Fraunhofer
UMSICHT

FRAUNHOFER INSTITUTE FOR ENVIRONMENTAL, SAFETY, AND ENERGY TECHNOLOGY UMSICHT

ANNUAL REPORT 2009 2010

In the interest of readability we did not use male and female forms in parallel. Nevertheless, references to persons always refer to both sexes.

CONTENT

WIR FEIERN!
20 JAHRE
KNACKIGE IDEEN

PREFACE

Dear readers,

Here you will find a very "green"annual report. This is not only to do with the many "green" themes but also with the image of the apple as an overall visual concept.
Despite the difficulties in 2009 spawned by the global economic crisis, we planted not a few little apple trees[1].

To do this we were helped by the economy booster program "K1" initiated by the federal government. We have invested the funds available in the topics of the utilization of biomass and energy storage. The newly built laboratories and equipment which is geared for future oriented experimentation, create good conditions to help open up new markets for and with our industrial partners.

"Trees" which we planted several years ago bore especially beautiful fruit in 2009: in this respect we have to mention ORC technology for the gaining of electricity from waste heat, biopolymers for agricultural films and GEVIS, a management system for hazardous materials. New topics are past the germination stage and joyfully, are growing. We have developed a new catalyst for the production of biodiesel which is significantly more effective than conventional systems. Our CO_2 intensified tanning process can potentially cut down on several hundred million cubic meters of waste water containing chrome. We are very pleased that the Federal Ministry of Education and Research (BMBF) has enabled us to set up a demonstration plant on an industrial scale as a reference. It is not only in these fields that we have continued expanding our IPR and patent portfolio. We are aware of the fact that it is not only important to protect outstanding ideas but also that these ideas form the basis for innovative projects and technologies.

With our assistance and financed by funds from the "Future For Bochum" program, the Ruhr-University Bochum has established a center of excellence for hydraulic fluid energy machines. This is an important major project which consolidates the top ranking position of the German pump industry and makes a big contribution to the efficient utilization of energy.

Here at UMSICHT we are proud of all these things. However, we are even more proud of our employees who advance our institute according to the motto "lifelong learning at UMSICHT". Whether the "Mit-Kind-Büro"(temporary child care provision), school projects, very good trainees or excellent dissertations, we are very pleased with their commitment.

"If you have got an apple and I have got an apple and we swap the apples, both of us will still only have one apple. But if you have got an idea and I have got an idea and we swap these ideas, then both of us will have two ideas[2]."
On this note we would like to exchange our ideas with you and thus multiply them to bring about our mutual success. After all, Newton himself was inspired to great discoveries by, according to legend, the apple which fell onto his head.

Finally, it cannot be left unmentioned that in 2010 Fraunhofer UMSICHT is celebrating its twentieth birthday. This too is a reason to be proud.

We would like to express our thanks to all our staff, to our supports, to our clients, and to our business partners and in June we are looking forward to celebrating with you the birthday of our institute.

Kind regards

Eckhard Weidner

Görge Deerberg

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.

[1] "Were I to know that the world would end tomorrow, I would plant a little apple tree today." (ascribed to Martin Luther)
[2] Ascribed to George Bernard Shaw.

OTHER HIGHLIGHTS 2009

February: Opening of an exhibition titled "Metamorphosen" – Sculptures by Babette Martini, faces and hands out of clay and wax.

March: Dr Christine Vogt, director of the Ludwig Galerie Schloss Oberhausen, opens an art exhibition with works from the Oberhausen Photographer Axel Scherer.

August: Opening of an exhibition titled "Ice-cold: the Artic/Antartic" with works from the photographer Brigitte Rühland.

HIGHLIGHTS 2009

Fraunhofer UMSICHT invests in biomass energy and storage – Funding for this comes from the economy booster program K1 set up by the German Federal Government with the aim of advancing research into the utilization of energy storage and biomass technology. This was announced by Professor Eckhard Weidner on March 24 at the opening of the "BIO – raffiniert V" congress to over 100 experts who were there to discuss the material and energetic utilization of biomass in bio-refineries.

