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Fraunhofer Institut
Umwelt-, Sicherheits-,
Energietechnik UMSICHT

# Annual Report | 2007

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# Preface

Dear Ladies and Gentlemen,

We love challenges, how about you? The fantastic thing about challenges is that there are so many of them. Reaching the top of one of the world's highest mountains, participating in a marathon race – all these are goals which make us reach our limits. But this is not quite the focus of our work. We are dealing with challenges of our future. Just take the prices of raw materials which have been soaring over the last few years as a result of inflation, or have a look at the climate change, the growing world population, the emerging industrial economies and their demands for raw materials, energy, for mobility and consumer goods, security and information – in one word – for a better standard of living.

These are the challenges that we have set out to face. For we wish to have our cars fuelled also in future, we wish to have a safe energy supply, since we have decided to implement new smart materials while making conventional materials more sustainable, therefore we are going to keep our eyes on relevant topics of today, and we are going to make developments affordable for our and for the coming generations. As I have put it before – we love challenges. And this is exactly why we are committed to industry-related contract and applied research, as is the mission of the Fraunhofer-Gesellschaft.

In our key research area "Biorefinery" we develop future production systems which will help advance the conversion of production in Germany and Europe to systems based on renewable resources. The key research area "Modular Energy Technologies" is dedicated to the development and implementation of novel, decentralized energy conversion and storage systems and technical solutions which stabilize our energy supply systems while making them more efficient.

"Matfunc" is the headline for the development of novel, self-organizing materials which are the basis for optimized industrial goods or consumer-oriented products. "Information Networks for Energy Technologies and Process Engineering" offer innovative services which allow making almost every kind of production process safer and faster.

Our success is the success of our staff to which we would like to express our sincere gratitude for their dedication to research, dynamic input and their tireless commitment to creating innovative products and services. We are indebted to decision-makers and players in political life, our customers and our partners for their trustful co-operation and valuable encouragement which gave considerable impetus to our work.

In this annual report, you receive an interesting insight into the world of Fraunhofer UMSICHT, into our offer of technologies and products. If you feel inspired and would like to learn more, do not hesitate to contact us – we are looking forward to your inquiry!

Eckhard Weidner

Görge Deerberg

# Highlights 2007

**April 2007**
During her visit at the Hannover Fair, Christa Thoben, Minister of Economic Affairs and Energy of the State of North Rhine-Westphalia, was informed by Dr Christian Dötsch, head of the business unit energysystems, on Fraunhofer UMSICHT's activities related to energy efficiency technologies.

**May 2007**
During a visit from the Rectorate of the Ruhr University of Bochum, discussions focused on the extension of the scientific networking of both research institutions. Synergetic effects in the fields of process engineering, environmental, material, process and energy technologies will be used to more precisely concentrate the research fields in the Ruhr area and to present high-class performance in science of the Ruhr area across regional borders.



**August 2007**
Nearly 250 guests came together to celebrate the first UMSICHT Family day and in having fun, they clearly stood up the competition of with the Love Parade event in the neighbor city Essen. The idea to start a family day was born at the end of the preceding year, when UMSICHT had been awarded the title "Model family-friendly enterprise in Oberhausen" by the Mayor of Oberhausen, Klaus Wehling.

**September 2007**
One and one sometimes is more than two. This also applies to the Plastics and Recycling Symposium which has grown into the congress "Future Utilization of Plastic Materials". Fraunhofer UMSICHT, the FkuR Kunststoff GmbH and the BKV Platform for Plastics and Plastics Utilization provided a discussion forum on the recent market development of plastic recycling for players in politics, industry and sciences.

**October 2007**
During his visit, the Chilean Energy Minister Marcelo Tokman Ramos focused on the analysis of alternative energy sources in Chile, Prof. Eckhard Weidner and the energy experts of the Institute informed him about energy efficiency technologies and recent trends in the fields of renewable energies.

**October 2007**
Fraunhofer UMSICHT and FKuR Kunststoff GmbH presented their business activities in the field of materials sciences at the K 2007, the world-wide leading trade fair for plastics and rubber. R&D activities range from the development of biodegradable plastics over bionic materials, functional additives, polymeric sealing materials, thermoplastic plastic powders for coatings and rapid prototyping, novel techniques for plastics processing up to cryogenic crushing and material characterization.



**November 2007**
With the participation in the International Environment Trade Fair POLEKO in Poznań, Fraunhofer UMSICHT pursued the objective to showcase both its long-year technological expertise in the development of environmentally friendly products and services abroad and its know-how in initiating international partnerships.

# The Fraunhofer-Institute for Environmental, Safety, and Energy Technology UMSICHT in Profile




Fraunhofer UMSICHT develops applied and custom-made process engineering technologies. Assuming a leading position in the fields of environmental and material technologies, process engineering and energy technology, Fraunhofer UMSICHT is committed to sustainable economic development, environmentally friendly technologies and innovative approaches designed to improve the standard of living and to promote the innovation capacity of the national economy.
To strengthen its position in the research landscape, the institute has focused its activities on four key research areas, these are:

- "Biorefinery – Products from Renewable Resources",
- "matfunc – Particles, Materials and Membranes with Functionality",
- "Modular Energy Technologies – Flexible Solutions for Sustainable Energy Systems",
- "Information Networks for Process and Energy Technology – Utilizing Dispersed Knowledge in Value Added Chains"

This thematic scope is designed to give interdisciplinary scientific impulses across the business units. It is in these key areas that the institute's profile is adapted to the rhythm of social and economic changes and focused on promising new lines of research.

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 innovation projects. The key research areas are thus continuously adapted to changing demands in a "bottom up" way.

Together with industrial and public customers, Fraunhofer UMSICHT develops and researches the latest 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.

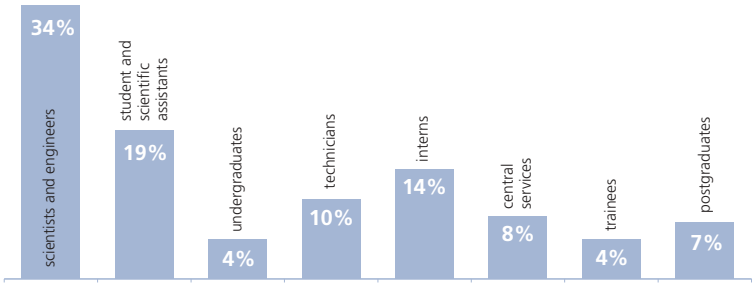
As a member of the Fraunhofer-Gesellschaft, the institute follows the line of applied, cutting-edge research and development.

Since its foundation 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.

# Facts and Figures

## Staff

| Staff at Fraunhofer UMSICHT 2007 | Number |
|---|---|
| **Permanent Staff** | **144** |
| - Scientists and engineers | 94 |
| - Technical infrastructure | 28 |
| - Central services | 22 |
| **Other Staff** | **129** |
| - Postgraduates | 18 |
| - Undergraduates | 10 |
| - Student assistants | 53 |
| - Interns, guest scientists | 37 |
| - Trainees | 11 |
| **Total Staff** | **273** |



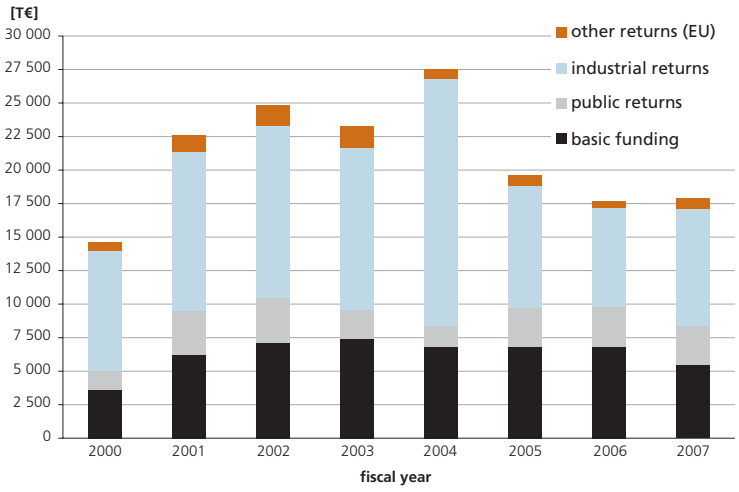

Structure of staff at Fraunhofer UMSICHT



## Expenditure and returns

| Expenditure 2007 | (m €) |
|---|---|
| **Operational Budget** | **17,9** |
| - Staff costs | 8,0 |
| - Other costs | 9,9 |
| **Investments** | **2,9** |

| Returns Operational Budget 2007 | (m €) |
|---|---|
| - Industrial returns | 8,7 |
| small and medium-sized enterprises | 7,0 |
| large enterprises | 1,7 |
| - Public returns | 2,9 |
| - Others (EU, communities) | 0,8 |
| - Basic funding | 5,5 |
| **Total Returns** | **17,9** |




Development of the operational budget since 2000

# Key Research Areas and Innovation Areas

**Fraunhofer UMSICHT: Our key research areas and innovation areas**

Growing resource conflicts, a flood of information and knowledge, demographic change, globalization, and climate change are all factors that influence our society and markets. Fraunhofer UMSICHT meets this challenge with its key research areas and innovation areas.
Four key research areas form the basis of the technological positioning of the institute within the German and international research landscape. Their thematic scope is designed to give interdisciplinary scientific impulses across the business units. With them, the profile of the institute is adapted to the rhythm of economic and social developments and focused on promising research directions. Selected focuses of research with a high innovation potential – the innovation areas – form the building blocks of the expandable and developable technological architecture of Fraunhofer UMSICHT.

## Key research area "Biorefinery"

Products from Renewable Resources



We strive to achieve that 20 percent of chemicals, materials and fuels are made from renewable materials in the year 2020. Projects focus on new technologies for the production of biodiesel including the utilization of residues and by-products, the production of diesel and ethanol from biomass as well as the development of bioplastics. Laboratories for the development of bioprocesses, downstream processing and for the production of plastic products form the basis for this work.

**• Innovation area "C4-chemistry on the basis of renewable resources"**

In this innovation area the focus is put on the development of a process chain from the starch containing raw material via biotechnological synthesis up to application and product development.

**• Innovation area "biofuels"**

The newly established business unit »Biofuels« has set the objectives to optimize biodiesel syntheses, to pyrocatalytically produce carbohydrates from biogenous waste fats and to thermochemically synthesize ethanol from lignocellulose biomass.

## Key research area "matfunc"

Particles, Materials and Membranes with Functionality

Our vision that even the smallest particles can be produced in any defined shape, and that complex structures, layers, and components can emerge through self organization is defining the path to the future. We develop intelligent materials and systems with functionalized surfaces which pave the way for new applications with properties that cannot be predicted yet. The installation of a particle synthesis laboratory as well as a membrane and microsieve laboratory forms the basis for this work.

**• Innovation area “impregnation”**

By using supercritical fluids we functionalize inner surfaces of heterogenous matrices as well as of homogenous, swellable materials and components with the aim of substituting organic solvents and creating products with improved properties.

## Key research area “Modular Energy Technologies“

Flexible Solutions for Sustainable Energy Systems

Sustainable energy supply is vital for the growing world population. Decentralized plants, energy efficiency and renewable energies are our answers for the changing energy markets.
We are backing energy from biomass and residues, the utilization of low BTU gases, landfill and sewage gas, biogas feed-in, polygeneration processes, combined heat, cold and power plants (CHCP), organic rankine cycle processes (ORC) and ambient cooling.
This is our contribution to keep energy costs under control, ensure energy supply and to protect the climate.

**• Innovation area “polygeneration”**

In this innovation area we focus on the development of energy concepts for an efficient energy conversion. We concentrate on organic rankine cycle, thermally driven chillers and energy storage media for power and cold.

## Key research area “Information Networks for Process and Energy Technology“

Utilizing Dispersed Knowledge in Value Added Chains

In complex production systems the amount of information concerning business processes, organizational procedures, technical and scientific processes in plants and apparatuses is continually expanding.
We are doing our share to make the vision come true that structured knowledge which is needed to solve complex technical problems can be provided at any place and at any time.
For this purpose we develop techniques and systems that can be used during the planning and operation of modern complex production systems.

**For further information please refer to http://www.umsicht.fhg.de/englisch/profil/leitthemen/**

# A Word or Two

Ernst Gerlach
Member of the Board of NRW.BANK and Chairman of the Fraunhofer UMSICHT Board of Trustees



The NRW.Bank is the financing bank of the federal state of North Rhine-Westphalia. As governmental partner of banks and saving banks, the NRW.Bank offers the whole range of loan management financing products: such as the financing of business ventures and financial support to small and medium-sized companies, the financial support of community housing, and the financing of local institutions, infrastructures as well as the financing of individual projects.

## Ernst Gerlach

Ladies and Gentlemen,

When I was asked to contribute a "word or two" to this year's UMSICHT annual report, I agreed spontaneously. However, not as quickly could I make up my mind about which words would suit best. Wrecking my brains, I decided to put it as briefly and simple as it is: "Keep it up!"

During the last two years a lot has changed at the Institute. Thematic reorientation – the introduction of key research areas and innovation fields - initiated a process of transformation, which was realized also in the organizational structures. Five established business units continued work after re-sharpening their research focuses, three new units were set up. The organizational chart as presented in this report, introduced in July 2006, is evidence for these changes.

Transformation management is a significant factor for success, if not the most important, as nature has taught us for millions of years. As a matter of fact, the strategy of evolution is nothing else than the successful adjustment to changing living conditions. In contrast to nature, however, economic changes can only be transported and be successfully implemented through communication – change communication – internally and externally. If staff, customers and cooperation partners equally recognize why innovations are mandatory, they will be open to new ideas and changes and will actively support them. Only this way, changes may also become also improvements.

In the case of Fraunhofer UMSICHT, change communication has been made in the right way. This becomes evident in the positive balance sheets of 2007 and is reflected in the research agendas of the institute which have been recognized in the scientific community. The institute is cooperating in the high-tech strategy of the German Government in the fields of environment, energy and plants, has extended regional networking, and internal information management structures have been improved. The investments made are yielding first fruits, and the scientific sector is being staffed up.

I am happy to see the Institute on its way to sustainable success. And therefore my advice for the coming year is: "Keep it up!"

# A Word or Two

Dr. Thomas Mathenia, Chairman of Technical Board, EVO Energieversorgung Oberhausen AG (Energy Supplier of the City of Oberhausen) and Chairman UMSICHT Friends and Patrons

## Dr. Thomas Mathenia

North Rhine-Westphalia is among the European regions with the most densely spread and most efficient research activities. This is a definite asset facing the challenges of the future:
We have to save energy and resources, we are on our way to protect the climate and to improve our standard of living. We have to develop new technologies to enhance more efficient production methods and products of better quality, and we need qualified and committed manpower to achieve this. The UMSICHT Friends and Patrons group is dedicated to the support of applied research in the field of environmental, safety and energy technologies in North Rhine-Westphalia, particularly in the Ruhr area.
As Friends and Patrons, we are prepared to create the conditions for this process: making good ideas become innovations and stimulating employment opportunities in the region through education, research and development.

Dr. Susanne Raedeker, Managing Director of the AGR Deponienachsorge GmbH & Co.KG (AGR Waste management company) and Deputy Chairwoman UMSICHT Friends and Patrons Group

## Dr. Susanne Raedeker

Our society is more and more becoming an information and science society. Those who can rely on good networking, recognize trends early and are able to identify new technologies which have an impact on competitiveness, are among the winners. Besides the goals mentioned by Dr. Mathenia, the UMSICHT Friends and Patrons group therefore concentrate on the exchange of experience and know-how among universities and industry, in the R&D network of the Fraunhofer-Gesellschaft, and among its members. This furthers innovative approaches and activities, supports research and also helps promote the creation of value for own activities. We cordially invite you to join us!



**Members of the UMSICHT Group Friends and Patrons**

- AGR GmbH
- AVIT GmbH
- Buchhandlung und Verlag K.-M. Laufen
- DECHEMA e.V.
- Energieversorgung Oberhausen AG
- Fernwärme – Forschungsinstitut in Hannover e.V. FFI
- Fernwärmeversorgung Niederrhein GmbH
- FITR e.V.
- FKuR GmbH
- Heine Gesellschaft für schlüsselfertiges Bauen mbH
- KonnexX Unternehmensberatungsgesellschaft mbH
- Loick AG
- LÜNTEC Förderverein e.V.
- National-Bank AG
- PUR-Technologie Hegemann
- Sesterhenn Energiedienstleistungen Titz
- Stadtsparkasse Oberhausen
- Verein zur Förderung der Energie- und Umwelttechnik e.V.
- WAGRO Systemdichtungen GmbH

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# Let's Work Together

"We believe our job is to create new solutions for our industry, to give our industry a new face and to pass on the benefits and achievements of this new type of network computing to our clients.
Fraunhofer UMSICHT is our partner and supports this path."

Heiko Gloge
Managing Director and partner IGEL Technology GmbH



The IGEL Technology GmbH is a subsidiary enterprise of the worldwide operating Melchers Group. The Bremen-based company, with a development center in Augsburg and several subsidiaries in Reading (UK), Fort Lauderdale (U.S.) as well as in Singapore and Hong Kong, is one of the world's most innovative software manufacturers with its Windows CE, Windows XP-Embedded and Linux-based Thin-Clients.

**Saving energy at your computer working place may seem to be some of us peanuts, however, in companies staffing a couple of hundred employees, the consumed kWh quickly sum up to an enormously high power invoice and – as a result of this – in considerable carbon dioxide emissions.
How much energy and costs can be saved through the implementation of "Thin Clients", a so-called "lean variant of computers", was investigated by Fraunhofer UMSICHT in a study commissioned by the IT manufacturer IGEL Technology GmbH. A brief insight into this cooperation is given by Heiko Gloge, the Managing Director of the enterprise.**

As one of the worldwide leading manufacturers of Thin Clients, computers that require low support, are reduced to input and output, we sure know the benefits of our products. Due to marketing aspects we require reliable data material, which compares the efficiency, production, usage and disposal phases of Thin Clients and personal computers. This is why we have commissioned Fraunhofer UMSICHT to perform an ecological analysis of the Thin-Client life cycle.

The results are quite impressive. The power savings working with Thin Clients compared to operation with traditional PCs reach up to 50 percent. This has a positive effect on $CO_2$ reduction and on the climate. Also regarding transportation, our equipment is definitely a winner: IGELs weigh only one third of a traditional PC and require only 11 to 20 percent of space compared to computers. This pays off with transporting costs.

In order to compare the costs of equipment and operation, Fraunhofer scientists have created the model of a typical institute which may be projected to medium-sized enterprises with a staff of 150 to 300 employees. And here lies another major asset of our IGELs. With IGELs, an enterprise may cut down 44 to 48 percent of costs compared to using traditional PCs. Starting from the level of about 40 to 50 workplaces, using Thin Clients has a mid-term positive impact on the total cost development.

