ENERGY STORAGE
(word/image trademark, Germany)
inFARMING (word trademark, Germany)
metallIQ (word trademark, Germany)
sustainnovate (word trademark, Germany)

PRIZES

Waste to energy + recycling AWARD for outstanding scientific theses for Andrea Gerstner, Materials and Energy business unit.
Project: Preparation and analysis of release profiles characteristic of a fuel by means of a testing plant for stepped thermal conversion of solid fuels (May 2011)

Biogas Innovation Prize of German Agricultural Industry for Ute Merrettig-Bruns, Renewable Resources business unit.
Project: Developing the Orga test for measuring the metabolic activity of bacteria in the fermenters of biogas plants (Mai 2012)

Fraunhofer UMSICHT is a "**Selected Location 2011 in the Land of Ideas**," selected by the site initiative "Germany – Land of Ideas" in cooperation with Deutsche Bank.
Project: Smell-induced recognition of critical cracks/tears (September 2011)

Heinz Nixdorf Prize of the Chamber of Industry and Commerce of Essen, Germany and the Heinz Nixdorf Foundation for Florian Schnellhase as the best trainee in the IT sector.
Project: Development of an antivirus solution for data servers at UMSICHT (September 2011)

Recognition by the UNESCO Commission for the interdisciplinary distance learning program "Environmental Sciences" (infernium) of Fraunhofer UMSICHT and the distance learning university in Hagen, Germany for the 2012/2013 period as "Project of the UN Decade of Education for Sustainable Development" (November 2011)

Nicolaus August Otto Prize 2011 of the city of Cologne for Cologne master tanner Helmut Geihlsler and co-inventors Manfred Renner and Prof. Eckhard Weidner (Fraunhofer UMSICHT).
Project: Tanning leather without generating wastewater and with reduced chemicals (December 2011)

Award "**Exemplary family-friendly company 2012**" of the city of Oberhausen for Fraunhofer UMSICHT for its flexible and family-friendly work structures (December 2011)

⁷ Contact

If you have any questions, suggestions or project ideas, please contact us.

You can reach us in many different ways.

We look forward to hearing from you

Fraunhofer Institute for Environmental,
Safety, and Energy Technology

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E-mail info@umsicht.fraunhofer.de

QR-Code how to reach us (pdf)



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47877 Willich, Germany

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Fax +49 2154 9251-61

Here you will find a description of your way to us
and a detailed plan of our premises

www.umsicht.fraunhofer.de/en/contact-how-to-reach-us.html

BY CAR

Freeway A42, coming from Dortmund:

Exit Oberhausen-Osterfeld/Neue Mitte. Go straight forward onto Osterfelder Strasse. Follow Osterfelder Strasse towards »Neue Mitte Oberhausen« or »Oberhausen-Zentrum/Essen« respectively. After approximately 1.5 km at the traffic lights (behind the sign »Fraunhofer UMSICHT«) turn left onto Brammenring, turn right after approximately 100 m and tright again into the access road to the institute. (Institute and parking lot are on the right hand.)

Coming from Duisburg:

Exit Oberhausen-Osterfeld/Neue Mitte. Turn right at the end of the exit onto Osterfelder Strasse towards »Neue Mitte« or »Oberhausen-Zentrum/Essen« respectively; to continue please follow the instructions above.

Freeway A 40, coming from Dortmund:

Exit Mülheim-Dümpten. Turn right at the end of the exit. At the next intersection turn left onto Mellinghofer Strasse and at its end turn left onto Essener Strasse. At the next major intersection turn right onto Osterfelder Strasse. Before the following traffic light turn right onto Brammenring; to continue please see above.

Coming from Duisburg:

Exit Mülheim-Dümpten. Turn left at the end of the exit. At the next intersection turn left onto Mellinghofer Strasse; to continue please follow the instructions above.

BY TRAIN

From Oberhausen central station. either with bus number 185 (towards Essen Borbeck Bf.), 957/958 (both towards Sterkrade Bf.) exit at the stop »UMSICHT«.

BY PLANE AND TRAIN/CAR

From Düsseldorf Airport terminal A/B/C take the Skytrain to Düsseldorf Airport Station, then change to the Regional Express to Oberhausen; to continue see: By train.

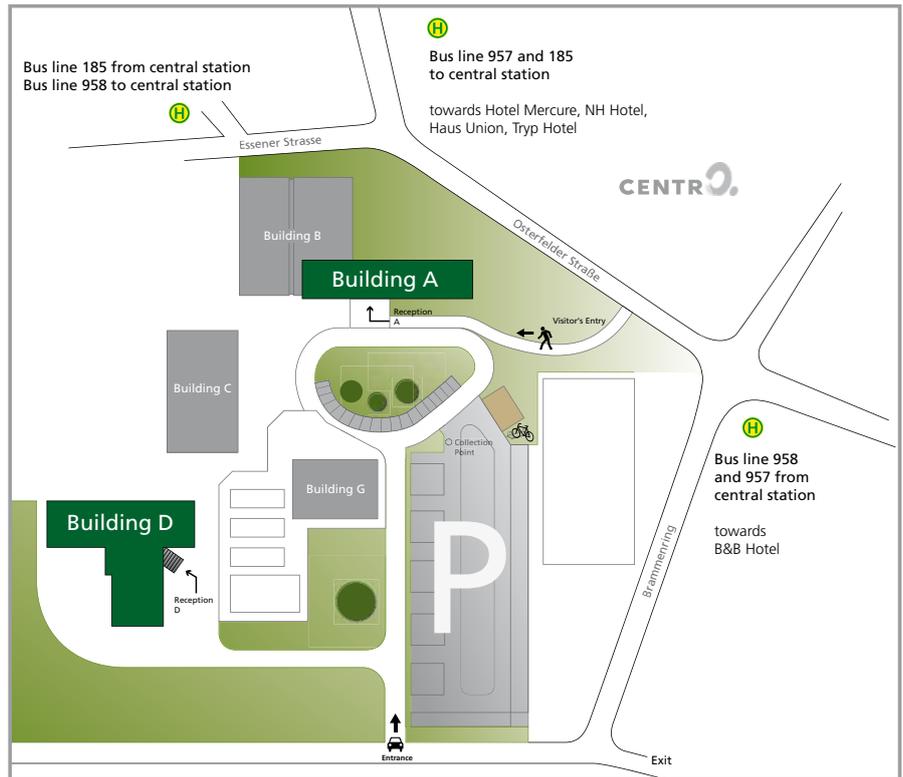
If you are traveling by car take Freeway A 44 from the airport till you reach intersection »Düsseldorf-Nord«. Take freeway A 52 (direction Essen/Oberhausen). At intersection »Breitscheid« change onto freeway A 3 and keep going until you get to intersection »Oberhausen-West«; from there turn onto freeway A 42 (direction »Dortmund«) and take the exit »Oberhausen-Osterfeld/Neue Mitte«; to continue see: By car.



The entrance to building A



Building D with multimedia room (left)



Site plan



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www.umsicht.fraunhofer.de/de/messen-veranstaltungen.html

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80686 Munich, Germany

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*Prof. Dr. Hans-Jörg Bullinger, President, Business Policy and
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*Prof. (Univ. Stellenbosch) Dr. Alfred Gossner, Finances, Control-
ling (incl. Business Administration, Purchasing and Real Estate)*
IT Dr. Alexander Kurz, Human Resources and Legal Affairs

Register court: Amtsgericht (District Court) Munich
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