Commendations for the best graduates in the interdisciplinary Open University course environmental sciences – On April 4 at the "infernum" conference in Hagen, in front of 90 invited guests, the anglicist and Diplom-Kaufmann (Certificate in Business Administration) Stephan Hild, the Diplom-Kaufmann Phillip Hasenmüller as well Gregor von Held MBA and soil scientist were distinguished as the best of their year in the degree program Master of Environmental Sciences.

The Research Award goes to Oberhausen – On April 28 2009, three UMSICHT employees were awarded this prize by the minister responsible for innovation Prof Andreas Pinkwart. They received the prize for their project dealing with small, thermally driven cooling machines with membrane-nano technology.

Opening Ceremony – Building D Fraunhofer UMSICHT – The fourth building on the Fraunhofer UMSICHT complex was officially declared open on April 30 2009. The former steel plant building comprises, apart from office facilities, the library with an "Info-lounge", the computing centre and a modern function room. Another 3,200 square metres of floor space is also available. The conversion was co-financed, to the sum of around 7 million Euros, by funds allocated by the federal and local state government for the refurbishment of buildings and improvement of grounds and additionally by funds from the EU.

THE HIGHLIGHT 2010

FRAUNHOFER UMSICHT 20 YEARS OLD

20

The federal Minister for the Environment at Fraunhofer UMSICHT – On August 6 2009 Sigmar Gabriel visited the institute to discuss themes such as the development of renewable energy, technologies for the protection of the climate and the environment and alternatives to oil. Furthermore the minister came to accept his role as a curator on the board of trustees for the UMSICHT Scientific Award.

Global Young Faculty with Fraunhofer UMSICHT – Two women members of the UMSICHT team take part in the "Global Young Faculty". This program initiated by the Stiftung Mercator (Mercator Foundation) is coordinated by the "Kulturwissenschaftliches Institut Essen" (Institute for Advanced Studies in the Humanities) and supported by the local State Ministry for Innovation, Science, Research and Technology. The aim is to establish a network of young scientists in the Ruhr area, to encourage cooperation on questions and problems which concern all.

Playing host to young talents – From October 21-23 2009, a "Talent School" for scientifically minded and technically interested high school students took place at Fraunhofer UMSICHT. During the course of three workshops, experienced scientists introduced the pupils to the themes of biomimetics, biofuels and energy supply.

The "Mit-Kind-Buro" an office facility whereby staff can work and have their child within close reach was officially opened in November 2009. It enables staff to deal better with short term problems in child care provision and thus contributes towards a better work-life balance.

Third place in the BEST EXCELLENCE Business Plan competition 2009 – Researchers from Fraunhofer UMSICHT were able to convince members of the jury of the BEST EXCELLENCE initiative with their concept concerning the production of "designer diesel" from waste grease. On November 3 2009 the Business Plan of the "Greasoline" team was awarded third place.

WIR FEIERN!
20 JAHRE
KNACKIGE IDEEN

FRAUNHOFER UMSICHT

FRAUNHOFER INSTITUTE FOR ENVIRONMENTAL, SAFETY, AND ENERGY TECHNOLOGY UMSICHT

THE INSTITUTE 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 at Fraunhofer UMSICHT

	Number
Permanent Staff	**183**
Staff in scientific business units	130
Staff in infrastructure departments	53
Other Staff	**148**
Trainees	15
Undergraduate students (diploma, master, bachelor)	26
Student assistants	86
Interns and persons in civilian service	21
Total Staff	**331**