IGEL stands for non-conventional ideas and innovative concepts. This is exactly what we expect from our contract partners and Fraunhofer UMSICHT offers interesting performances at an excellent level. Communication between UMSICHT and our development department was always open and easy, the studies were supplied promptly and smoothly. We were especially happy about our common promotional activities in order to disseminate the results of the studies.
The feedback to these publications was outstandingly positive, so that we were able to sell roughly 20 percent more products in 2007, compared to the first half of the preceding year – partly also due to the extensive dissemination of the study results. We are determined to continue this successful cooperation with Fraunhofer UMSICHT. The preparation of a follow-up study is already under way.

# Organizational Chart

## Directorate

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

**Dr.-Ing. Görge Deerberg**
Deputy Director

## Business Units

### Renewable Resources
**Dr.-Ing. Stephan Kabasci**
**Deputy:**
Dipl.-Ing. Carmen Michels

- Bioengineering
- Chemical Conversion
- Plastics Technology

### Process Technology
**Dr.-Ing. Görge Deerberg**
**Deputy:**
Dipl.-Ing. Josef Robert / N.N.

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

### Biofuels
**Dr.-Ing. Axel Kraft**
**Deputy:**
N.N.

- Catalytic Processes
- Refinery Concepts
- Fuels

### Advanced Materials
**Dipl.-Ing. Jürgen Bertling**
**Deputies:**
Dr. rer. nat. Holger Wack /
Dipl.-Ing. Marcus Rechberger

- Polymeric Compounds and Components
- Functional Particles and Composites
- Hydrogels, Wood and Leather

### 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 Technology
**Dr. rer. nat. Thomas Marzi**
**Deputy:**
Dr.-Ing. Barbara Zeidler

- Refuse Derived Fuels and Biomass
- Biogenous Low BTU Gases
- Biomass Conversion

### Energy Systems
**Dr.-Ing. Christian Dötsch**
**Deputy:**
Dr.-Ing. Wilhelm Althaus

- Energy Storage
- Polygeneration
- Optimization of Energy Systems

### Resources Management
**Dr.-Ing. Hartmut Pflaum**
**Deputy:**
Dr.-Ing. Markus Hiebel (MSc)

- Material Flow Management
- Networks / Supply Chain Management
- Innovation Processes

## Networks

### Development and Demonstration Centers

### University Cooperations

### Board of Trustees

### Circle of Friends and Patrons

### Branch Teterow
**Dr.-Ing. Görge Deerberg**
**Deputy:**
Dipl.-Ing. Toralf Goetze

- Rotary Kiln Pilot Plant

### Branch Willich
**Dipl.-Ing. Carmen Michels**
**Deputy:**
Dipl.-Ing Thomas Eisenburger

- Plastics Pilot Plan

### Fraunhofer Technology Academy/Training Center
**Dipl.-Ing. Anja Gerstenmeier**

- infernum

## Infrastructure

### Administration
**Dipl.-Betrw. Andreas Weber**
**Deputy:**
Dipl.-Region.-Wiss. Nina Junen

- Finances/Controlling/Contracts
- Human Resources Development
- Library

### IT Management
**Dipl.-Ing. Andreas Schröder**
**Deputy:**
Dipl.-Inform. Christian Knermann

- Network Management
- Individual IT-Infrastructure
- Management of Measuring Data

### Chemical Laboratory
**Dr.-Ing. Edda Möhle**
**Deputy:**
Dr. rer. nat. Anna Fastabend

- Anorganic Analysis
- Organic Analysis
- Development of Methods

### Marketing, Communication, Business Planning
**Dr.-Ing. Hartmut Pflaum**
**Deputy:**
Dipl.-Chem. Iris Kumpmann

- Marketing / PR / Strategy
- IPR / Licensing
- International Projects / EU

### Central Technical Services
**Dipl.-Ing. Richard Sprick**
**Deputy:**
Dipl.-Ing. Joachim Hillers

- Pilot Plant Stations and Workshops
- Construction / CAD
- Operational Center

### Occupational Safety and Environmental Protection
**Dr.-Ing. Ulrich Seifert**
**Deputy:**
Dipl.-Ing. Jürgen Stein

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

# Business Units/Infrastructure

Fraunhofer UMSICHT presents itself in the market for applied research with eight business units. These business units represent the taylor-made combination of products and R&D services with the requirements of the respective business segments. They apply modern methods of project management and realize successful innovation projects. At the same time they use research and science to advance the institute´s key research areas "bottom up". The knowledge basis for maintaining and extending our core competencies lies within the business units.

Successful research and development demand good service and adequate management – externally as well as internally! That is the reason why we make allround servicing that our business units profit from available to our customers as well.

## RENEWABLE RESOURCES

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**Bioengineering**
Fermentative synthesis of valuable material; downstream processing; microbial biomass utilization, extract production; biogas production; biological wastewater, waste air and solid waste treatment; testing of compostability of plastic products; enzymatic syntheses

**Chemical Conversion**
Platform chemicals, monomers and polymers from renewable resources; hydrogenation; analytics (IR, TG, DSC, GC, HPLC, GPC, viscosimetry); biorefinery systems

**Plastics Technology**
Material development: polymers from renewable resources, biodegradable polymers, wood fiber reinforced compounds, tailor-made blends; compounding; injection molded or extruded prototypes, small scale production; material and component characterization; thermochemical and spectroscopic analysis

## PROCESS TECHNOLOGY

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**Downstream-Processing**
Process development; biorefinery; process development for membranes, microsieves and thermal separation processes; process media cleaning; processing of fermentation solutions; phyto materials; sample batch processing

**Water and Wastewater Technology**
Valuable material recovery; acid processing; closing of water cycles; decentral water and wastewater technology; degermination; pipeline technology; network and cavitation hammer simulation

**Multiphase Reaction Technology**
Process development and optimization of multiphase processes in chemical and biotechnology; sample batch production; process intensification; process modeling and simulation; optimization; CFD; reaction calorimetry

## BIOFUELS

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**Catalytic Processes**
Gas phase transformation of fats, oils and renewable materials to biogenous diesel and gasoline; alternative ways to biodiesel and partial glycerides; processes for the use of raw glycerol from the biodiesel production; synthesis of butanol from ethanol; synthesis of catalyst prototypes, catalyst lifetime and recycling tests; chemical process development

**Refinery Concepts**
Sustainable use of oil plants; conversion of biobased alcohols, poly alcohols and sugars to intermediates and products; production of lactic acid and its derivatives from renewable resources; chemical lignin cleavage; analysis of fuels and chemical intermediates with chromatographic methods (GC, GC-MS, LC-MS); on-line analytics; thermal analysis

**Fuels**
Development of processes and syntheses for biobased gasoline, diesel, kerosene, butanol and LPG; fixed bed and pressure reactors; batch and continuous reactors; downstream processing by distillation; processing of biological residues to fuels

## ADVANCED MATERIALS

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**Polymeric Compounds and Components**
Compounding of technical polymers (TPU, TPE, POM, PBT, PA, PP); fields of application: tribology, sealings, coatings, injection molded powder sintered components; processing technologies: melt mixing, injection molding, profile and foil extrusion, rapid prototyping, powder spraying, fluid bed sintering, comminution and granulation, high pressure spraying, impregnation

**Functional Particles and Composites**
Production of microcapsules, micro hollow spheres, nano and micro particles, hydrogel particles as carrier systems; biomimetic material concepts (tribology, self-healing); polymers equipped with indicators, latent heat storage (PCM) systems, materials equipped with aroma, effect pigments; FEM and DEM-simulations

**Hydrogels, Wood and Leather**
Switchable hydrogels; self-repairing sealing systems; volume impregnation of porous and non-porous materials, extraction and decontamination of wood; leather tanning with supercritical carbon dioxide

## INFORMATION TECHNOLOGY IN PROCESS ENGINEERING

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**Information and Knowledge Management**
Information logistics; data acquisition; data consolidation; visualization; customized user interfaces; database architectures; business intelligence; process logic; local-based information providing

**Server Based Computing**
Application service providing; operational concepts; service oriented architectures; role concepts; access technologies; terminal equipment

**Environmental and Safety Law**
Legally compliant structural and operational organization, sustainable company documentation; hazardous substance management and information; guidelines; authorization procedure; safety analyses and concepts

## ENERGY TECHNOLOGY

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**Solid Fuels from Biomass and Waste**
Combustion (e.g. of wood, RDF, sewage sludge), grate firing systems, refuse derived fuels, fuel characterization, development of "waste to energy" concepts; ashes and slags

**Biogenous Low BTU Gases**
Biogas feed-in into gas networks, catalytic and adsorptive cleaning, development of selective adsorbents, oxygen separation, analytics, mobile test rigs for on-site development, efficiency analysis, landfill gas utilization, burner technology

**Biomass Conversion**
Synthesis gas utilization; studies/surveys; development of biomass-CHP-technology; catalytic tar reforming; tar measuring

## ENERGY SYSTEMS

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**Energy Storage**
Investigation and development of electric energy storage: Network integration, regulation/management; development and generation of hybrid cold/heat carriers as phase-change materials/phase change slurries (PCM/PCS)

**Polygeneration**
Development and construction of ORC plants (waste heat into power); planning and optimization of CHCP cogeneration plants; development of thermally driven chillers

**Optimization of Energy Systems**
Energy system analysis, benchmarking and optimization of heat, cold and power supply system operations; $CO_2$-emissions management (monitoring/trading), elaboration of feasibility studies

## RESOURCES MANAGEMENT

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**Material Flow Management**
Optimization of material and energy cycles; recycling concepts, benchmarking of technical systems with key figures; cost-benefit analyses for decision support; ecological and economic optimization of waste management networks, identification and assessment of biomass potential, scenario analyses, sustainability management

**Networks / Supply Chain Management**
Analysis and optimization of material flow and energy flow systems, location planning and optimization, optimization of technical and infrastructural processes, master plans for decision support, development and management of network projects

**Innovation Processes**
Innovation and knowledge management, brainstorming and realization of ideas, development and monitoring of innovation processes, market research and analyses, technology trends, roadmaps, marketing/PR, IPR and licence strategies

## ADMINISTRATION

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Budgeting; finance and controlling; financial project monitoring; accounting; personnel planning, recruitment and development; organization of business trips; contract management; equipment management; purchasing; library; infrastructure

## MARKETING, COMMUNICATION, BUSINESS PLANNING

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Dipl.-Chem. Iris Kumpmann
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Fax: +49 208 8598-1289
iris.kumpmann@umsicht.fraunhofer.de

Innovation management and marketing; business area planning; market and technology studies; composition and layout of printed media; media work; press and public relations; information medium internet; marketing concepts; strategy; property rights; international project development/EU

## IT MANAGEMENT

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Fax: +49 208 8598-1425
andreas.schroeder@umsicht.fraunhofer.de

DV-auditing; planning, installation and operation of local networks; conception of central data management and security; data base development; development of web applications; client server solutions; system architecture



## CENTRAL TECHNICAL SERVICES

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Fax: +49 208 8598-1425
richard.sprick@umsicht.fraunhofer.de

Plant construction; project management; basic and detail engineering; sampling, analytical and pilot programs; technical service; central implementation of measurement and control; operating technology center; mechanical and electronic workshops

## CHEMICAL LABORATORY

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Analysis (inorganic/organic), fuel characterization (biofuels/refuse derived fuels), biotechnology (compostability/production processes), chemical-physical measurement methods, material characterization, syntheses, environmental chemistry

## OCCUPATIONAL SAFETY AND ENVIRONMENTAL PROTECTION

Dr.-Ing. Ulrich Seifert
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Fax: +49 208 8598-1290
ulrich.seifert@umsicht.fraunhofer.de

Internal coordination and advice in topics related to occupational safety and environmental protection: vocational training and on-the-job courses; registration and notification procedures; monitoring of legislative regulations

## LIBRARY

Dipl.-Bibl. Kerstin Hölscher
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Fax: +49 208 8598-1290
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The UMSICHT library provides basic literature and procures project-related literature. For this purpose it offers among others online researches in online databases (STN). The scientists of UMSICHT can use a portal, where they can research autonomously; at present SciFinder, CEABA, TEMA, INSPEC and some free (or accessible via Fraunhofer framework contracts) databases are available. In addition, the library provides support concerning publications (Fraunhofer IRB-Verlag).

## BRANCH TETEROW

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At its site in Teterow, Fraunhofer UMSICHT, supported by the State of Mecklenburg-Western Pomerania and the City of Teterow, operates a rotary kiln pilot plant for the development and sample production of specific high-performance adsorbents made from renewable resources. The link between laboratory research and commercial production is supposed to stimulate agricultural businesses and companies to realize innovative projects in the fields of "utilization of renewable resources" and/or "biofuels".

## BRANCH WILLICH

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At its site in Willich, Fraunhofer UMSICHT offers broad customer and future-oriented services in the areas of compounding and material development. Biodegradable plastics, polymers from renewable resources, nanocomposites and recycling plastics are developed systematically and produced in pilot and small-scale series. Process optimization, analytics and test engineering round off the portfolio of the branch Willich.



## TRAINING CENTER/FRAUNHOFER TECHNOLOGY ACADEMY

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We qualify specialists and business executives with the aim of strengthening Germany's innovative potential. The interdisciplinary distance learning program for environmental sciences infernum – "official project of the decade of the united nations for the education for sustainable development 2005-2014" – imparts environmental know-how from more than 10 disciplines and qualifies its students – who are mainly enrolled in the program parallel to their job – to think and act in interdisciplinary ways. The master's degree infernum is offered in co-operation with the FernUniversität in Hagen (Open University) and is part of the Fraunhofer Technology Academy.
»**www.technology-academy.fraunhofer.de**« or
»**www.umweltwissenschaften.de**«

## UNIVERSITY COOPERATIONS

Ruhr-University of Bochum
University of Dortmund
University of Duisburg/Essen
FernUniversität in Hagen
Hochschule Niederrhein
Fachhochschule Göttingen
University of Rostock
Unidad de Desarrollo Tecnológico (UDT), Institute of the Universidad de Concepción, Chile

The market for research and development is changing fast. As an institute operating at the interface between university research and industrial practice and offering cutting-edge and application-oriented services and products we rely on strategic partnerships with universities and universities of applied sciences in Germany and Europe.

This way we can integrate basic research into our projects.

## CIRCLE OF FRIENDS AND PATRONS

Chairman:
Dr.-Ing. Thomas Mathenia
(Energieversorgung Oberhausen AG)

Deputy:
Dr. rer. nat. Susanne Raedeker
(AGR Deponienachsorge GmbH & Co. KG)

Managing Director:
Dr.-Ing. Görge Deerberg

The objective of the Friends and Patrons Group (UMSICHT Förderverein) is to initiate innovative research and development projects, ideally and by monetary means, at an early stage to open up the access for North Rhine-Westphalia – and in particular for the Ruhr area – to sustainable technology developments. The focus is on project ideas for environmental, safety and energy technology in the research areas "biorefinery", "materials and membranes with "functionality", "decentral, modular energy technologies" and "networks for process and energy technology".
Additional to a technical-oriented preliminary work (e. g. proof of principle) the member companies invest in forecast-studies about current topics, shape the public opinion concerning the sponsorship of events and they encourage the next generation of economy executives.

# About energy, Georg Friedrich Händel and the MSV Duisburg
## In dialogue with Dr. Thomas Marzi

*1. More than one year ago, you were assigned head of the business unit energy technology. Just imagine your daughters ask you what your research is about – what would you reply?*

This is not quite as easy as it seems – as has become obvious in a recent school program project, which was performed at my work place. In the course of this project, my daughters could observe what I am doing all day long at work. At the end of the day, I was not sure if I had been able to give them a realistic insight into my everyday work. Nevertheless, I am quite definite that I could make clear on what kind of research our business unit focuses, and on the fact that we are a team. Working in research always means also working in a team.

Nobody performs research work on a specific topic only personally. Our business unit is dedicated to the key topics biomass, renewable raw materials and alternative fuels, and this describes it perfectly. Briefly said, we develop and optimize new, alternative fuels, no matter if gases or solid fuels. In this framework, we specialize in regenerative energies since fuels from renewable energies will play a major role, next to fossil fuels, in future. Indeed, they are very important already now. If you take a look at statistics, you might see that biomass has the largest share of regenerative energy carriers. We are going to optimize the utilization of this potential, in particular by making materials/ resources available which have been hardly accessible up to now, such as loppings and straw. Our aim is to use each option to protect resources and to reduce the $CO_2$ problem.

*2. This is exactly what I was going to ask you next. The threatening climate change and rising energy costs call for action In one of its key research areas, the Institute heads towards the development of flexible solutions for sustainable energy systems. Would you give us an example project to explain how your business unit works to implement modular energy technologies?*

An interesting project which might give a good insight into the aforementioned topics, is the feed-in of biogas into the natural gas grid. Biogas is normally produced in decentralized plants, since biomass is a regionally generated product and normally utilized on-site in agricultural operation. Our target is to make this gas, which is similar to natural gas regarding its properties, available cross-regionally. What is required here is the synthesis of both material flows – natural gas and biogas. This is exactly what the project is about. The project is to clarify which treatment technologies are required to feed biogas into natural gas grids and how it is going to be fed in. Another focus of the project is the identification of optimum feed-in points. If the biogas plant is located far from the natural gas grid, the logistic work, required for the feeding of biogas into this grid, will not be economic from a certain level of distance. Geographic information systems are tools to assist us in finding solutions to this problem (for further details cf. page 80).

*3. The German Federal Ministries of Economy and for the Environment are currently working on a law on climate and energy protection, focusing on three topics: supply safety, economic efficiency and environmental compatibility. The amendment to the Renewable Energy Sources Act (EEG) will be part of this. The amendment is expected to make this law more efficient and simple, the proven basic structures will be maintained. What is your wish regarding the amendment of the EEG?*

According to the EEG, all those who feed electricity from renewable energies into the power grid receive a compensation payment from the grid operator. The categories of compensation rates differ as to how power is generated, the amount of the single rate is defined in detail in the EEG. However, to date only those who use pure biomass, receive a compensation payment at all. As soon as biomass is combusted together with other materials, no compensation is given. This is not the case in other parts of Europe. If I was asked to express my wish regarding the amendment of the EEG, I would stand out for compensation for co-combustion of biomass with other combustibles. This would definitely be a step forward for the marketing of decentralized energy technologies.

*4. At which point do you see the business unit energy technology in three years?*

We are going to further expand the three centerpieces of our business units: gases, solid fuels from biomass and wastes and the gasification technologies by including different possibilities of biomass conversion into our technological range. In future, our offer will include technologies which are capable of making biomass usable which is difficult to utilize. One technology that we have in view is hydrothermal conversion, the conversion

Dr. rer. nat. Thomas Marzi (born 1961) studied chemistry at the University of Duisburg, receiving his PhD on the "Influence of Humidity on the mechanical and thermal properties of glass fibre reinforced epoxy resins".
Dr. Marzi's key competencies are in the field of fuel characterization and environmental chemistry. For the Interdisciplinary Master Studies Environmental Sciences infernum he is responsible for the courses and seminars on "Global risks – Climate" discussing the possibilities and risks of the clean coal technology.