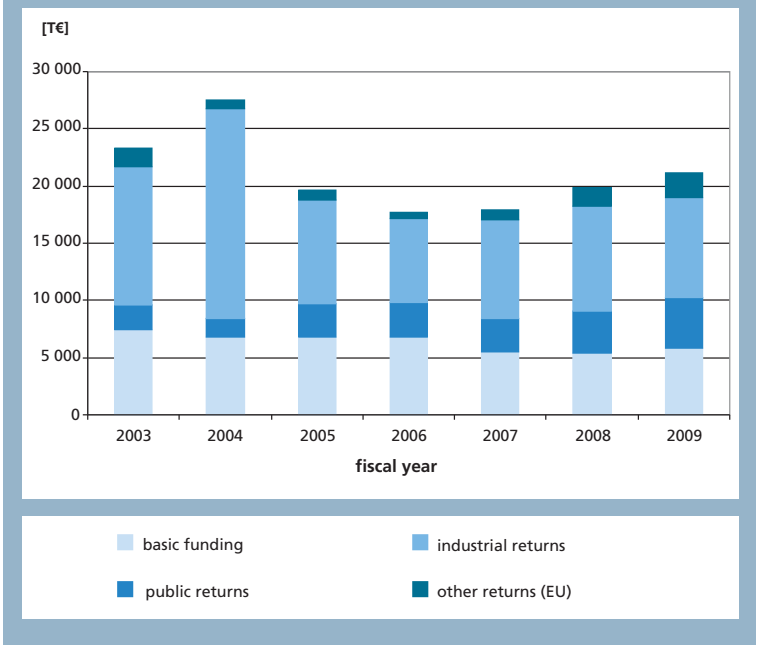
Expenditure and Returns 2009

	(m €)
Operational budget	**21,1**
Staff costs	10,0
Other costs	11,1
Investments	**0,9**

Returns Operational Budget 2009

	(m €)
Basic Funding	5,8
Public Returns	4,5
Industrial Returns	8,7
Others	2,1
Total Returns	**21,1**

We would like to draw your attention to our Sustainability Report!
Contact: nachhaltigkeit@umsicht.fraunhofer.de



UMSICHT FRIENDS AND PATRONS

UMSICHT-FRIENDS AND PATRONS

Dr. Thomas Mathenia, Chairman UMSICHT Friends and Patrons and Member of the Board of Energie-versorgung Oberhausen AG

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

Dr. Görge Deerberg
Managing Director UMSICHT Friends and Patrons and Deputy Director of Fraunhofer UMSICHT

FRIENDS AND PATRONS

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 for more efficient production methods and for products of better quality, and we need qualified and committed people 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.

Our society is more and more becoming an information and science society. Those who can rely on good networking, who recognize trends early and who are able to identify new technologies which have an impact on competitiveness are among the winners. The UMSICHT Friends and Patrons group therefore concentrates on the exchange of experience and know-how among universities and industry, within the R&D network of the Fraunhofer-Gesellschaft, and among its members.

Our guiding principle is to initiate innovative R&D projects already in a very early phase, both materially and non-materially. We aim at opening up an early and straightforward access to future-oriented and sustainable technology developments. Apart from technically oriented preliminary work (e.g. proof of principle) our member companies invest in forecast studies on current topics, they contribute to shaping the public opinion by sponsoring events and they support future executives.

We cordially invite you to join and enrich our circle.
Visit us at: www.umsicht-foerderverein.de

UMSICHT SCIENTIFIC AWARD

SCIENTIFIC AWARD

There are three sorts of people: those who make things happen, those who stand by and observe what is happening and those who wonder what has happened.

This popular saying pinpoints exactly what is needed in a country whose economic capital is based on the resource "knowledge". For the future efficiency of that country, for its innovative strengths and performance, people with good ideas and the will to implement those ideas are essential. People too are needed who are able to stimulate the dialogue between science and society in general and improve mutual understanding in these areas.
These are precisely the type of people whom the friends of the UMSICHT Friends and Patrons would like to address with this scientific award in the fields of environmental, safety and energy technology. The award is based on research which is close to the market and industry and targets also on the reporting of such research in the public domain.
Germany is ranked second in world listings concerning the concentration of patents (patent registrations per inhabitant). However, using international comparisons, Germany is only middle ranking when it comes to transforming innovations into products which are market-ready.
There are many different reasons for this. A significant aspect is that, faced with the economic application of innovative ideas and the presentation of them in a way which is clear and intelligible, a certain know-how is missing. The Fraunhofer-Gesellschaft has long since recognized this shortcoming and demonstrates just how mutually productive co-operation between science and industry can be.
The UMSICHT Scientific Award is intended to motivate, to advance innovative thinking and initiatives in the fields of environmental, safety and energy technology. The idea is to show that research and development in accord with entrepreneurial thinking and the reporting of this theme, offers added value for individual initiative. Moreover it is fun and rewarding. The prize carries a value of 15,000 Euros and is awarded in the categories of science and journalism.

Applications should be submitted by January 31, 2011 to:
www.umsicht-foerderverein.de.

UMSICHT SCIENTIFIC AWARD

Professor Dietrich H. W. Grönemeyer, Chairman of Wissenschaftsforum Ruhr e.V. and Director of the Grönemeyer Institute for Microtherapy is Patron of the UMSICHT Scientific Award.

Contact:
Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik e.V.
(UMSICHT Friends and Patrons)
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BOARD OF TRUSTEES

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

BOARD OF TRUSTEES

Ladies and Gentlemen,

A crisis can be a creative state of mind, you just have to remove the underlying feeling of impending catastrophe. Or to put it less succinctly as in this quotation from Max Fritsch: when we have got over the initial shock, crises force us to move forward, to progress. And progress is always associated with new chances.

When we think of progress, we think first and foremost of technical progress. My thoughts immediately turn to Fraunhofer UMSICHT. And this is not only because of my position as chairman of the board of trustees but because of the fact that the institute couples innovative ideas with their economic application. This is a core competence which is needed to accompany structural change, particularly in our region with its constantly changing economic and social environment. This will be more than ever in the focal point when the Ruhr area becomes the European Capital of Culture in 2010. It is exactly in this region that the people stand out for their pronounced form of pragmatism – and the top priority for Fraunhofer UMSICHT is to be in step with actual practice.

Progress can mean a change in values. Especially in difficult times traditional values experience a renaissance. Currently, the relationship between material and immaterial values and their appraisal in our knowledge based society is being discussed. Sustainability, social responsibility and the management of values are crucial guiding themes which Fraunhofer UMSICHT, in its business model, is gradually anchoring, refining and carrying through.The institute was one of the first research institutes of its kind to produce a sustainability report. Indeed it brought about the sustainability mindset

in the Fraunhofer-Gesellschaft. This type of lobbyism for sustainability has my full support.

Guaranteeing progress in the future, means investing in tomorrow today. Under the motto "Got talent – Use it!!!" Fraunhofer UMSICHT brings together young talents with scientists from the institute. This has had so much success and has been so much fun that the Talent-School in Oberhausen will go on until 2013!

Frequently new things are generated at the interface between special fields of knowledge and fields of experience especially at the point where interdisciplinary knowledge is pooled in an unconventional manner. The Global Young Faculty, an initiative of the Mercator Foundation, promotes the linking-up of scientific young talent as part of the official program of the European Capital of Culture. Two young women members of the UMSICHT staff belong to the approximately 100 young academics from the Ruhr area.They hold interdisciplinary discussions about possible new, sustainable solutions for tomorrow's world and the role of politics, the economy, the sciences, and culture in all this. I am already very curious as to the outcome of these debates. Then it is this multidisciplinary, academic connectedness which really promises progress.

That works too: Promoting the generation of new ideas through rewards! Let me mention the UMSICHT Scientific Award as an outstanding example of this. The prize which will be first awarded in 2010, is for industrial and market oriented research in the fields of environmental, safety and energy technology and for the intelligible depiction of these themes in the medium of journalism. The Circle of Friends and Patrons of the UMSICHT advance the creation of innovative ideas with this competition. For my part I would like to see this setting a precedent, since progressive thinking must be rewarded!
With so much talk of progress I would now like to look back twenty years: in 1990 the "think tank UMSICHT" was launched. After having already celebrated the sixtieth anniversary of the founding of the Fraunhofer-Gesellschaft, I am specially looking forward to the twentieth anniversary of the institute.