Dr. Marzi is married and has two daughters.



of humid biomass to carbon-enriched products using dehydration. Here, the organic part of the biomass reacts with water vapour under increased pressure.

*5. How do you save energy?*

I have an economic car. Driving on the motor way, my car consumes about 6.5 l per 100 km, at a mean velocity of 100 to 110 km/h, which I guess is quite alright for a minivan. Generally, I do what all people do: we lower the heating, when we are not at home, prefer short house ventilation to the long one, and switch off electric devices when we do not operate them. This might sound quite commonplace, but it pays – above all if everybody contributes. Currently we are also refitting our house with energy-saving lamps.

*6. Now that we have learned a lot about your activities on the job – we would like to know something about you personally. Which book might we find on your bedside table?*

Until recently, you would have found the volume "Die Evolution des Göttlichen". This book is about the evolution of religious ideas beginning in ancient times of Europe until the modern days, a cultural history of religion. Basically, I enjoyed reading this book, yet I must admit, as is often the case with non-fiction, that it is not a quite easy reading for evenings. Depending on how hard my day was, I proceeded differently in reading this book. In this case it took me half a year to finish it.

*7. And which disc has recently been played on your CD player?*

It is the "Messias" by Händel, and the official song of the MSV Duisburg football club, what I listened to often. The latter one because of their lack of success – but – unfortunately, with a decreasing tendency.

*Die Evolution des Göttlichen. Ursprung und Wandel der Gottesvorstellung, Fritz P. Schaller (Patmos-Verlag, 2006, ISBN-10: 349172502X; ISBN-13: 978-3491725027)*

# Training Center/Fraunhofer Technology Academy

A first-class education is the mainspring for a successful workforce development– this is true today, more than ever. The education model TheoPrax® is a programme that has been made for students at school and university level and combines theory and real-life experience at an early stage. Fraunhofer UMSICHT acts as regional coordinator for enterprises who supply practical problems from industrial practice to schools and universities, where the projects are worked on by pupils and students.

Today, innovations emerge at a breathtaking pace, economic conditions are constantly changing and globalization leads to an increasing competitive challenge from abroad. Those who want to face these challenges successfully can no longer confine themselves to traditional studies or vocational training as it used to be. Lifelong learning is a must today. We offer career development for scientific and management staff in order to strengthen the innovation potential in Germany.

The interdisciplinary distance learning program environmental sciences infernum (www.umweltwissenschaften.de), official project of the "United Nations Decade for the Education for Sustainable Development 2005 to 2014", provides environmental know-how in more than ten fields and encourages interdisciplinary approaches in theory and practice. Employees in business, associations, science, administrative bodies, freelancers and qualified junior scientists get insight into cutting edge technologies and interdisciplinary know-how in environmental technologies. The accredited master studies infernum is offered in cooperation with the FernUniversität in Hagen (Open University) and is part of the Fraunhofer Technology Academy.

The Fraunhofer Technology Academy bundles the career development offer of the Fraunhofer-Gesellschaft and offers excellent career opportunities to scientists and management staff. The latest knowledge in R&D is reflected in the content of teaching. This guarantees a unique transfer of know-how from Fraunhofer research into enterprises.
www.technology-academy.fraunhofer.de

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# Marketing, Communication, Business Planning

The marketing of products and services, analyzing, and handling of business sectors, developing new market strategies, and finally representing the institute in public are the tasks of the department of "Marketing, Communication and Business Planning". Being directly responsible to the directorate, we support the scientific staff in the positioning of new products and fields and in tailoring them to the customer's requirements. Market surveys and technology studies help to assess opportunities and risks of new developments at an early stage. In order to protect innovations against plagiarism, we provide support in the field of industrial property rights, we monitor and assist in patenting procedures and offer consulting in licensing contracts.



# IT Management

An efficient and reliable information and communication technology service is an indispensable prerequisite for any efficient project work. The IT management provides internal and external services, focusing on the following areas of expertise:

- planning, continuous operation and support of the DP infrastructure
- provision and update of software packages
- assistance in IT-specific problems

A powerful and available network enables the effective utilization of the IT services. In addition to redundant fileservers that include capacities in the terabyte range with adequate data security, an increasingly important intranet is at our disposal.

Apart from that the IT management supports apprenticeships for computer scientists with a concentration on system integration.

# Library – Specialist Information Service

"Knowledge" has long since become an economic factor securing technological advantages of a location. For keeping the scientific-technical qualification of our staff always highly up to date, the scientific specialist library provides literature on the UMSICHT-specific topics environmental, energy, safety, process and material technology as well as on know-how and technology transfer.

The intranet homepage supports the staff in the retrieval of specific technological information.

Services range from literature and patent research to in-house training in end user services, from documentation of in-house publications for the Fraunhofer Publica database to documentation of conference publications, PhD theses, from author support to the delivery of the printed copy to the Technical Information Library (TIB) at Hanover.



# Central Technical Services

The cycle times of technological innovations are minimizing rapidly in industrial and process engineering.
In order to secure a technological head-start and not only keep pace with others, a smooth and prompt realization must be guaranteed.
The central technical facilities realize technological know-how for internal and external costumers quickly and competently.

Specialized on the sector of test, pilot and demonstration plants our strenghts lie in:

- basic and detail engineering
- implementation of process control systems and
- measurement, control technology and control engineering.

# Branch Willich – Plastics pilot plant station

At the Willich site, Fraunhofer UMSICHT offers customer and product-oriented services in the field of plastics compounding and material development. Biodegradable plastics, polymers from renewable resources, nanocomposites and recycling plastics are systematically developed and manufactured in pilot and small series. Process optimization, analytics and test engineering round off the portfolio of the Willich branch.

The target is to generate practice-oriented and economic solutions for the customers' requirements. A broad range of technical facilities from laboratory to industrial scale and our know-how of many years of research are available.

Materials laboratory:
- Hot-cold mixer, Labtech LMX-10-S-VSF
- Laboratory roll mill, Labtech-LMR-SC-110/3E
- Laboratory press, Labtech LP-S-20
- Laboratory blown film plant, Labtech LCR -300
- Twin screw extruder, TSA EMP 26-40

Extrusion lines:
- Berstorff ZE 50 Ax 47D
- Leistritz ZSE 70-36D
- Leistritz ZSE 40-36D
- APV MP 40TC-40D
- Several granulators units (water-ring, underwater and line-granulators)
- Conveyor systems and gravimetric metering systms for the processing of powder, granulate and liquid raw materials.



# Branch Teterow – Rotary kiln plant

At Teterow, Fraunhofer UMSICHT develops products and technologies for using renewable resources as a source of energy and materials close to the agricultural sector. Together with partners from the region, at Teterow, sustainable operational concepts for bioenergy production and technologies for desulphurization of biogas are developed and tested. The objective of our work is to encourage closed production systems which are called biorefineries today.

High performance adsorbents from renewable resources are developed and produced in batch production in a rotary kiln plant. The target products are specific products on the basis of activated carbon such as specifically doped adsorbents, which are then used for the cleaning of (bio)gas and waste gas. In the technical plants, both new formulae are developed and sample production is conducted.

The technologies available comprise mixing, homogenization, granulation, pressing, drying, pyrolysis, combustion, activating, sintering, calcination, sieving, acid washing and dip impregnation as well as the necessary testing methods. High flexibility in the production process leaves ample space for process engineering investigations so that optimum conditions for the development of custom-made products are given.

You will find the contact data of our branch offices on page 21.

# The UMSICHT laboratories

The UMSICHT laboratories stand for the solution of analytical, biotechnological, process technological and material- and particle-technological problems. Highly qualified and experienced teams consisting of scientists and technical staff work closely together to handle to these future-oriented tasks. The laboratories of Fraunhofer UMSICHT comprise the analytics laboratory, the biotechnological lab, the physical and the chemical lab.

## Analytics Laboratory

Precise and reliable analytics is a prerequisite for the solution of environmental and process technological problems.
The institute is equipped with comprehensive facilities including most modern analytical system combinations.

The wide range of services offered includes normative procedures and in particular the development of innovative, customized methods.
Examples from the analytics portfolio:

- Analytics of fats, oils, organic acids and alcohols
- Hormone analyses
- Tar analyses
- Fuel characterization
- Characterization of biofuels

The validation of the measuring results is conducted via comparison with external laboratories (ring testing). Another focus is on the optimization of technical processes for quality improvement and analyses of refuse derived fuels.

Our team offers analytical solutions, consulting services in the planning of examinations and helps evaluating your analytical results.

## Biotechnological Laboratory

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

New biotechnological processes and plants are planned step by step, designed and examined to ensure technological feasibility at a high level of efficiency and operational safety. The biotechnological laboratory can realize creative and efficient solutions by co-operating with the engineering departments.

As an approved testing laboratory of "Bundesgütegemeinschaft Kompost e. V." (Federal association of compost quality standards), and approved testing laboratory of DIN CERTCO for testing of composting capability of materials according to DIN V 54900-1 to -3, ISO 13432, ASTM 6400 we offer:

- microbiological analyses according to DIN, ISO, OECD-processes
- testing of biodegradability under aerobic and anaerobic conditions (e. g. $AT_4$ and $GB_{21}$ according to "Abfallablagerungsverordnung" [Regulations concerning waste disposal])
- Development of biotechnological production processes
- Fermentation tests

# Physical Laboratory

For years Fraunhofer UMSICHT has intensively done research and development in the fields of material sciences and particle technology. As a result we can offer a broad-ranged portfolio for the characterization of dispersions, powders, polymeric compounds, hydrogels and specific nano and microparticles.

Our service range comprises in particular the following investigations:

- Particle size and shape (static and dynamic light scattering, sieving, microscopy)
- Interfacial properties and porous structures (e. g. tensiometry, electrophoresis, mercury porosimetry, gas sorption)
- Composition, structure and phase conversions (e. g. thermal analysis, rotation rheometry, IR-spectroscopy)
- Determination of mechanic parameters (e. g. tensile tests, notched-impact strength test, tribological measurements)

Besides providing reliable measurement results – particulary when no standardized methods are available – our team excels in the interpretation of data related to process engineering and to latest trends in materials technology.



# Chemical Laboratory

The recently set-up chemical laboratory focuses on :

- Parallel reactor system, reaction calorimeter
- Biofuels: small-scale systems for the cleaning of biodiesel products (flash distillation, mini-plant for the production of biodiesel)
- DSP: small-scale systems for the cleaning and concentration of product flows (rectification; extraction; crystallization)
- SynLab: chemical synthesis. Inert gas and vacuum lines, compression reactors and special gases.

Analytical problems are solved in co-operation with the analytics and physical laboratories. One focal point is the analysis of plastic materials using the following methods:

- Chromatographic methods: HPLC-MS, GC-MS, GPC, IC
- Thermo-analytical methods: DSC, TG (range to 1 000 °C and to 1 600 °C)
- Spectroscopic methods; IR (reflexion and transmission, film press, TG-IR-coupling, IR-databases, ICP-AOS)
- Elementary analysis

The chemical laboratory synthesis offers outstanding services through the co-operation in a team of chemical experts and chemical engineers of different scientific areas, who offer their competencies for the solution of your technological problem.

"An enormous reservoir of natural raw materials grows every day. Let the diversity inspire us to think of and develop new products beyond crude oil."

[Dr.-Ing. Stephan Kabasci,
Business Unit Manager
Renewable Resources]

We develop and optimize technical processes for the production of materials and for the generation of energy from renewable resources and biogenous residues. Our strengths lie in the application of biotechnological processes and chemical conversion steps as well as in plastics technology.

We focus on environmentally compatible generation of power, heat and cold, on sustainable production of platform chemicals and on the development of novel materials and products. Our laboratories and pilot plants allow us to scale-up from first samples of new materials to small scale production.

# Renewable Resources



Conference Series "BIO-raffiniert"

Development of Water Soluble, Biodegradable Compounds

Biotechnological Production of Succinic Acid

Local and Regional Bioenergy Potentials –
Acting Locally against Global Challenges

# Conference Series “BIO-raffiniert“



The utilization of raw materials with white bio-technology processes or via chemical conversion pathways in biorefineries is an important emerging technology. The development of bio-based products and processes requires innovative technologies, which are currently still in an early research phase. However, it is expected that future prosperity and competitiveness of several industrial sectors will be influenced significantly by this trend.

In the context of long-term expertise in the energetic and material utilization of renewable resources, Fraunhofer UMSICHT initiated the conference series “BIO-raffiniert“ (BIO-refined). The goal of these events is to develop public opinion and to drive the information exchange between science, politics, and industry in this research field.

“BIO-raffiniert I“ was organized in 2003 and offered 40 participants from industry, science, and the public sector



a forum for the discussion of technical utilization of renewable resources. At "BIO-raffiniert II" in 2004, over 80 participants listened to presentations about recent developments and inspected first products from renewable resources at a small exhibition. Due to the increased attention for this topic from the political and public sectors, "BIO-raffiniert III" was planned in cooperation with the state initiative Zukunftsenergien NRW (Future Energies NRW), (now: EnergieAgentur.NRW [energy.agency.NRW]) as a two day event with a special focus on the competency network "Fuels of the Future". 120 participants attended this conference and exhibition at the Science Park Gelsenkirchen.

In 2007, "BIO-raffiniert IV" was held under the patronage of Dr. Jürgen Rüttgers, Minister President of the state of NRW. The 150 participants consistently rated the event as "exceptional" to "very satisfied". This is where "BIO-raffiniert V" shall pick up:

Dr. Rüttgers has already renewed his patronage for the conference which will take place on March 12th and 13th, 2009.

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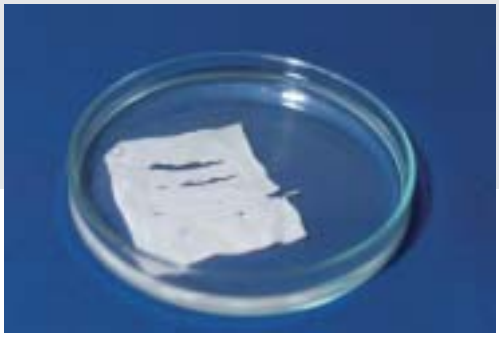
# Development of Water Soluble, Biodegradable Compounds





Dissolving characteristics in water

As part of a research project, a biodegradable and water soluble compound for films was developed which exhibits similar characteristics to LDPE[1].

A selection of suitable polymers had to be made which, on one hand, have good film characteristics but, on the other hand, dissolve in water after a defined time period. The polymers have to be environmentally friendly, and they must not have a negative impact on wastewater and sewage treatment plants. Moreover, they must not cause skin irritation upon contact.

The biodegradable compound developed is based on polyethylene glycol, a biodegradable polyester and mineral fillers.

Depending on the field of application, the water solubility of the material and, thus, the film made from it can be tailored to specific requirements. For example, it is possible to utilize the film

Production of a blown film from the compound



in a moist environment for a defined time period without any loss of function. The required degradation does not ensue until afterwards.

Aside from the very good mechanical characteristics, the developed blend shows an excellent machine suitability on conventional plastic processing equipment. According to the current findings, the material can be extruded, injection molded and processed into blow films with high throughputs without machinery modifications.

Possible areas of application are products in the hygiene, agricultural, automotive, and aeronautical industries. For example, the development of new toilet systems is being pursued for the transportation sector, specifically trains and passenger aircrafts, due to environmental and hygienic aspects. This is where the use of hygiene films from water soluble compounds would make sense since they could be disposed of in a waste tank and, subsequently, in a sewage treatment plant.

Good market prospects are expected for this product.

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[1]LDPE= Low density polyethylen

# Biotechnological Production of Succinic Acid

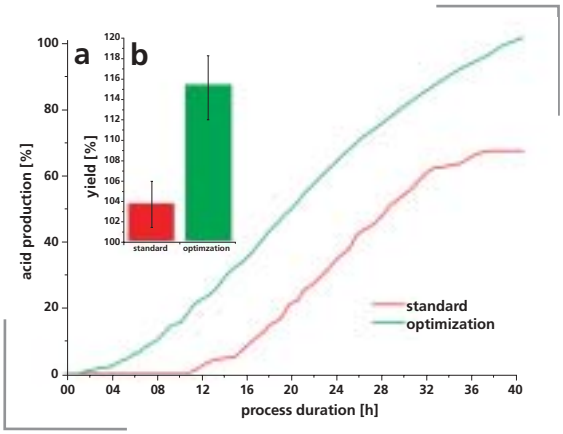


Amber

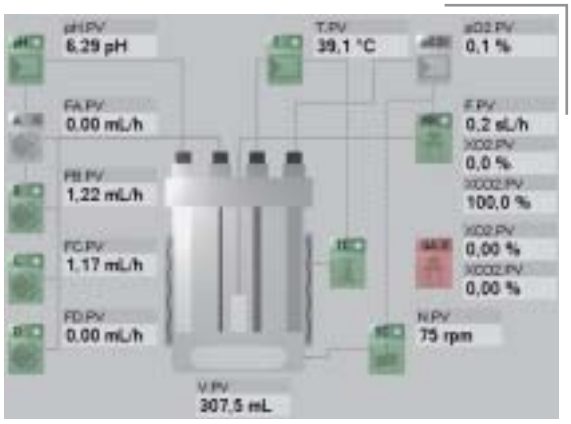
Succinic acid has been identified as one of the future platform chemicals, that can be derived from renewable resources, for the manufacturing of plastics, paints, food additives, and other products.

Succinic acid is currently being produced by a chemical process from the C4 fraction of crude oil or its cracking products. White biotechnology offers a good alternative to petrochemistry. Succinic acid lends itself well to fermentative production since it is an intermediate product of the citric acid cycle and one of the end products of the anaerobic metabolism of microorganisms.

In the context of the junior research team "C4-GAIN" (funded by BMELV/FNR[1], funding reference 220-249-05), Fraunhofer UMSICHT is developing a bio-technological production process for succinic acid in addition to subsequent chemical conversion and polymerization.




a) Comparison of succinic acid generation in the first 40 hours of digestion according to literature with those of the process, optimized by Fraunhofer UMSICHT.
b) Representation of the product-substrate yield achieved with digestion according to literature and the optimized process.




Process display of the control software of the DASGIP "fedbatch-pro" parallel digester system.



Starting from the research results of MBI (USA) and KAIST (South Korea), the fermentation with *Anaerobiospirillum succiniciproducens* was optimized in order to increase the product yield and space-time yields. The optimization of the physical parameters such as the gas sparging rate and the agitation in the utilized "fedbatch-pro" system (DASGIP AG, Jülich) resulted in the first improvements. The yield was increased by 11 % (see figure 1) through the selective modification of the feed medium composition. Additionally, the process time was reduced by 30 %, which results in a significant increase of the space-time yield.