My sincere congratulations to UMSICHT!

LET'S WORK TOGETHER

DEPARTMENT OF MECHANICAL ENGINEERING

The Department of Mechanical Engineering of the Ruhr University Bochum is a divided into 4 institutes with 23 teaching units. The teaching units encompass the conception, construction, and manufacturing of functional and construction parts for technical components, machinery, and plants as well as their sale, operation, management, and maintenance.

The department has set itself the task to assume a leading position – on the basis of excellent basic research – in the development of innovative industrial products, processes and services. The department focuses on 4 strategic research areas:

- Biomedical & Micro Engineering
- Energy & Environmental Engineering
- Materials Engineering
- Product & Service Engineering

Publically funded basic research projects are complemented by research cooperations with leading companies. The department is the coordinator of the Collaborative Research Center 459 – shape memory technology, SFB/TR 29 – Industrial product service systems – Dynamic interdependency of products and services in the production area, and the Max Planck Research School for Surface and Interface Engineering in Advanced Materials. The DFG-Emmy-Noether-Junior Research Group "Twinning in structural and functional engineering materials" and the DFG-Heisenberg professorship "Materials in Microtechnology" are further, outstanding examples of the close connection between the department and basic research.
In June 2008, the new Research Centre ICAMS (Interdisciplinary Centre for Advanced Materials Simulation) was officially opened. ICAMS develops new materials on different scales via computer simulation – an approach that combines the previously separate worlds of natural and engineering sciences for the first time. International networking in these research projects is of great importance which is further evidenced by the integration into a large number of EU research consortia.

Over 30 % of the research funds for the department are provided by industrial companies. A clear signal that the department strives to transfer research findings into innovative products in addition to performing basic research. The Department of Mechanical Engineering offers the following Bachelor/Master studies: Mechanical Engineering, Sales Engineering and Product Management, Environmental Engineering, and Resource Management.

Prof. Dr.-Ing. H. Meier, Dean of the Department of Mechanical Engineering of the Ruhr University Bochum

Fakultät Maschinenbau
fortschritt studieren

Prof. Dr.-Ing. Eckhard Weidner holds the Chair of Process Engineering at the Faculty of Mechanical Engineering.

The Faculty of Mechanical Engineering offers the following Bachelor/ Master studies: Mechanical Engineering, Sales Engineering and Product Management, Environmental Technology and Resource Management.

PUMP CENTER

UNIVERSITY COOPERATIONS

Pump Center

The first center of excellence for hydraulic turbo machines was created in the Ruhr area, supported by the Faculty of Mechanical Engineering of the Ruhr-University Bochum and Fraunhofer UMSICHT. From a technological point of view, Germany plays a leading role world-wide in this field. All in all more than 300 firms, about 100 of which are located in North Rhine-Westphalia, are involved in the business of hydraulic turbo machines, ranging from the heart pump to the concrete pump. The need for research in this field is huge and varied, especially with regard to the use of energy but also with new turbines. Any new know-how is bundled and linked in the Pump Center, especially developments in the fields of processing and energy technology, manufacturing technology, electrical drive engineering, measurement and control technology. Along with ten scientists, who lecture at the Ruhr-University, it is one of the aims of a group of young academics at Fraunhofer UMSICHT to establish the theme of hydraulic turbo machines as a focal point in the study of mechanical engineering. Pump companies can consequently benefit from highly qualified, skilled employees. For the first three years the center is funded to the sum of 3.4 million Euros by the "Growth For Bochum" program. A further 1.7 million Euros is being contributed by the Ruhr-University.