The next step towards a competitive process is the development of a fedbatch-process with continued parameter optimization. A total of three promising approaches for the purification of the succinic acid from the fermentation broth (downstream processing) were identified, which are currently not mentioned in the literature. Upcoming experiments will show which of these separation technologies will be integrated in the final process.

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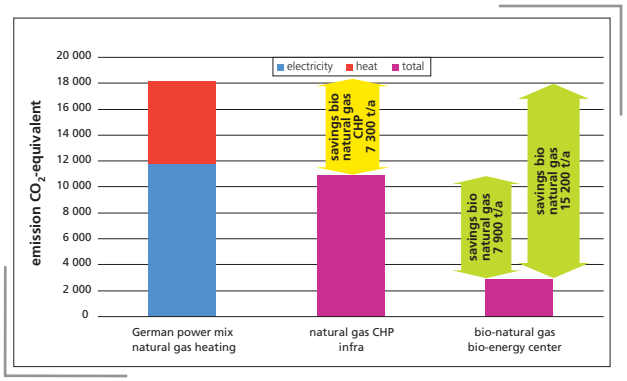
[1]BMELV = Federal Ministry of Food, Agriculture and Consumer Protection
[2]FNR = Agency for Renewable Resources

# Local and Regional Bioenergy Potentials – Acting Locally against Global Challenges



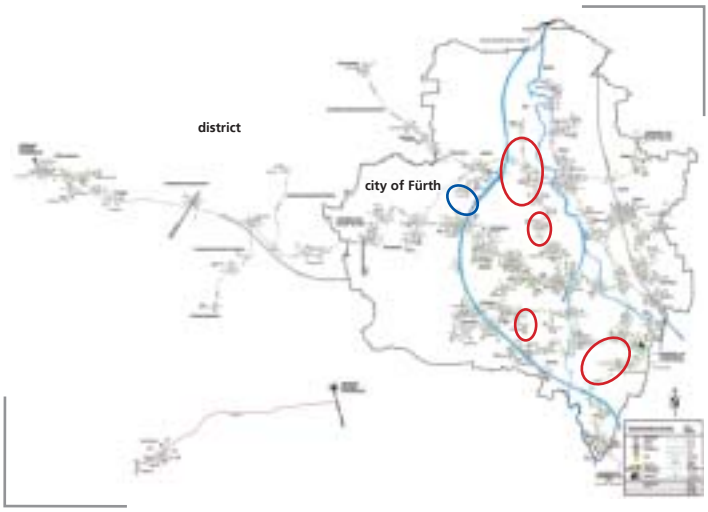



Reduction of the $CO_2$-equivalent-emissions through the project "Bioenergiezentrum Fürth" (Fürth Bioenergy Center)

Since the fourth UN-World Climate Report was issued, the topic of "climate protection" has achieved a great significance in the public conscience. Municipalities and regions can be important contributors to an efficient climate protection since they are often shareholders of the local energy distribution grids.

Among the renewable energies, biomass – aside from geothermal energy – has the advantage that it is available for base load and for combined heat and power generation. As a result, this has led to the formation of so-called "Bioenergy villages" in many rural regions. In these villages, the entire energy supply is based on biomass (e. g. Jühnde, Mauenheim).

Fraunhofer UMSICHT also sees good opportunities for the integration of biomass utilization into energy supply in urban areas. The goal is to use the existing biomass resources with the highest possible efficiency – even if only




Schematic of the natural gas grid of the infra fürth gmbh with potential location of the bioenergy center O and the location of the district heating networks O



a part of the energy demand of the cities can be met.

The possibilities for the utilization of wood or agricultural biomass from the region was investigated in a feasibility study for the infra fürth gmbh, utility (electricity, natural gas, district heat and drinking water distributor) for the City of Fürth (114 000 residents). The process chain, biogas generation, treatment, and feed-in into the Fürth natural gas grid enables the supply of renewable fuel to the existing CHP plants of the Fürth district heating networks. An industrial area near the harbor was identified as a possible location for the biogas generation. The biomass to be used can be delivered from the agricultural areas to the west of the city with short transport distances. Fraunhofer UMSICHT determined the biomass potentials, the economics, and the possible $CO_2$-emission reduction for the Fürther Bioenergiezentrum (Fürth Bioenergy Center).

Further biomass utilization studies were performed for the city of Berlin (Contractor GASAG), the Emscher-Lippe-Region (Contractor WiN Emscher-Lippe GmbH), and the right Lower Rhine (Contractor Gelsenwasser AG).

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"Process technology means to view the process chain as a whole. Modeling, simulation, and demonstration plants are our tools. That is how theory is turned into tangible practice."
[Dr.-Ing. Görge Deerberg, Business Unit Manager Process Technology and Deputy Director]

We develop and realize system solutions for process technology using pilot plants in the laboratory and the technical shops as well as model-based simulation software. In doing so we look at the process chain as a whole: from the idea to the commercial process and from the raw material to the utilization of residues at the end of the product life cycle.

Our strengths lie in membrane, separation and reaction technology as well as in pipeline technology. Our technical services range from closing of water cycles, wastewater treatment, resource recovery from process flows and thermal process engineering up to an extensive know-how in the areas of multiphase systems and downstream processing for white biotechnology and biorefineries.

# Process Technology

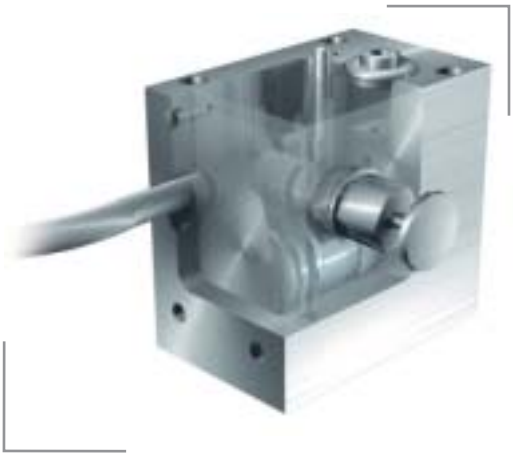
# Avoidance of Pressure Surges and Cavitation Hammer with the PCD-System



PCD-System at the Fiege Brewery, Bochum

The avoidance of pressure surges and cavitation hammers in pipeline networks is important for the safety of an installation but also for a problem-free, long-term operation. By using the newly developed "PCD"-System ("PCD" = Pressure Control Device), which was developed by Fraunhofer UMSICHT and EBRO Armaturen, Hagen, production outages and damage to the plants in various industries can be reduced significantly (water, chemicals, power, oil and gas).

The process works as follows:
Using an impulse line, the pressure in the pipe is constantly monitored during the closing of the controls. If the pipe pressure surpasses a critical value, the closing process is interrupted immediately. Subsequently, the pressure drops to a set value and the closing continues. The pressure transfer occurs without wear via a piston separation system directly on the transport line so that the product and hydraulic cycles are separated from each other.



Installation example with flap

Schematic representation of the PCD-Sytem
(Source: EBRO Armaturen, Hagen)



This method makes it possible to close the pipeline safely and as quickly as possible so that the line does not get damaged and the safety and availability of the plant are increased significantly.

Compared to conventional solutions such as piston or bladder accumulators or air chambers, PCD is technically superior, maintenance free, and significantly less costly.

Since January 2007, the system is successfully being tested in the Fiege Brewery in Bochum in a field test. Additional field tests at CHEMION in Leverkusen, BP in Gelsenkirchen, and INFRACOR in Marl are planned.

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# Transman[1]: Supply Security through Oil Cleaning



Transformer oil dirty/clean

In a world that is increasingly based on the use of electricity, supply security is necessary. Transformers are implemented to be able to convert electrical energy to a different voltage level and are, therefore, an indispensable link in the supply chain. Within the transformer, oil and wound cellulose paper ensure electrical insulation. The aging process causes the cellulose chains to split, releasing water which further accelerates the aging process and, even with small amounts, significantly reduces the disruptive strength, a measure of the insulation ability of oil, so that short circuiting threatens.

If the insulation fails mechanically or electrically, it can lead to a total shutdown of the transformer. The transformed electric capacity has to be temporarily transferred to other transformers which can cause further failures due to overloads. Transformer failures are associated with a high economic impact; firstly due to the relatively high invest-

Active portion of a transformer

200 MVA transformer



ment costs for a new transformer and secondly due to the lost energy which cannot be fed into the grid. Thus, several hundred thousand Euros can be lost on a daily basis.

Fraunhofer UMSICHT has developed a process that removes particles and water from transformers. The continual water removal results in a permanently dried physical insulation and significantly reduces or stops the aging process. In addition, the electrical resistance of the oil is renewed. Therefore, the transformer can be operated much longer and more safely until it has to be replaced with a new one due to wear. This also provides additional planning security. Theoretically, the use of this process could double the life of new transformers.

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[1]EU (funding reference/contract):
COOP-CT-2005-513137

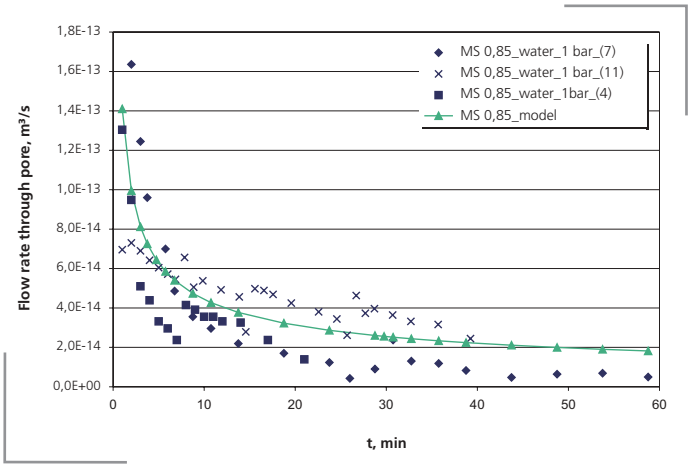
# Technology with Holes: A Look into the Pore of a Micro Sieve



Characterization of a micro sieve on a confocal microscope

The fluid flow through pipe systems is described in detail by numerous physical-mathematical models. Can these traditional models also be transferred to tiny channels with geometries that are 1 000 times smaller compared to conventional flow systems?

Thus far, micro-scaled effects have not been observed when evaluating micro sieves which have numerous evenly distributed isopores on a micrometer scale that act as a highly selective filter medium. In order to understand the performance behavior of micro sieves and to simplify the plant layout, existing micro sieve models were expanded to include micro-scaled phenomena. The model applies to particle-free media, very slow flows, and under the assumption that all flow effects are independent from each other. Micro-roughness and electro-kinetic effects (flow-internal effects based on the wall charge) were identified as the phenomena influencing flow




Comparison of micro sieve flow-through model and experiment



through pores which result from the tiny channel diameter (0,5 µm < $D_{Pore}$ < 40 µm). The influence of micro-roughness was captured in the new model through the introduction of a roughness-dependent viscosity. Electro-kinetic effects, which are negligible in macro-scaled systems, can lead to a reduction of up to 20 % flow through micro sieves. The new pore flow-through model de-scribes the flow through conical and cylindrical pores in good agreement with experiments.

In order to understand filtration processes with particle-laden media such as found in the food, water, and wastewater industries in the future, particle paths are calculated based on the model for clean media which model the formation of deposits. Currently, the application spectrum of micro sieves is being extended to the area of particle removal from air streams (fine dust in wood ovens).

Whether the developed models can be transferred to particle scaling from gases is being investigated in continuing efforts.

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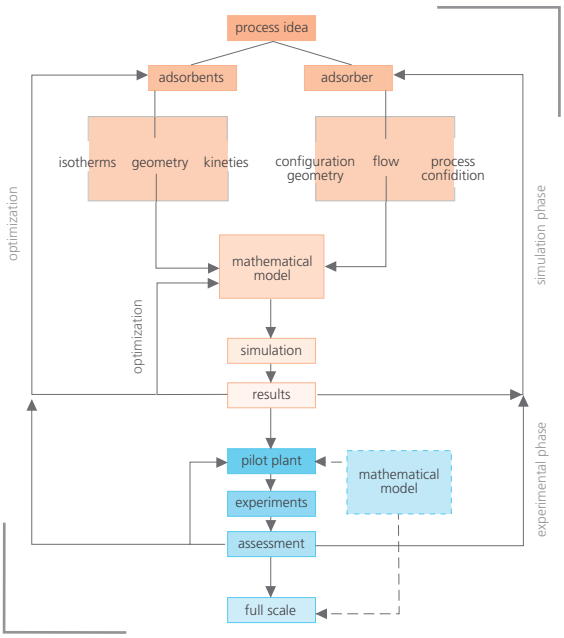
# Computer Models for the Simulation of Adsorption Processes






This is how a simulation of an adsorption process could look like

Adsorption processes in which components are deposited from the gas phase on the inner surface of porous solids are of great significance in the process industry. While previously mostly used to perform separation tasks, adsorption processes have been increasingly used for the storage of gases in recent past. This results in a stronger industry demand for know-how in this area.

Adding to the previous research activities, a tailored package of offers for industry customers was developed and successfully implemented into practice in several projects at Fraunhofer UMSICHT during the report year. The offering encompasses

1. the measurement of adsorption parameters (e. g. adsorption isotherms, porosities) in the laboratory,
2. the interpretation and critical assessment of existing data,
3. the development of tailored calculation models and



4. the implementation of computer programs and their use for the prediction and optimization of processes.

Tasks from the industrial sector were in this case the storage of natural gas in new adsorbents, the cleaning of a shielding gas in the context of a fabrication process as well as the retention of gasoline vapors in automotive tank systems. In all cases, special attention had to be paid to the thermal process behavior which was accomplished through the careful modeling of the exothermic processes and the heat transport in a fixed bed. This made it possible to show the customers the consequences of various operating modes and cooling options as well as the use of carrier materials with good heat transfer characteristics.

The increasing utilization of biofuels in vehicles and the interest in adsorptive $CO_2$-sequestration technologies will bring new tasks to adsorptive technologies on which Fraunhofer UMSICHT will put increased focus in the future.

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"Mobility is seen as the epitome of personal freedom. We conduct research today so that biofuels become important factors in paving the way for sustainable transportation and environmentally friendly mobility with the highest supply security."

[Dr.-Ing. Axel Kraft, Business Unit Manager Biofuels]

We develop and optimize biofuel production processes. Specializing in biodiesel synthesis we combine experience in the analysis of the reaction process of catalytic conversion using alkaline and in particular nitrogenous catalysts with our know-how in chemical and process engineering and detailed modelling of biological and physiochemical processes.

Our services cover the entire range from basic research to the process-technological concept of plants. Our contribution to sustainable mobility is completed by extensive know-how in the field of pyro-catalytic hydrocarbon synthesis from biogenous waste fats.

# Biofuels

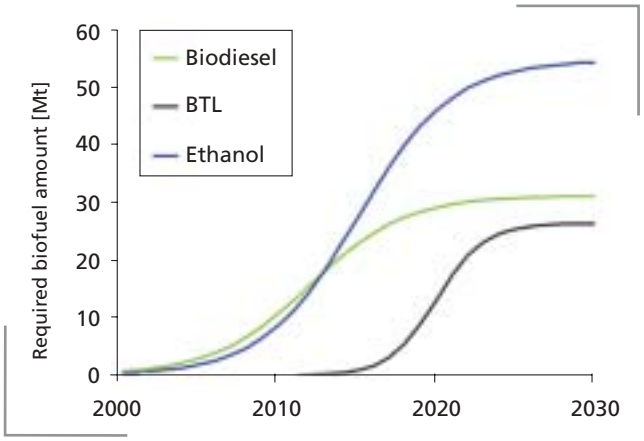


Biofuel of the Next Generation – Synthesis of n-Butanol from Ethanol

greasoline® – Biogenous Waste Grease as Raw Material for Diesel and Gasoline Components

# Biofuel of the Next Generation – Synthesis of n-Butanol from Ethanol






Forecasted demand for bio-based fuels.

The EC-Guideline 2003/30/EC (Bio Fuel Guideline) sets benchmarks for the addition of biofuels as a replacement of conventional fuels in the transportation sector. In order to achieve these benchmarks, bioethanol is already a widely used gasoline additive. It is expected that the demand for n-butanol as a biofuel gasoline additive of the second generation will increase significantly because it exhibits the following advantages compared to ethanol:

- Higher energy density (nearly the same as gasoline)
- Lower solubility in water (thus also transportable in pipelines)
- Unlimited miscibility with gasoline (associated with that the possibility for direct mixing with gasoline at the refinery)
- Lower vapor pressure

The goal of this project is not the fermentative production of n-butanol from ethanol which is available utilizing renewable resources. The supply of

Catalyst



bioethanol in the global market is currently growing and is widely expected to increase even further in the future due to the utilization of cellulose as a raw material.

As opposed to the fermentative production of n-butanol, elaborate product purification and the risk of mutation of the utilized bacteria strains is to be avoided. There is already a pressureless heterogeneous-catalytic route using ethanol as source material described in the literature. This process is to be developed further through the advancement of alternative, improved catalytic methods. Furthermore, process simulations and cost estimates based on them are planned. Most of the catalysts will be manufactured in-house and, if possible, a reference catalyst will be purchased.

Based on the results of the work, a strengthening of the market for biological fuels as replacement for conventional gasoline is expected. Additionally, butanol is used as a solvent for paints. Given successful conclusion of the work, this would also represent another solution based on renewable resources.

The project is financially funded by the RWTÜV-Foundation.

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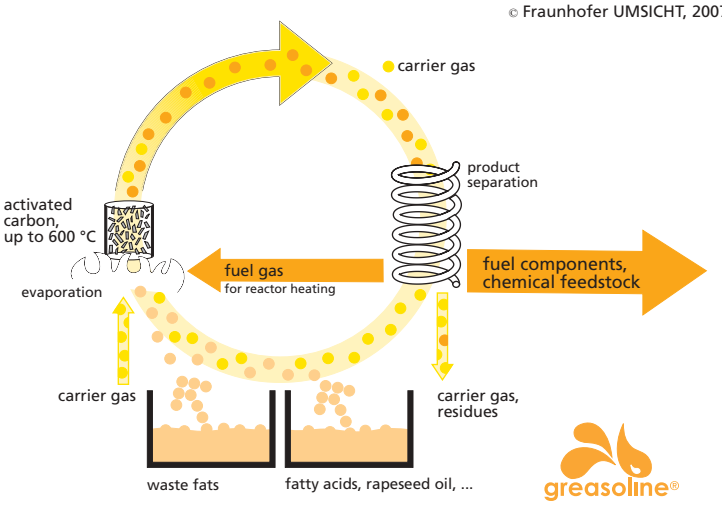
# greasoline® – Biogenous Waste Grease as Raw Material for Diesel and Gasoline Components



The use of silica or alumina-based catalysts is known for the catalytic conversion of biogenous fats and greases to long-chain hydrocarbons and simple aromatic compounds. The utilization of activated carbon as catalyst with simultaneous steam addition represents a promising alternative.