University Cooperations

Ruhr-University of Bochum
Technical University of Dortmund
University of Duisburg/Essen
FernUniversität in Hagen
Hochschule Niederrhein
Fachhochschule Gelsenkirchen
Hochschule Ruhr-West
Folkwang-Hochschule
TU Bergakademie Freiberg
University of Rostock
Unidad de Desarrollo Tecnológico (UDT),
Institute of the Universidad de Concepción, Chile
Hochschule Karlsruhe
RWTH Aachen
University of Michigan
University of Assiut
University of Bayreuth
Chinesische Akademie der Wissenschaften (CAS)
Fachhochschule Münster, Standort Steinfurt
HAWK, Hochschule für Angewandte Wissenschaften und Kunst, Fachhochschule Hildesheim/Holzminden/Göttingen
TU Dresden
TU Berlin
Heinrich-Heine University Düsseldorf

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 in Germany and Europe. This way we can integrate basic research into our projects.

KEY RESEARCH AREAS

Fraunhofer UMSICHT: Our Key Research Areas

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.

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.

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.

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
www.umsicht.fraunhofer.de/englisch/profil/leitthemen/

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Dipl.-Ing. Josef Robert

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

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Dr.-Ing. Axel Kraft

Deputy:
N. N.

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- Refinery Concepts
- Biofuel Processes

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Dipl.-Ing. Marcus Rechberger

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Information Technology in Process Engineering

Dipl.-Phys. Thorsten Wack

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Dipl.-Ing. Andreas Schröder

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- Environmental and Safety Law
- Server Based Computing

Energy Technology

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Deputy:
Dr.-Ing. Barbara Zeidler-Fandrich

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

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Deputy:
Dr.-Ing. Wilhelm Althaus

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

Resources Management

Dr.-Ing. Hartmut Pflaum

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

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

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Our competencies

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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Our competencies

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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Our competencies

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); online analytics; thermal analysis

Biofuel Systems
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

MATERIALS AND SYSTEMS

Dipl.-Ing. Jürgen Bertling
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Our competencies

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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Our competencies

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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Our competencies

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 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 EFFICIENCY TECHNOLOGY

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Our competencies

Electrical Energy Storage
Development of Redox-Flow batteries, testing of Li-batteries as well as optimization of CAES plants and network integration and operation optimization of storage

Polygeneration
Development, optimization, construction, system integration of ORC plants, primarily for waste heat conversion into electricity, e.g. for engines, thermally driven solar power plants and wood-fired cogeneration plants in the perfomance range of 20-200 kW_{el}

Thermal Cooling/Storage
Steam jet ejector chilling technology (waste heat, solar) 5-1000 kW; absorption chilling technology (waste heat, solar) 5-1000 kW; cold storage (PCM/PCS)

Optimization of Energy Systems
Modeling and optimization of central and decentralized energy systems for the supply of power, heat, cold; LowEx; feasibility studies

RESOURCES MANAGEMENT

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Our competencies

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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- Personnel Development

PUBLIC RELATIONS

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- Public Relations
- Event Management
- Meda Design Digital and Print

IT MANAGEMENT

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- Network Management
- Individual IT Infrastructure
- Data Management

OCCUPATIONAL SAFTEY AND ENVIRONMENT PROTECTION

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- Consulting and Coordination
- Safety Analysis and Tests
- Registration Procedures

LIBRARY – SPECIALIST INFORMATION SERVICE

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- Specialist Information Service
- Support of Publications
- Archive

CENTRAL TECHNICAL SERVICES

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- Technical Services and Workshops
- Construction/CAD
- Operational Center

INNOVATION MANAGEMENT/ IPR

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- Innovation Management
- Industrial Property Rights/Licenses
- International Projects/EU

CHEMICAL LABORATORY

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- Inorganic Analysis
- Organic Analysis
- Development of Methods

ABOUT USEFUL ICE CREAM PARLORS AND "THE LOVELY COMPUTER"

In dialogue with Dipl.-Phys. Thorsten Wack

1. Knowledge worldwide doubles every five to seven years. You develop, along with your team, information and management systems meant to separate unnecessary knowledge from valuable knowledge.
What are such systems like?
They comprise two components. One component structures the knowledge. It creates the correct folder for the correct contents. The second component scans these contents with the aim of extracting relevant documents. It operates in a similar way to Google the difference being that, instead of browsing through the worldwide web, the number of documents (e.g. in a company) to be scanned is relatively small.