Using fat evaporation and a pyrolytic catalysis in a fixed bed reactor (at atmospheric pressure and a temperature of up to 500 °C), followed by thermal product separation, diesel, kerosene, or gasoline like distillation cuts are produced. These can be used as fuel source materials but also potentially as raw materials in the chemical industry. Steam can be added as an additional reactant, for example to reduce coking or to extend catalyst lives. The glycerol byproduct of the source grease is internally converted into gaseous products and, together with short-chained cracking products of the fatty acids, can be utilized to cover the thermal energy




greasoline®-Process



demand of the process entirely or partially depending on process control.

The product characteristics and yields of the diesel and gasoline fractions are primarily influenced by the characteristics of the activated carbon as well as the residence time in the catalyst bed and the other hot plant sections. Thus, liquid products with a diesel content of more than 60 % by weight can be achieved at temperatures of 450 °C; at significantly higher temperatures, the liquid properties are more similar to the composition of gasoline.

Using gas chromatography, the composition of the reaction products could be largely matched with commercial diesel which fulfills the EN 590. However, it will be necessary to remove the still present short-chained hydrocarbons.

The project was completed with the financial support of the European Commission and the State of Mecklenburg-Western Pomerania.
Up-to-date information can be found at www.greasoline.com.

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"There are 20 million known chemicals. Thus, material innovations do not emerge from new materials but by the smart combination and structuring of available materials. Our approach: We develop functional micro and nano particles in order to functionalize polymers!"

[Dipl.-Ing. Jürgen Bertling, Business Unit Manager Advanced Materials]

On the basis of your requirements, latest findings in material research or inspirations from nature we develop strategies for new materials and test their industrial practicability under ecological and economical aspects.

One major focus is the modification and functionalization of thermoplastics, wood and leather with functional additives, nano or microscale particle systems or hydrogels. Matrix materials are modified and processed in laboratory and industrial scale with the help of innovative technologies and industrially established processes. On the basis of virtual and real specimens or prototypes we use intelligent simulation and testing procedures to examine the appropriateness of the respective materials for their special applications.

# Advanced Materials



Spherical Nano Composite Particles – Polymer Processing under High Pressure

Rodentics – Self-Sharpening Cutting Tools

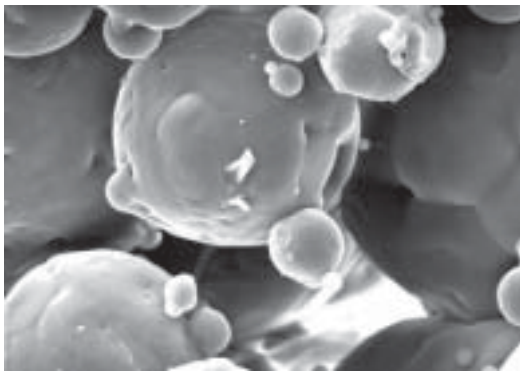
Soft Touch Surfaces

European Center for Elastomeric Powders euCEP

# Spherical Nano Composite Particles – Polymer Processing under High Pressure



Plastic powder for coatings and laser sintering processes



Nano composite particles

Pulverized, thermoplastic nano-composites exhibit many application options. However, the powders, which are mostly produced through cryogenic grinding, do not represent the optimal material solution for every application. Especially in the currently expanding market segment of powder coating and rapid prototyping, spherical particles with optimum flow characteristics are required. However, conventional comminution of plastic granules is more likely to generate inhomogeneous particles with sharp edges which influence the flow characteristics and thereby the suitability of the corresponding nano composite powders.

The business unit Advanced Materials is currently developing an integrated process, which enables the use of super critical carbon dioxide ($scCO_2$), to generate flowable powders with spherical nano composite particles directly following compounding. A high pressure injection unit was constructed in-house for that purpo-

High pressure injection unit



se which can be used on an existing extruder in a modular fashion. With the help of the $scCO_2$, which dissolves in the melt, the melting point is lowered, the polymer liquefied, and the material transport sped up. This improves the dispersion of the nano particles and also allows the extrusion process to occur at milder temperatures. The Joule-Thomson effect creates a sudden cooling during the subsequent spraying of the melt which retains the drop structure of the liquid polymer, i. e. spherical particles. On one hand, this process eliminates the costly additional cryogenic grinding step, while, on the other hand, a product is created that is suitable for demanding modern technologies.

Based on the spherical particle shape, markets for the utilization of pulverized nano composites can be developed and existing applications can be optimized. The powders currently available on the market for the use in coating or rapid prototyping processes are subject to significant material-related restrictions. Especially nano composites, which combine good friction reducing properties with high wear resistance, are undeveloped for such applications. Due to this process development, it can be assumed that the market for polymer powders will expand to polymeric nano composites not only because of the reduced production costs.

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# Rodentics – Self-Sharpening Cutting Tools

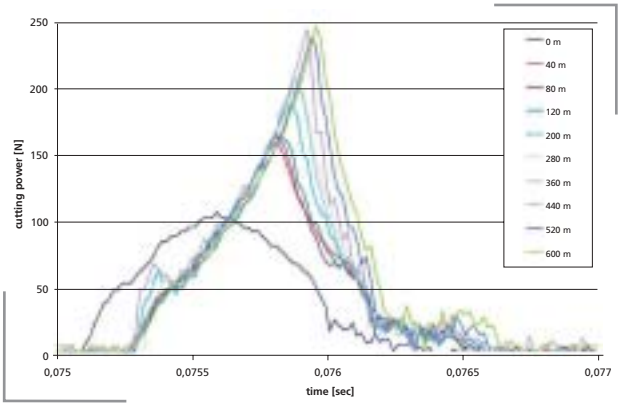


Pilot plant for the controlled wear of cutting tools

Almost all objects of daily life are cut during their production process: plastics, textiles, wood, paper, and even glass. Prerequisites for an effective and clean cut are sharp knives. Based on abrasive[1] wear mechanisms and high dynamic loading on the cutting edge, knives become dull. In some processes, the knives therefore have to be exchanged after a few hours. The plant designed for high throughput is down and often as a result all up and downstream processes.

The business unit Advanced Materials tries to improve the durability and life expectancy of the cutting tools by other means than harder high-performance materials. Due to the intelligent combination of harder and softer zones, the tribology[2] of the cutting process can be laid out in such a manner that the existing abrasive forces cause the sharpening of a cutting edge. The self sharpening incisors of rodents served as a model for this solution. Behind this is the Rodentics®-effect.


Cutter drum for the cutting of printing products (presentation as part of the "BMBF-Bionik-Wettbewerb" 2007 (BMBF-Bionic-Competition) in Berlin)




Change of the cutting force characteristics



So how does wear occur during cutting anyway? Which material options exist for the influence of the tribology? What influence do geometric boundary conditions have in this context? In order to answer these questions, a pilot plant was developed. Extensive know-how on the correlation of the cutting geometry, cutting force characteristics, and abrasive mechanisms on the highly dynamic cutting process was developed on it in 2007.

The findings were implemented in numerous industrial processes. Based on extensive cutting tests in a printing business, prototypes of self sharpening knives for the cutting of paper were tested. They are characterized by an innovative layering system which was applied to the free surface of the cutting tool by Fraunhofer IST. Market introduction is planned for 2008.

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[1] Abrasive wear = Wearing off of surfaces via grinding media

[2] Tribology encompasses the scientific description of friction, wear, and lubrication as well as the development of technologies for the optimization of friction processes.

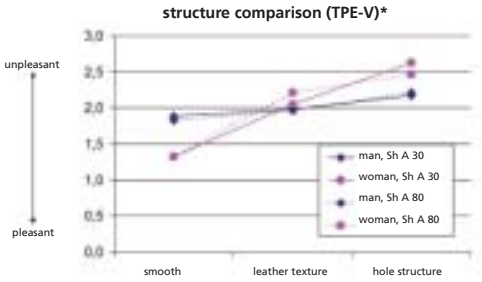
# Soft Touch Surfaces



Due to their characteristic profile, surfaces made from TPE offer many advantages compared to conventional surfaces and coatings. They not only entice the senses through their matt, esthetic optics and warm, "soft" feel, but also distinguish themselves through their excellent mechanical characteristics and simple processing.

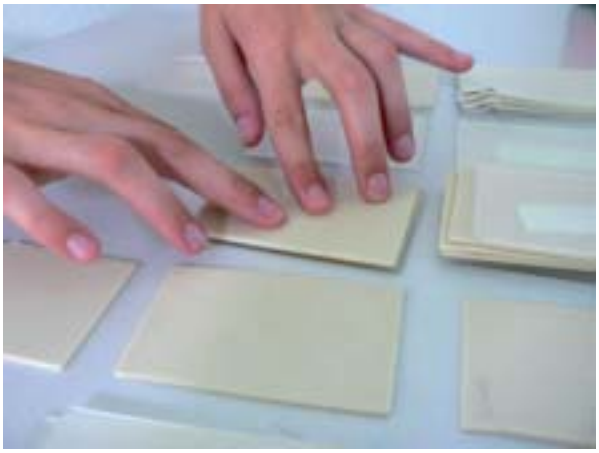
An extensive consumer test generated a scientific basis about the individual tactile perception and reaction to specific material samples. This feel-test differentiated age groups and genders and researched the reaction to different base materials, structure characteristics, and shore hardness. These factors were judged in relation to topography, grip, hardness perception, and emotional impressions.

Based on the previous results, the exploratory study was accompanied by surface and material development in the form of innovative test objects.




Materials are perceived differently in their hardness based on gender; the higher the shore hardness value the harder the material.

*Cross-linked thermo-plastic elastomers based on olefines



Consumer test



Aside from the strictly functional side in plastics development, esthetic dimensions were considered in equal measure.

The methodology developed during the previous work and the results form the basis for additional surface research. The developed know-how can be applied on commodities in the field of consumer goods as well as the automotive industry and consumer electronics.

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# European Center for Elastomeric Powders euCEP



Rubber granulates and fine rubber powders have major potential in terms of possible applications. In the past, rubber granulates were in the best case used for secondary products such as sports surfaces. Now, rubber granulates are increasingly being recognized as high-quality raw materials or as components of new raw materials. The goal of the European Center for Elastomeric Powders (euCEP) is to optimize the added value in recycling of elastomers by means of a systematic analysis of the topic.

One is familiar with elastomers or rubber from technical applications – so called general rubber goods (GRG) – such as treads, seals and insulation materials. What is new is the development in material recycling of GRG, which is making increased added value possible. In the past, rubber granulates were regarded only as cheap, recycled raw materials. Now, rubber granulates are increasingly developing into functional additives

The project is being financed by the EU program INTERREG IIIA of the euregio rhine-maas-north and by the ministries for economic affairs of the Netherlands and North Rhine-Westfalia.

Gecofinancierd door het EU-programma INTERREG IIIA van de euregio rijn-maas-noord en door de ministeries van Economische Zaken van Nederland en Nordrhein-Westfalen.



in the modification of thermoplastics, lacquer, paint and coatings and as raw materials for the development of new – high-quality – applications.

With the goal of building up a European centre of competence for recycling of rubber and production of rubber granulates, and to do practical research into the recycling of GRG and subsequent use of rubber granulates, the Fontys Technical and Management College in Venlo and the German research institute Fraunhofer UMSICHT in Willich have started an alliance.

The project comprises capture and cataloging of elastomer residues from production waste, development of logistics concepts for segregated collection of elastomer residues to assure quality, research into cryogenic and ambient comminution methods, physical/chemical characterization of elastomer powders and granulates, building of equipment and systems for technical analysis of elastomer powders and granulates, and physical/chemical characterization of base materials modified using elastomer powders and granulates.

Additional information can be found at:
www.eucep.de

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european center for elastomeric powders

"Every five years the world-wide accessible knowledge doubles.
Intelligent target group-oriented information management can help to quickly separate relevant from non-relevant information and thus plays a central role in today's production value added chains."

[Dipl.-Phys. Thorsten Wack, Business Unit Manager Information Technology in Process Engineering]

According to forecasts of the EU Commission 80 % of technologies applied today will be substituted by new technologies within the next 10 years.

Value added chains in companies are closely connected to the supply of information. Often, optimizations cannot be realized without a sufficient data pool.

The close linking of operational processes to specific organizational and technical information in connection with ergonomic user interfaces bridges existing information gaps. For this purpose service-oriented architectures (SOA) are created and provided in form of application service providing (ASP) which enables the access from any location and from any client.

# Information Technology in Process Engineering



Hazardous Material – Management and Information System GEVIS II

Hazardous Material Storage – Optimization of Logistics and Security

Ecological Aspects of Server Based Computing and Thin Clients

# Hazardous Material – Management and Information System GEVIS II




When dealing with hazardous materials, many things have to be paid attention to. For example, it is important to know which material is classified as hazardous, how appropriate measures reduce risks during storage, transport, and handling of hazardous materials, etc. The software system GEVIS ll developed by Fraunhofer UMSICHT can help with these and other issues.

Approximately 42 institutes of the Fraunhofer-Gesellschaft work with hazardous materials. So far, about 21 500 materials and 15 000 manuals have been administered by the software system GEVIS. The new software edition, GEVIS II, is characterized by a centralized, failsafe SBC[1] architecture which provides a client sided (institute or location related) presentation level. The utilized software cell architecture affords flexibility with regards to reacting to changes in the GefStoffVO2 as well as the workflow. An ergonomic and intuitive user guidance via a web




front-end makes access to the relevant information for specific jobs and the associated hazardous materials much easier for the employees of the individual institutes.
During the hardware technology realization, special care was taken to provide the highest performance and availability to the users. The local requirements at the institutes could be decreased to a minimum level. The implemented SBC solution does not require any changes on the network structure or firewall configuration at the institutes.

Special attention was paid to the user administration which, according to a certificate of the Fraunhofer-Gesellschaft, provides a transparent representation of the user under consideration of the corporate directory after login. Thus, no additional account data (user name, password) is required. Security is ensured via the use of SSL-VPN based on the certificates of the Fraunhofer-Gesellschaft.

After the successful Fraunhofer-wide launch of the system, continous development in the fields of plant permitting and documentation are being worked on based on GEVIS II. The highly scalable layout and the granular role specification provides the basis for a documentation and information management tool which supports collaboration between groups involved with plant planning in the best possible way.

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[1]SBC = Server Based Computing

INFORMATION TECHNOLOGY IN PROCESS ENGINEERING

# Hazardous Material Storage – Optimization of Logistics and Security




During the storage of hazardous materials, the storage facility operator has to pay attention to numerous logistical and legal requirements. Especially in storage facilities with broad ragnge of hazardous material, conflicts between the economic (logistics) and legal (safety technology) goals can arise at times which can only be optimally solved by utilizing appropriate software systems for the storage facility operator. Currently, these systems only offer support for meeting the logistical requirements. The legal requirements have to be identified and tested for each hazardous material separately. Particularly, small and medium-sized enterprises (SME) are having difficulties with this because they do not have the necessary experts at their disposal. Additional problems arise when time periods with parallel regulation occur as it will between 2008 and 2015 with the "Globally Harmonised System" (GHS).

As part of the research project "Development of an assistance system for the



enabling of environmentally sound and economically viable hazardous material storage“ of the German Federation of Industrial Research Associations “Otto von Guericke“ e. V. (AiF), Fraunhofer UMSICHT is compiling the regulatory requirements for hazardous material storage in the form of rules. In cooperation with Fraunhofer IML, a suitable structure is being developed which allows the coupling of the developed body of regulation with the commercially available storage administration software. Thus, the software is enhanced to consider the legal requirements in addition to logistics for the storage of hazardous materials. Additionally, the combined software-supported assessment of legal and logistical requirements allows the simulation of future storage occupancy scenarios. If legal requirements prohibit the storage of individual materials (e. g. insufficient ventilation), the operator can determine the necessary modification of the storage facility under consideration of the existing storage situation with the support of the software. The output of the data is accomplished with 2D and 3D visualization methods. The connection to existing storage administration systems is simple due to the utilization of service oriented architecture.

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# Ecological Aspects of Server Based Computing and Thin Clients

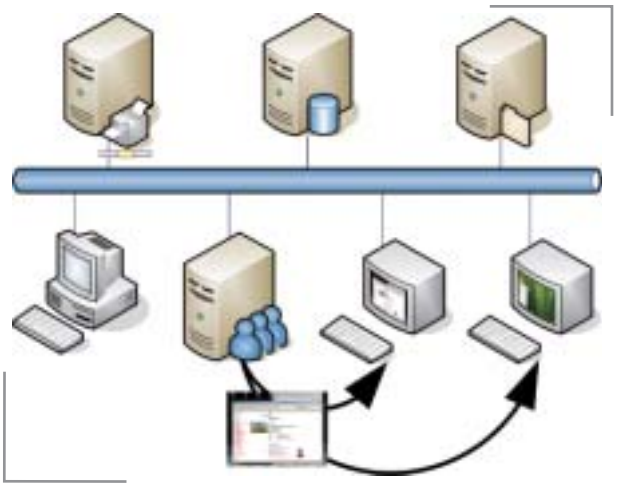


Since the use of Thin Clients and Server Based Computing is less material intensive, the electronic waste mountain is also smaller.

(Photo: IGEL Technology GmbH)

The principle of Server Based Computing has been known since the early days of the computer age. Back then it was typical that very expensive resources such as processors and memory were provided on few central servers. The users accessed them via text-based terminals without any own computing capacity. Under the aspect of operating cost minimization, this classic concept is once again getting attention.
Of course, the terminals of today – also referred to as Thin Clients – have graphical user interfaces and, thus, combine the known comfort with a maintenance friendly, centralized operating concept.

Since recent reports concerning the changes of the global climate are calling for immediate action more than ever before, the environmental aspects of IT systems are also being discussed more. Contracted by the manufacturing company IGEL Technology GmbH, Fraunhofer UMSICHT investigated



Terminal servers execute programs centrally and transfer the monitor content to their clients.



the manufacturing, use, and disposal phases of Thin Clients as compared to conventional personal computers already in 2006. The results showed that Thin Clients already lived up to their names in the production period. They only weigh about one third of a PC and require only about 11-20 % of the space – a decisive advantage, which translates into lower transport requirements and significantly less electronic waste at the end of the life cycle. The Thin Client is also environmentally friendly during the operating phase. Even when considering the operation of the required terminal server and its climatization, the electricity savings of up to 50 % are achieved compared to a PC. On the basis of new production data which were published in 2007, a follow-up study is to investigate detailed numbers for material and energy intensity of the entire production cycle in the context of an ecological balance. It is planned to present the study at the CeBIT 2008.

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"Fuels from biomass and waste will play an important role in future energy supply. The central task of research and innovation must be to effectively treat and utilize materials and energy, to save resources and to avoid emissions."

[Dr. rer. nat. Thomas Marzi, Business Unit Manager Energy Technology]

The objective of our work is an application-oriented development of energy conversion plants for efficient and economic power, heat and cold supply. We use our competencies in the fields of energy conversion, renewable energy sources and "waste to energy/biomass to energy" in order to successfully position our customers in the dynamic energy and waste market.

Our work focuses on the treatment, combustion and gasification of heterogeneous material mixtures as well as on the extraction, cleaning and utilization of biogases and low BTU gases and their utilization in local combined heat and power plant systems.

# Energy Technology



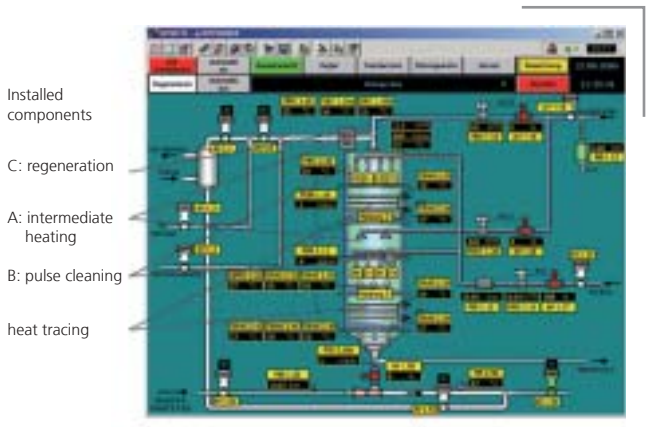
Long-Term Test for Tar Reforming Catalyst

Material Handling und Firing Related Technical Parameters of Refuse Derived Fuels

Feed-in of Biogas into the Natural Gas Grid

# Long-Term Test for Tar Reforming Catalyst






Screenshot of the process visualization

Gasification of woody biomass is a promising technology for combined heat and power generation. Despite extensive research activities of several working groups in Europe and around the world, the commercial breakthrough of this technology still has not occurred yet. One technical hurdle that has not been satisfactorily solved until now is associated with the tar content of the product gas which causes deposits in the cooler areas of the plant and can ultimately lead to complete plugging. The catalytic reforming of the tars in the hot gas stream is an elegant solution for this problem since it converts the tar molecules into smaller molecules which are equivalent to the main components of the gases. In contrast, other approaches for the removal of tar from product gas generate a waste stream that is difficult to dispose of.

Photo of the catalytic tar reformer at the biomass power plant in Güssing, Austria and a detailed view



Fraunhofer UMSICHT developed and demonstrated this technology up to application readiness in their own pilot plant for biomass gasification in the past. Now, the catalyst for tar reforming will be tested under realistic, industrial conditions in a long-term test. For that purpose, a test reactor was installed at the biomass power plant in Güssing, Austria, which generates electricity and heat from wood chips on the basis of allothermic gasification. A small slip stream of the gasifier product gas is fed into the test reformer where the tar is removed through reformation after which it is mixed back into the main stream. The pilot plant is completely automated without any required operator interference. It can be monitored from Oberhausen via phone line. The cleaning effect of the reformer is regularly tested by frequently sampling upstream and downstream of the reactor by the project partner, the Technical University of Vienna. A test duration of 4 000 operating hours is forseen.

The project is funded by the Fachagentur Nachwachsende Rohstoffe e. V. (FNR) (Agency for Renewable Resources) under the funding reference 22013402.

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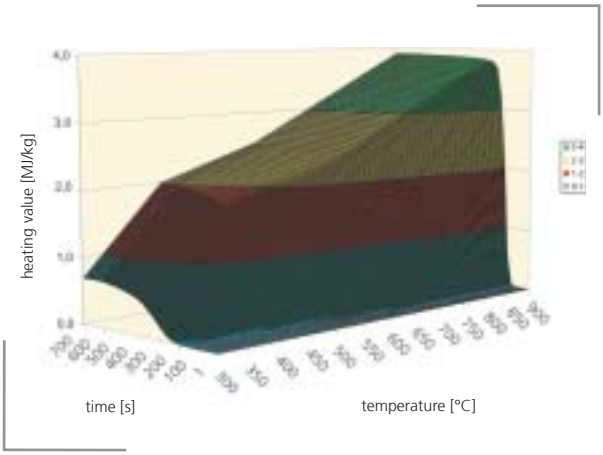
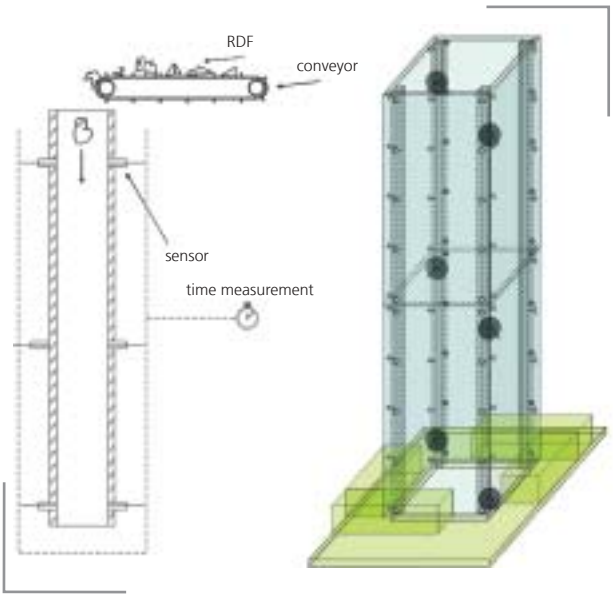
# Material Handling and Firing Related Technical Parameters of Refuse Derived Fuels






Heating value of the volatiles of a fuel depending on time and ambient temperature

The utilization of fuels from processed municipal waste represents an important contribution to sustainable development with the resources available to us. In order to research the aerodynamic behavior of these fuels, which are often conveyed pneumatically, Fraunhofer UMSICHT, in cooperation with Di Matteo Förderanlagen GmbH, has developed a new process. The combination of special sink velocity determination chute and crossflow classifier with laboratory generated data on the combustion process allows the assessment of the fuel burnout completeness of the fuels dependent on the trajectory. This is important, for example, in rotary kilns in the cement industry or in anthracite power plants in which refuse derived or secondary fuels are co-fired. It is planned to standardize individual process steps.




Special sink velocity determination chute of the sink rate of the coarse particles



The laboratory processes to research the combustion processes of heterogeneous fuels encompass mass and heating value determination of the released volatile compounds depending on the ambient temperature and the kinetics of the $C_{fix}$-burnout. These methods, developed at Fraunhofer UMSICHT, are currently being applied in several areas of fuel characterization such as the assessment of cement kilns, but also for the modeling of grates for municipal waste combustion plants.

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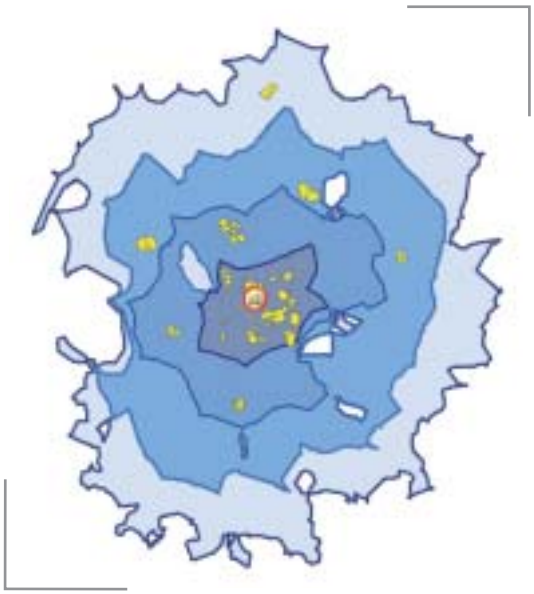
# Feed-in of Biogas into the Natural Gas Grid

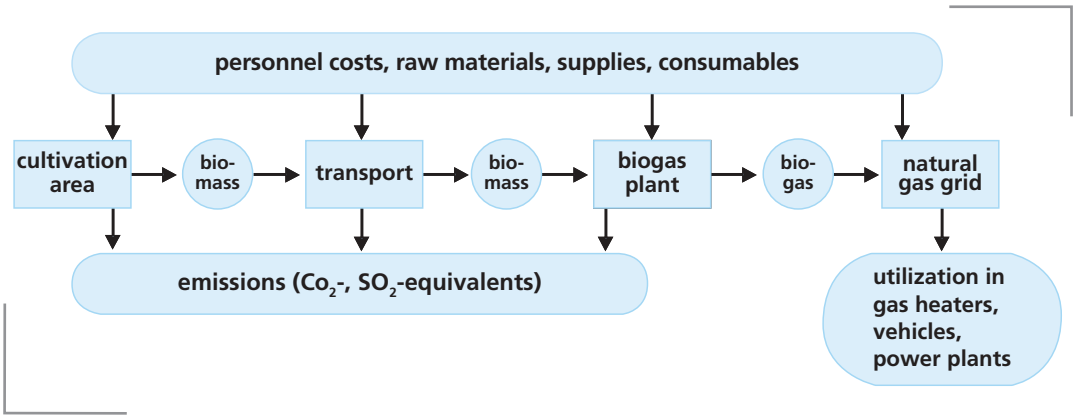




Determination of location-specific biomass potentials on the basis of natural characteristics of real areas.

The generation and utilization of biogas exhibit a great potential for the best possible energetic biomass utilization and thus for the optimum climate protection. As part of the project »Biogas Feed-in« of the Federal Ministry for Education and Research (BMBF), seven partners are researching the realistic possibilities and potentials of biogas feed-in by identifying constraints for generation, processing, feed-in, and distribution of biogas via the natural gas grid, and for developing approaches for mitigating them. The work focuses on the creation of a geographic information system (GIS). The tool combines (geo)-data with biomass potentials for location identification and transport logistics with analysis tools for the planning of biogas plants under consideration of the current land use, area-specific sector planning as well as infrastructure for users.

An interdisciplinary team of economists, ecologists, engineers, lawyers,




Biogas feed-in – material flows



and geographers are investigating the chosen model regions with regard to

- the nature and location-related biomass potential for a sustainable energy crop cultivation,
- the climate protection potential of the biogas feed-in technology option,
- the optimization of locations for biogas plants, the biomass transport logistics, and the potential feed-in points under consideration of infrastructure (traffic, natural gas grid),
- the consequences of biogas feed-in on the natural gas grid,
- the political, legal, and socio-economic boundary conditions of a sustainable biogas utilization as well as
- the required technologies for the generation, processing and feed-in of biogas.

The goal is to provide a technology guide for the generation and processing of biogas as well as tools for a wholistic scenario evaluation and strategic assessment of different biomass utilization options on the topics of climate change, regional added value, sustainable land use, and economic considerations.

**Project partners**
Fraunhofer UMSICHT,
Oberhausen (Project coordination)
alta4 Geoinformatik AG, Trier
Ruhr-University Bochum, Institut für Berg- und Energierecht, Bochum
E.ON Ruhrgas AG, Essen
University of Magdeburg, FB Wasserwirtschaft, Magdeburg
Institut für Energetik und Umwelt gGmbH, Leipzig
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"Industrial societies need energy. In order to guarantee a sustainable and economic supply of more efficient energy plants for energy conversion and storage must be developed and integrated optimally into already existing supply systems."

[Dr.-Ing. Christian Dötsch,
Business Unit Manager Energy Systems]

Our objective is the intelligent integration of energy systems into existing and new supply structures as well as their efficient utilization. We combine fossil and regenerative energy sources with central and local conversion processes in order to create custom-made, economically and ecologically balanced systems which pave the way for local synergies.

Local regenerative polygeneration plants combined with district heating networks already represent such integrated systems: On the one hand, they open up the possibility of economic and $CO_2$-neutral heating and cooling, and, on the other hand, they provide competitive products for the electricity market as a "virtual power plant".

# Energy Systems



Development of a Small ORC-Process for Converting Gas Engine Waste Heat into Electricity

Storage Technology for Electric Energy for Improved System Integration of Renewable Energies

Exergy Efficient Energy Systems

CryoSol$^{plus}$

# Development of a Small ORC-Process
## for Converting Gas Engine Waste Heat into Electricity

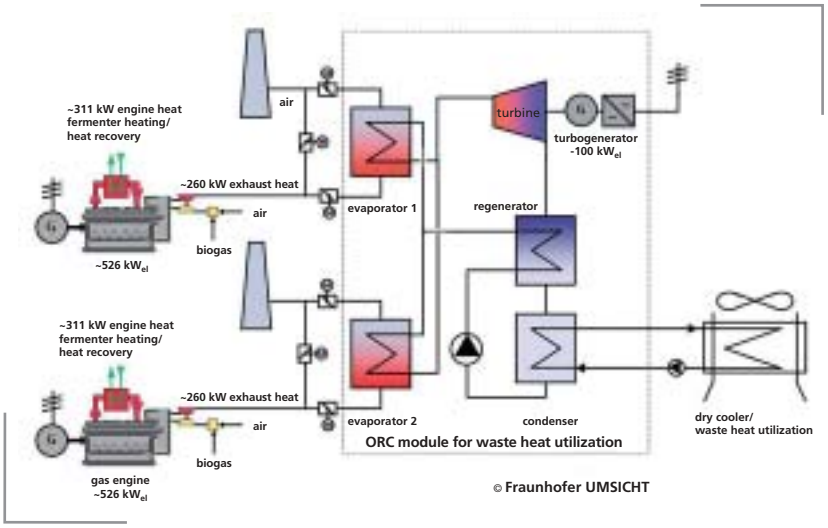


View of the pilot ORC module

New energy efficient technologies for the conversion of small streams of heat/ waste heat at a relatively low temperature level into high quality useful energy, especially electricity, are subject to a great amount of interest.

In the electricity generation capacity range of 300 to 2 000 $kW_{el}$, the ORC-process[1] shows particular economic promise. It is a steam power process with an organic working fluid[2]. The unique advantages of the technology are the multitude of suitable heat sources and the relatively high efficiency.

Thus far, ORCs are only offered above capacities of 300 $kW_{el}$ by a small number of providers, especially for wood-fired combined heat and power plants and geo-thermal power generation. The strong and currently unmet market demand for smaller ORCs (e.g. for waste heat utilization from CHPs) exhibits the potential for the development of (waste) heat power generation in the capacity range below 300 $kW_{el}$.




ORC process 100 $kW_{el}$, selectably driven by exhaust gas heat of up to two biogas engines of approximately 500 $kW_{el}$
(Pilot project Wasmerslage Agricapital AG/Fraunhofer UMSICHT)



Therefore, Fraunhofer UMSICHT, in cooperation with medium sized partners, has conceptualized a scalable ORC process for the utilization of waste heat from biogas engines as part of an AiF-NEMO-project. Based on in-house research and cooperation with Cyplan Ltd. and GE Jenbacher, a prototype with approximately 100 $kW_{el}$ design capacity with an efficiency of 18.3% was developed, installed at a biogas plant by agri. capital GmbH, and put into operation in August 2007. Following commissioning, the plant has exhibited an efficiency of 13.5 % at a partial load of 60 $kW_{el}$, and is currently running on automatic operation and going through CE certification.

The next development phase shall include process optimization to achieve increasing capacity and efficiency as well as lowering the specific investment costs. Fraunhofer UMSICHT is pursuing the extension of the capacity range to approximately 30 to 300 $kW_{el}$ so that electricity can be generated efficiently from engines between approximately 300 and 3 000 $kW_{el}$. Fraunhofer UMSICHT is also working on modifications for the application of the ORC process for small solid biofuel firings, MCFCs[3] or micro gas turbines and on the development of adequate solutions for low-level waste heat for the utilization of engine cooling cycles or solar thermal drives.

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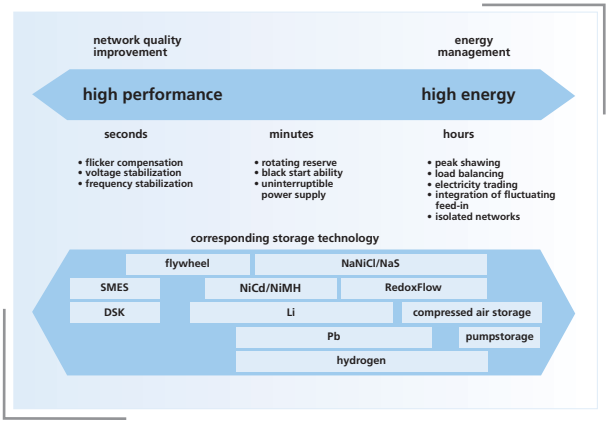
[1] ORC = Organic Rankine Cycle
[2] Organic working fluids e. g. paraffins, aromas, alcohols, silicone oils; adapted to the temperature regime of the process cycle and the waste heat source
[3] MCFC = Molton Carbonate Fuel Cell

# Storage Technology for Electric Energy for Improved System Integration of Renewable Energies






Application field of various storage technologies

Supply and demand rarely coincide. This statement also holds true in the energy industry, especially in power supply.

The feed-in of renewable energy funded and requested by the EU and German government has the consequence that an increasing portion of the power supply is provided by decentralized, regenerative energy sources with fluctuating generation (solar, wind). The current power supply network is set-up for "vertical" operation on the basis of centralized, large power plants. Due to the increasing decentralized and fluctuating feeding into the low and medium current networks, sub-grids are reaching their transfer capacity and stability limits, and renewable energy generation plants have to be turned off today.

The storage of electric energy exists in many different storage technologies




at various stages of development. The important criteria for these are costs, availability, energy and performance density, efficiency, durability, dynamic response. Based on these differences there are ideal applications or system services for each storage technology. Storage in the capacity range of 0.1 to 10 MW with a storage discharge period of several hours are primarily used for the smoothing of fluctuating feed-in of renewable energy (see figure 1). This application range is exactly what Fraunhofer UMSICHT is focusing on.

The business unit Energy Systems is leading a Fraunhofer-Gesellschaft project (Partners: AST, ICT, ISE, ISI) for the development of new storage technologies for electric energy. Aside from the corresponding capacity range and storage discharge period, only storage system solutions are being developed which enable an independent scalability of performance and work for the storage device. In this manner, it can be ensured that the storage device can be flexibly adapted to the local situation of supply networks with a high degree of fluctuating feed-in.

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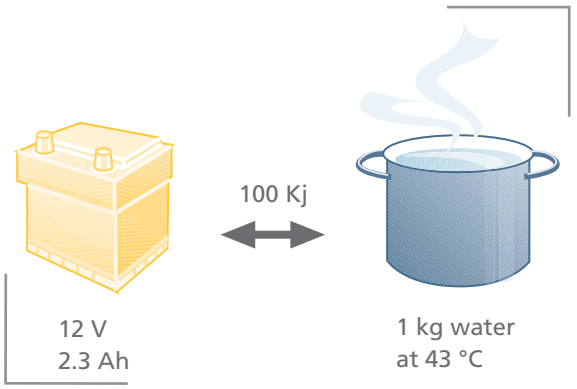
# Exergy Efficient Energy Systems



LowEx – Using primary energy in the best possible manner

While the energy efficiency of machines and processes is widely discussed nowadays, the integral optimization of energy systems has only begun. A promising starting point for the identification of efficient solutions is an exergy analysis.

In a simplified way, exergy describes the ability of to generate work that can be associated with an energy transfer. For example, electric energy always has a high specific exergy, whereas heat at decreasing temperature levels is associated with declining specific exergy. Therefore, space heating requires only comparably small amounts of exergy, despite a relatively high energy demand. The goal of an exergy optimization (LowEx) is to provide all energy streams at the exact level of specific exergy at which they are required. In this manner, processes can be optimized and all primary energies are used in the best possible way.




Same energy, different possibilities



On this basis, the combination of energy generators/converters, energy networks and users is being investigated in order to match exergy supply and demand as part of the project "LowEx für Fernwärmebestand und LowEx im Fernwärmeneubau (LowEx for existing and newly-constructed district heating networks)" (funded by BMWI – Ministry for Economy). The focus lies on the application of technology available on the market to incorporate renewable and fossil energies into a centralized heating and cooling system.

During the project "Fernwärme in der Fläche (Rural District Heating)" (BMWI funded), Fraunhofer UMSICHT, in cooperation with GEF (Leimen), and (Fernwärme Niederrhein (District Heating Niederrhein) investigated under which conditions heating networks can be commercially viable in less densely populated areas. The results are summarized in "Handbuch zur Entscheidungsunter-stützung – Fernwärme in der Fläche (Guidebook for Decision making – Rural District Heating)". The results showed that an economically viable operation of a pipe-based district heating network is possible even away from urban areas by taking advantage of the specific characteristics of rural areas such as large unsealed areas and the regional availability of renewable resources.

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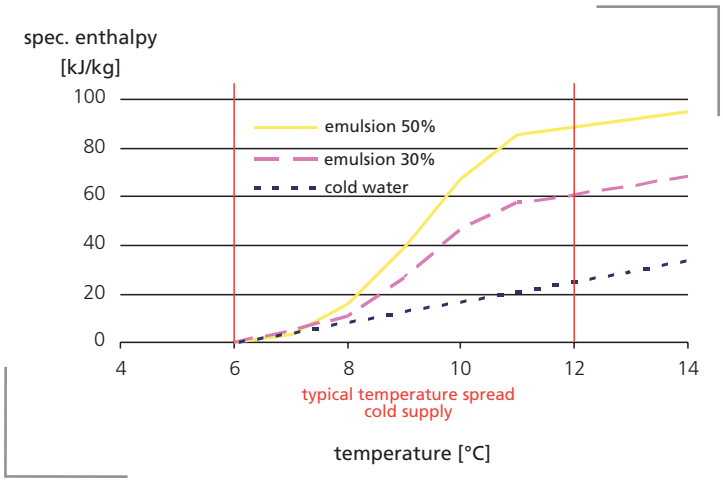
# CryoSol$^{plus}$



Cold storage medium CryoSol$^{plus}$

Thermal energy storages are becoming ever more important in today's energy systems. The non-synchronized load behavior of energy demand and supply associated with fluctuating energies (solar energy) or energies difficult to regulate (waste heat) creates the need for energy storage. In addition, energy storage is indispensable for the coupling of thermally driven chillers and CHPs, which to gives this efficient energy supply the necessary degree of freedom.

So far, mainly simple, water-based storage systems are available in the market. The achievable energy density in these systems is dependent on the temperature difference which can be used for storing the heat amount. This temperature difference is particularly low in cooling networks. In addition to sensible heat, latent storage systems utilize the latent heat during a phase changing process which enables the realization of much higher energy densities.




Specific enthalpy change to compare heat capacities:
CryoSol$^{Plus}$, 30 % and 50 % by weight (paraffin) and water



For example, ice storages are used in cooling networks as latent storage system.

However, the important field of building air conditioning in the temperature range of 6 to 18 °C cannot be adequately serviced by these ice storages, because the systems are requiring a working temperature below 0 °C. Fraunhofer UMSICHT is currently intensively developing the innovative storage medium Cryosol$^{plus}$. It is based on an emulsion of PCM (Phase Change Material: paraffin) in water. The storage medium CryoSol$^{plus}$ utilizes sensible and latent heat for energy storage.

By choosing an appropriate PCMs, the temperature range phase changing can be virtually chosen freely to suit the intended application.

Significantly higher energy densities can be achieved with CryoSol$^{plus}$ which results in a reduction of storage volumes.

Even in a "frozen" state, it remains liquid so that it can not only be used as storage medium but also as a cold transfer medium in cooling networks.
Therefore, CryoSol$^{plus}$ can significantly increase the storage and transport capacity and avoid "bottlenecks". Fraunhofer UMSICHT, in cooperation with Fraunhofer ISE, is currently testing CryoSol$^{plus}$ on a pilot plant scale.

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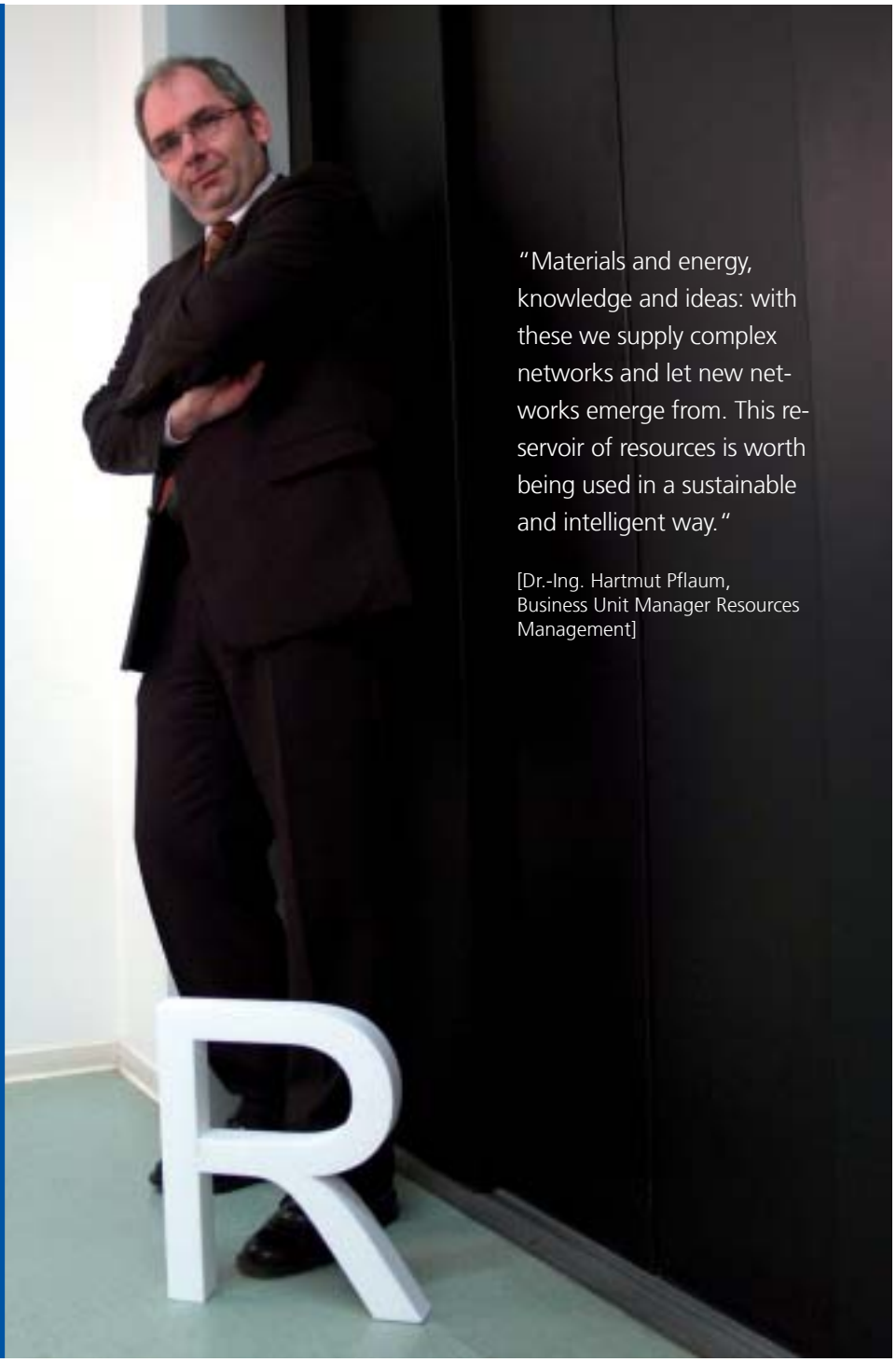


"Materials and energy, knowledge and ideas: with these we supply complex networks and let new networks emerge from. This reservoir of resources is worth being used in a sustainable and intelligent way."

[Dr.-Ing. Hartmut Pflaum, Business Unit Manager Resources Management]

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

We combine modern management instruments with the know-how on resources and technologies. The results enter into strategic studies and consulting services focussing on resources management, waste management, renewable energies and innovation management. Thus, technical and infrastructural processes and procedures can be optimized.

# Resources Management



Renewable Energies in Central and Eastern Europe: Market and Innovation

Utilization of Renewable Raw Materials on the Example of the German State of Mecklenburg-Western Pomerania

Cost-Benefit-Analyses in the Waste Management Sector

# Renewable Energies in Central and Eastern Europe: Market and Innovation



Participation of Fraunhofer UMSICHT in the round table talks at the stand of the Ministry of Education and Research at the POLEKO 2007 in Poznań

The new member states of the European Union in Central and Eastern Europe have high potentials for the utilization of renewable energies. The applications already in use are power generation from water, heat generation through energetic wood utilization as well as geothermal energy for balneological therapies. As the European Union has set ambitious targets for the utilization of renewable energies, and the new member states themselves are intensely striving for a reduced dependency on imports in the energy industry, the sector of renewable energies has experienced a remarkable upswing. This becomes evident, among other, in the annual increase of the share of renewable energies of the total primary energy demand. Accordingly, the amount of energy generated by renewable energies has grown over the past few years, e. g. in the Czech Republic, by an annual rate of roughly 10 percent.

As a result, the CEE countries demonstrate high readiness, also in collaboration

Energy plants plantation with *Miscanthus sinensis,* Company Parképitö RT., Tata, Hungary

Preparatory culture (meristem culture) of *Miscanthus sinensis*, Company Parképitö RT., Tata, Hungary



with experienced partners from abroad, to develop new application fields for renewable energies and/or to investigate innovative technologies in order to open up market potentials for an increased share of renewable energies. The implementation of innovative technologies requires, in addition to experienced partners from industry and research, suitable tools to control and prevent the imminent risks of innovations.

A platform has been developed by the Fraunhofer MOEZ Centre for Central and Eastern Europe titled "Central European Platform for Renewable Energies" (CEPRE) which is designed as a cooperation basis for future German, Czech and Polish enterprises, public bodies, research institutions and financing companies working jointly to realize and further joint projects.
As a project partner experienced in the fields of energy technologies and energy systems and in specific cooperation projects with the CEE countries Fraunhofer UMSICHT supports the MOEZ centre.

Among its contributions this year is an internal market study on renewable energies in the target countries.

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Dipl.-Geogr. Simone Krause
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simone.krause@umsicht.fraunhofer.de

# Utilization of Renewable Raw Materials on the Example of the German State of Mecklenburg-Western Pomerania



Mecklenburg-Western Pomerania – rich in renewable resources

The German federal state of Mecklenburg-Western Pomerania has decided to continuously promote technologies which facilitate the sustainable utilization of natural resources. This federal state already ranks among the top players in Germany when it comes to utilizing renewable energies and renewable raw materials. About one third of the power consumption of Mecklenburg-Western Pomerania is supplied through environmentally friendly technologies based on wind, bio, water and solar energy. Biomass, biogas and biodiesel plants become increasingly important for the generation of energy. Hence it is evident that the strategic options for a further utilization of renewable resources focusing on the total value added chain need to be investigated.

Utilizing renewable raw materials, efficiency and value creation may be increased considerably, e. g. through the generation of new, high quality



by-products during their storage. In the case of freshly harvested biomass, this may be achieved via silo storage and isolation of valuable fractions. Here, relevant technologies still have to be developed or optimized.

Silo storage includes processes of lactic acid fermentation, which means that considerable amounts of lactic acid are produced from biomass by micro-organisms. The lactic acid may be separated as a by-product before the silo materials are used, e.g. for energy generation in the biogas plant. Lactic acid is an increasingly demanded chemical raw material. It is used as preliminary product for the production of biologically degradable plastic materials, environmentally friendly solvents, but also in the food industry.

A further not yet fully exploited potential is the additional, multi-phase disintegration of the biomass, which facilitates utilization of the substrates. It is especially in biogas plants where waste heat is required that a thermal-mechanical disintegration method is considered to be promising.

Starting from scientific analyses, it is the objective of the project to elaborate and assess different strategic issues for the regional raw materials supply within varying scenarios, and subsequently, in a more detailed second step, to develop technological elements; e. g. for silo storage.

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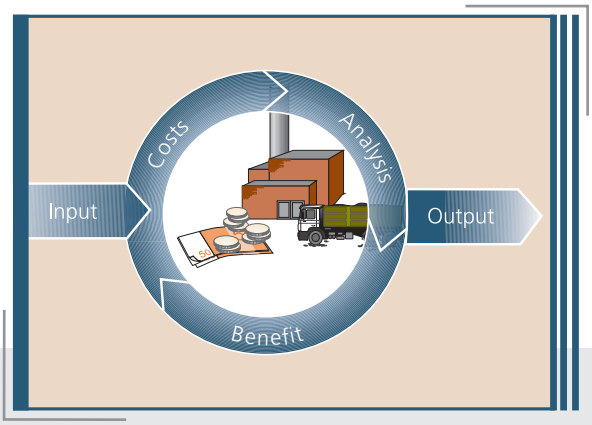
# Cost-Benefit-Analyses in the Waste Management Sector



Political decisions often rely on cost-benefit analyses. The results of these analyses mostly attract wide interest, the underlying criteria and procedures, however, receive less consideration. Fraunhofer UMSICHT has been awarded a research contract from the German Environmental Agency (Umweltbundesamt UBA) and has developed an assessment scheme which allows to compare cost-benefit-analyses in the waste management sector.

The motivation for the project is given by the planned revision of the European Waste Directive, for which cost-benefit analyses are of central importance. The waste hierarchy (preference of prevention to recycling to disposal/elimination) is supposed to be re-introduced as a common rule again. Deviations, however, are possible, if ecobalances and cost-benefit analyses do suggest this. In order to guarantee the objective




Cost-benefit in waste management



assessment of different waste management options, topic-related European studies were investigated with regard to comparability and data bases as well as their impact on the ranking of waste treatment options.

The investigations have yielded that each analysis was based on a different approach. The various assessment methods for material data range from life-cycle-analysis (LCA) through cost-benefit analysis (CBA) to individual assessment methods, such as the modified cost-efficiency analysis. In many cases, the underlying material data are not clearly indicated, and therefore not comprehensible and reproductible. Further differences are to be found in the economic data: some studies are based on market prices including profit margins, other studies start from real costs. Variations have been found in balances and assessment limits.

In order to improve the comparability of studies in future, an optimized assessment scheme for cost-benefit-analyses (CBA) was elaborated. This concept focuses on data reproduction & transferability, data documentation and data safety as well as on the identification of uncertainties and the impact of influencing factors on the system stability. Evidently, further research regarding the methodological approach of cost-benefit-analyses and a clear differentiation between local and global effects is required.

## Contact

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"The most useful books are those of which readers themselves compose half."

Voltaire (1694-1778), Philosophical Dictionary

With this quotation in mind we wish you many inspiring moments.

You may search for Fraunhofer publications and patents online at:
http://publica.fraunhofer.de/starweb/publica/index.htm

# Names, Data, Events

# Publications

*The following survey only includes lectures and publications which were written and/or delivered in English. For a complete bibliography, see the German version of our annual report.*

Hiebel, M.; Mrotzek, A.; Keuter, V.:
**Material flow management: Approaches for emission reduction and cleaner production in Vietnamese foundries**
In: Journal of Geology. Series B, (2007) 29, p. 22-27

Huang, L.; Pollerberg, C.; Doetsch, C.:
**Evaluation of properties of paraffin oil-in-water emulsion as phase change slurry.** (International Congress on Refrigeration <22, 2007, Beijing>)
In: International Institute of Refrigeration -IIR-: 22nd IIR International Congress of Refrigeration 2007. CD-ROM: August 21-26, 2007; Beijing, China. Paris: IIR Secretary, 2007

Huang, L.; Pollerberg, C.; Doetsch, C.:
**Stability analysis of paraffin oil-in-water emulsion as phase change slurry.** (International Congress on Refrigeration <22, 2007, Beijing>)
In: International Institute of Refrigeration -IIR-: 22nd IIR International Congress of Refrigeration 2007. CD-ROM: August 21-26, 2007; Beijing, China. Paris: IIR Secretary, 2007

Jentsch, A.; Dötsch, C.; Manderfeld, M.:
**A chance for rural areas: District heating and the integration of renewable energy sources**
In: Euro Heat & Power / English Edition 4 (2007), 2, p. 36-40

Keuter, V.:
**Development of an interactive engineering tool for technology and technical innovation, related to integrated water management in decentralized regions**
In: Journal of Geology. Series B, (2007) 29, p. 42-45

Keuter, V.; Gehrke, I.:
**Low-maintenance hygienization of WWTP outflow and new approaches in water treatment facilities**
In: Journal of Geology. Series B, (2007) 29, p. 3-7

Marzi, T.; Mrotzek, A.; Görner, K.:
**Combustion behaviour of refuse derived fuels – development of a characterisation method.** (International Waste Management and Landfill Symposium <11, 2007, Cagliari>)
In: Cossu, R.: Sardinia 2007, Eleventh International Waste Management and Landfill Symposium: Executive summaries. Cagliari: CISA, 2007

Meterc, D.; Petermann, M.; Weidner, E.:
**Extraction of green tea and drying with a high pressure spray process**
In: Hemijska industrija = Chemical industry, 61 (2007) 5, p. 222-228

Peter, S.; Weidner, E.:
**Methanolysis of triacylglycerols by organic basic catalysts**
In: European journal of lipid science and technology, 109 (2007) 1, p. 11-16

Pfeifer, C.; Hofbauer, H.; Unger, C.; Schulzke, T.; Ising, M.:
**Dual fluidized bed biomass steam gasification combined with catalytic gas cleaning.** (European Biomass Conference and Exhibition <15, 2007, Berlin>)
In: 15th European Biomass Conference & Exhibition 2007. From research to market deployment. Biomass for energy, industry and climate protection: Proceedings of the International Conference, Berlin, 7-11 May 2007. Florence: ETA, 2007, p. 860-867

Pollerberg, C.; Dötsch, C.:
**Model of a solar driven Steam Jet Ejector Chiller and investigation of its dynamic operational behaviour.**
2nd International Conference Solar Air-Conditioning. Proceedings: Tarragona, Spain, October 18th/19th, 2007. Regensburg: OTTI, 2007, 5 Bl.

Schlüter, S.; Wack, T.:
**Model based monitoring of COD in industrial waste water networks**
In: Journal of Geology. Series B, (2007) 29, p. 17-21

Urban, W.:
**Elimination of technical, legal and economic restraints for the feed-in of biogenous gases into the gas network with the aim of reducing climate relevant emissions by means of developing and applying a geo-referenced database - strategy development for the political and techno-economic realization.**
In: Bundesministerium für Bildung und Forschung -BMBF-: Klimazwei - Research for Climate Protection and Protection from Climate Impacts. Proceedings: February 28th to March 1st, 2007, Berlin, Germany. Bonn: BMBF, 2007, p. 34

Venter, M. J.; Willems, P.; Kareth, S.; Weidner, E.; Kuipers, N. J. M.; Haan, A. B. de:
**Phase equilibria and physical properties of $CO_2$-saturated cocoa butter mixtures at elevated pressures**
In: Journal of Supercritical Fluids, 41 (2007) 2, p. 195-203

Wack, H.; Ulbricht, M. U.:
**Method and model for the analysis of gel-blocking effects during the swelling of polymeric hydrogels**
In: Industrial and Engineering Chemistry Research, 46 (2007) 1, p. 359-364

**Dissertation**

Hiebel, M.:
**Development and application of a method to calculate optimal recycling rates with the help of cost-benefit scenarios**
Stuttgart: Fraunhofer IRB Verlag, 2007 (UMSICHT-Schriftenreihe 58)
Zugl.: Duisburg-Essen, Univ., Diss., 2007
ISBN 3-8167-7416-4
ISBN 978-3-8167-7416-7

# Selected Clients and Contacts

**Selected Clients and Contacts**

*Since its foundation Fraunhofer UMSICHT has successfully been co-operating with customers from all industrial sectors and with companies of all sizes. The following extract of the institute's reference lists is an overview on project and co-operation partners and customers:*

A. u. E. Lindenberg GmbH & Co. KG, Bergisch-Gladbach
Abfallbehandlung Nord GmbH, Bremen
Abfallwirtschaftsgesellschaft mbH Wuppertal, Wuppertal
Abwasserzweckverband München-Ost, Finsing
ACCESS e.V., Aachen
AdFiS products GmbH, Teterow
AGR Deponienachsorge GmbH & Co. KG, Essen
agri.capital GmbH, Münster, Münster
Air Products GmbH, Hattingen
aix-o-therm GeoEnergien, Aachen
alta4 geoinformatik ag, Trier
Altenburger Maschinen Jäckering GmbH, Hamm
aqua society GmbH, Herten
Assyst/Bullmer Spezialmaschinen GmbH & Co.KG, Mehrstetten
Aufbereitungstechnologie Noll GmbH, Bobingen
Aufwind Schmack GmbH Neue Energien, Regensburg
AVIT Hochdruck Rohrtechnik GmbH, Essen
BASF SE, Ludwigshafen
Bayer CropScience AG, Branch Frankfurt, Frankfurt am Main
BHC Gummi-Metall GmbH, Meckenheim
BioPowerDevelopment GmbH, Niestetal
BKB Hannover GmbH, Hannover
BKV Beteiligungs- und Kunststoffverwertungsgesellschaft mbH, Frankfurt
Brennerei + Biogasanlage Bernd Josef Wenning, Rhede
Buchhandlung und Verlag K.-M. Laufen, Oberhausen
Bundesforschungsanstalt für Landwirtschaft, Institut für Technologie und Biosystemtechnik, Braunschweig
BWS Technologie GmbH, Grevenbroich
Chemion Logistik GmbH, Leverkusen
Claas Selbstfahrende Erntemaschinen GmbH, Harsewinkel
Cognis Deutschland GmbH & Co. KG, Düsseldorf
Cornpack GmbH & Co. KG, Teterow
CUT GmbH & Co. KG, Düsseldorf
Cyplan Ltd., Unterlemnitz
DataPool engineering GmbH, Oberhausen
DBU Deutsche Bundesstiftung Umwelt, Osnabrück
DECHEMA e.V., Frankfurt am Main
Degussa AG, Hanau
Delu AG – Deutsche Leckageortungs- und Umwelttechnik AG, Gladbeck
Deutsches Zentrum für Luft-und Raumfahrt e.V., Institut für Technische Thermodynamik, Cologne
Di Matteo Förderanlagen GmbH & Co. KG, Beckum
DIN CERTCO Gesellschaft für Konformitätsbewertung mbH, Berlin
DMT GmbH, Essen
E.ON Energie AG, München
E.ON Engineering GmbH, Gelsenkirchen
E.ON Ruhrgas AG, Essen
ecoprog GmbH, Cologne
Elastogran GmbH, Lemförde
elementar Analysensysteme GmbH, Hanau
Energieversorgung Oberhausen AG, Oberhausen
Ernst-Moritz-Arndt-Universität Greifswald, Institut für Geologie, Greifswald
EUS Gesellschaft für innovative Energieumwandlung und -speicherung mbH, Dortmund
Evonik Degussa GmbH, Hanau
Evonik Degussa GmbH, Marl (Science-to-Business-Center)
Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Gülzow
FEBA-Forschung u. Engineering für Biotechnologische Anwendung GmbH, Dortmund
FernUniversität in Hagen, Hagen
Fernwärme Niederrhein FN, Dinslaken
Fernwärme-Forschungsinstitut e.V. FFI, Hemmingen
Fernwärmeversorgung Niederrhein GmbH, Dinslaken
FITR e.V., Weimar
FKuR Kunststoff GmbH, Willich
Fluent Deutschland GmbH, Darmstadt
Forschungszentrum Karlsruhe GmbH, Eggenstein-Leopoldhafen
GAGFAH M Immobilien-Management GmbH, Essen
GASAG Berliner Gaswerke, Berlin
Gaswärme-Institut e.V. (GWI), Essen
Gelsenwasser AG, Gelsenkirchen
Gesellschaft zur Förderung von Medizin-, Bio- und Umwelttechnologien e.V. Halle/Saale
GKT Gummi- und Kunststofftechnik Fürstenwalde GmbH, Fürstenwalde
GVT Forschungs-Gesellschaft Verfahrenstechnik e.V., Frankfurt am Main
Haas Anlagenbau GmbH, Chieming
Hahl Filaments GmbH/Lenzig Plastics, Munderkingen
Harvestore Deutschland, Unna
Heine Gesellschaft für schlüsselfertiges Bauen mbH, Oberhausen
Hochschule Magdeburg-Stendal (FH), Magdeburg
Hubert Loick VNR GmbH, Dorsten
Humana GmbH, Herford
Humboldt-Universität zu Berlin, Institut für Mathematik, Berlin
Hündgen Entsorgungs-GmbH & Co. KG, Swisttal
HV Umweltservice GmbH, Swisttal-Ollheim
Hydac-Accessories GmbH, Sulzbach/Saar
iaks Ingenieurbüro für Abfluss-, Kläranlagen-, Steuerung GmbH, Sonthofen
IGEL Technology GmbH, Bremen
Impreglon AG, Lüneburg
INFA-Institut für Abfall, Abwasser und Infrastrukturmanagement GmbH, Ahlen
infra fürth gmbh, Fürth (Bavaria)
Innovene Deutschland GmbH Köln, Cologne
Institut für Energetik und Umwelt gGmbH, Leipzig
Interseroh AG, Cologne
io-li-tec Ionic Liquids Technologies, Denzlingen
ITProtect GmbH & Co. KG, Gevelsberg
IZEG Informationszentrum Entwässerungstechnik Guss e.V., Bonn
Jura Placages S.A.S., Souvans, France
KonnexX Unternehmensberatungsgesellschaft mbH, Güstrow
Kreisverwaltung Neuwied, Abfallentsorgungsanlagen, Neuwied
Loick AG, Dorsten
LÜNTEC Förderverein e.V., Lünen
Malvern Instruments GmbH, Herrenberg
MAN Ferrostaal AG, Essen
Matino GmbH, Kyritz
Mehldau & Steinfath Umwelttechnik GmbH, Essen
Mingas-Power GmbH, Essen
Ministerium für Umwelt und Naturschutz, Landwirtschaft und Verbraucherschutz des Landes NRW, Düsseldorf
Ministerium für Wirtschaft, Mittelstand und Energie des Landes NRW, Düsseldorf
MNT-Systeme GmbH, Oberhausen
Momentive Performance Materials Inc., Leverkusen
MTS Machinery Tools & Services AG, Oetwill am See, Switzerland
MVV Energie AG, Mannheim
National-Bank AG, Oberhausen
Newtec GmbH, Dortmund
Novoplastik Produktions- und Vertriebs GmbH, Mannheim
NRW.BANK, Düsseldorf
NuTech Solutions GmbH, Dortmund
Oel-Wärme-Institut gGmbH, Herzogenrath
Osram GmbH, Augsburg
OXEA Deutschland GmbH, Oberhausen
Pantreon GmbH, Gmunden, Austria
Permapack AG, Rorschach
Pfleiderer AG, Neumarkt
PUR-Technologie Hegemann, Essen
Renolit AG, Salzgitter
rpm – rapid product manufacturing – GmbH, Helmstedt
Ruhr Oel GmbH -BP Gelsenkirchen, Gelsenkirchen
Ruhr-Universität Bochum, Bochum
RWE Power AG, Essen
RWTH Aachen, Aachen
S&B Industrial Minerals GmbH, Marl
Schering AG Werk Bergkamen, Bergkamen
Sesterhenn Energiedienstleistungen, Titz
Silesian Technical University, Institute of Engineering of Water and Wastewater, Gliwice, Poland
Siloxa Engineering AG, Essen
Solvay Fluor GmbH, Frankfurt am Main
Stadtwerke Strausberg GmbH, Strausberg
Technamation Technical Europe GmbH, Aachen
Technische Universität Darmstadt, Darmstadt
Technische Universität München, München
Thermoprozess Wärmebehandlungsservice GmbH, Mülheim an der Ruhr
ThyssenKrupp Stahl AG, Duisburg
ThyssenKrupp Xervon Energy GmbH, Duisburg
ThyssenKrupp Real Estate GmbH, Essen
Toda Kogyo Europe GmbH, Düsseldorf

# Selected Clients and Contacts/Patents

Tönsmeier Dienstleistung GmbH & Co. KG, Porta Westfalica
TÜV Industrie Service GmbH, TÜV SÜD Gruppe, Mönchengladbach
UBE Engineering Plastics S.A., Düsseldorf
Uhde High Pressure Technologies GmbH, Hagen
Unidad de Desarollo Tecnologico de la Universidad de Concepcion, Coronel/Chile
Universität Dortmund, Dortmund
Universität Duisburg-Essen, Duisburg, Essen
Universität Siegen, Siegen
Universität Stuttgart, Stuttgart
Universität zu Köln, Cologne
Verbandsgemeindewerke Montabaur, Montabaur
Verein zur Förderung der Energie- und Umwelttechnik e.V., Duisburg
Viking GmbH, Langkampfen/Kufstein
Wacker Chemie AG, Werk Burghausen, Burghausen
WAGRO Systemdichtungen GmbH, Dortmund
Werner Evers, Wassertechnik und Anthrazitveredelung, Hopsten
Westfalia Separator Food Tec GmbH, Oelde
WiN Emscher-Lippe GmbH, Herten
Windwärts Energie GmbH, Hannover
Wuppertal Institut für Klima, Umwelt, Energie GmbH, Wuppertal
Zentrum für Sonnenenergie- und Wasserstoff – Forschung Baden Württemberg, Stuttgart
Zukunft Emden GmbH, Emden
Zwiesel Kristallglas AG, Zwiesel

**Patents 2007**

Iussed Patents:

Method for producing shaped, activated charcoal
(Guderian, Henkenjohann*, Müller*, Goetze) – Germany

Swellable composition and use thereof
(H. Wack, Rechberger, J. Bertling) – Europe

* = external inventors

Registered trademarks

european center for elastomeric powders
(word trademark/figurative trademark)

euCEP (word trademark)

polymero (word trademark)

Rodentics (european word trademark)

# Spin-offs

**Spin-offs**

AIROX GmbH, Alpen
Systems for oxygenation
www.airox.de

Andreas Schröder IT-Consulting GmbH, Schermbeck
Counseling and service in the area of information and telecommunication technologies

A-TEC Anlagentechnik GmbH, Duisburg
Innovative solutions concerning coal mine gas; hazard prevention: analyses, extraction, safety concepts; utilization for power and heat generation: energy concepts, design and operation of plants
www.atec.de

Carbon-TF B.V., Venlo, Netherlands
Emissions trading

DataPool Engineering GmbH, Oberhausen
Software development, system analyses, EDP-consulting
www.dp-e.de

Emissions-Trader ET GmbH, Alpen
Emissions trading
www.emissions-trader.de

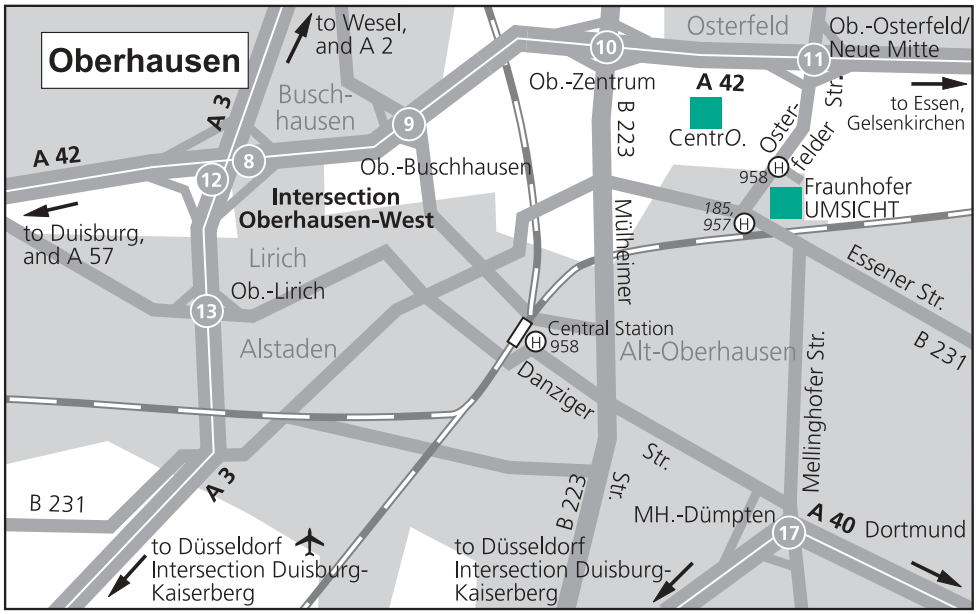
FKuR Kunststoff GmbH, Willich
Innovative solutions concerning plastics and recycling; comminution technology; extrusion, injection molding; elastomer recycling; material analyses; test technology; recycling concepts
www.fkur.de

SOLid Composites GmbH, Voerde
Plastic powder at its finest!
Thermoplastic coating powders, laser sinter powders, functional filler systems – custom-made specialties are our daily work:
www.solidcomposites.de

VENTAX Big-Bag Network GmbH & Co. KG, Willich
Big-Bag cleaning facilities, reusable Big-Bag, packaging systems
www.ventax.de

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

# How to Find us




**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 kilometers (behind the sign "Fraunhofer UMSICHT") turn left into the access road to the institute.

*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 A40

*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. At the first traffic lights turn right into the access road to the institute.

*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.) to Fraunhofer UMSICHT, 957 (towards Oberhausen Sterkrade Bf.) or 958 (towards Oberhausen Spechtstraße), exit at the stop "UMSICHT".

**By plane and train/car**

From Düsseldorf Airport terminal A/B/C take the Sky Train to Düsseldorf Airport Station, then change into the Regional Express to Oberhausen central station. To continue see: By train

*or 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.

**Adress**

Fraunhofer Institute for
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Energy Technology UMSICHT

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**Deputy Director:**
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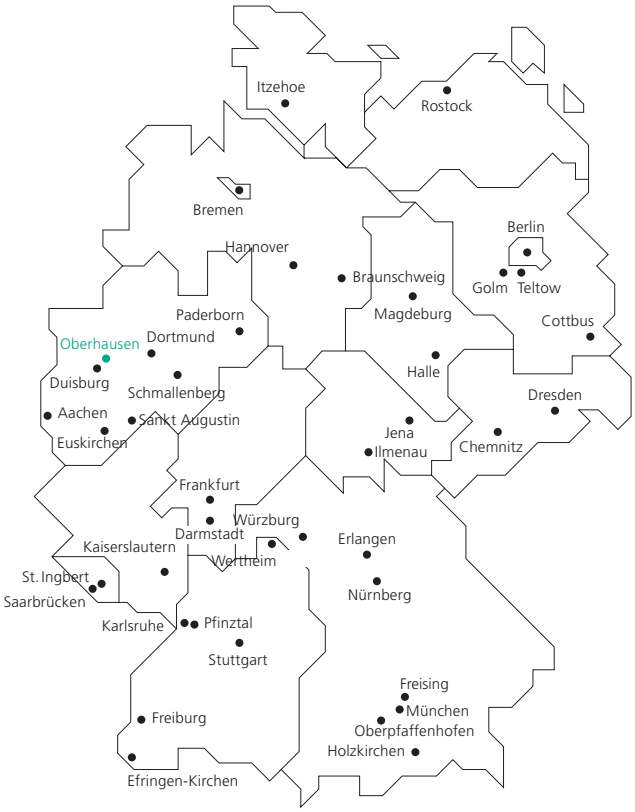
Your way to us online:
www.umsicht.fhg.de/profil/anfahrt/index.php

# The Fraunhofer-Gesellschaft

## The 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 organization also accepts commissions from German federal and Länder ministries and government departments to participate in future-oriented research projects with the aim of finding innovative solutions to issues concerning the industrial economy and society in general.




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, accelerating technological progress, improving the acceptance of new technologies, and not least by disseminating their knowledge 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, in other scientific domains, in industry and in society. Students working 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.

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units, including 56 Fraunhofer Institutes, at 40 different locations in Germany. The majority of the 13,000 staff are qualified scientists and engineers, who work with an annual research budget of 1.3 billion euros. Of this sum, more than 1 billion euros is generated through contract research. Two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Only one third is contributed by the German federal and Länder governments in the form of institutional 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 research centers and representative offices in Europe, the USA and Asia provide contact with the regions of greatest importance to present and future scientific progress and economic development.

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

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