2. Are there certain sectors which are especially interested in this method?
The answer is no. The method is not restricted to any one particular sector. Many of our customers are small and medium sized enterprises in different sectors like metal-working companies or the operators of sewage treatment and waste incineration plants.
With our developments which always incorporate a server based computing component, we have specialized in companies with a filial/interdivisional structure. These are companies which have a lot of homogenous customers and which operate in a consolidated fashion.

3. You brought up the topic of server based computing. How would you explain to a child what this means?
I would take the child to an ice cream parlor and would simply try to distract it. (laughs) This topic is somewhat com-plicated.

4. Which is the most successful system already in operation?
GEVIS, the system which we developed for the management of hazardous materials at the Fraunhofer-Gesellschaft, is the mother of all our projects. What happens here is exactly as I mentioned at the start. Knowledge is structured and made, as a whole, available along with search mechanisms. This system has been in operation in the Fraunhofer-Gesellschaft since 2007 and is intensively used.

5. Which project are you working on at the moment?
Currently I'm looking into computer virtualization. This means that not only a single operating system is running at a workplace PC but rather a computer is the host system for numerous, varied operating systems which are virtualized on it. At the moment such a system is being developed by us here for the Fraunhofer-Gesellschaft. A virtualization platform is to be set up for each of the 59 Fraunhofer institutes , on which certain company services such as domain name service or e-mail or communications systems are mapped.
Currently we are developing the basic information to enable, in the future, the operation of a multitude of virtual computers in a so-called BladeCenter (more on this theme: pages 78/79).

6. Although knowledge management systems are useful,

many companies are wary of the existence of large data banks. Are there smaller solutions and what are they like?
Of course there are smaller solutions but they always involve cutting back. For this reason we propagate "Software as a Service". This is an operating model whereby the IT is not hosted at the customer's but is centralized. The end user no longer needs their own software products because all the services are outsourced and can be called upon on demand.

7. From a professional point of view, we have learnt a lot from you. Now we would like to know something about your private life. How do you personally manage to separate the unimportant from the important?
Difficult (laughs). Basically we are bombarded with so many things that we have to come to terms with. Trying to get the priorities right is often very hard. As far as the finding and storing of information is concerned, I am, through my work well equipped with algorithms and systems. I can cope well with that.

8. Have you got a favourite technical device?
Oh. I think the computer is my favourite device. I bought my first programmable pocket calculator when I was nine. From a very early age I was confronted with technology and became fascinated by it.

9. Do you read on the computer or do you have a book lying on your bedside table?
I find it difficult to read on the computer. That's why I've got books near my bedside. Currently I'm reading "Limit" by Frank Schätzing. An interesting book which fantasizes about the computer technology of the future.

Thorsten Wack is head of the business unit Information Technology in Process Engineering. He studied physics at the TU Dortmund and with the development of computer software, he made his hobby into his profession. The computer is actually his favourite technical device. He became completely enthralled by this at the age of nine when he bought his first programmable pocket calculator. In his free time he enjoys music and relaxing at home with his wife and son. When he himself isn't playing the accordion, drums or guitar, he listens to all kinds of music from classical to hard rock and heavy metal.

Frank Schätzing: Limit.
Publisher Kiepenheuer & Witsch
2009; ISBN-10: 3462037048

TRAINING CENTER/FRAUNHOFER ACADEMY

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

Sonja Hage, Volkswagen AG, Wolfsburg (graduate of the masters' degree program infernum)

"I have never learnt so much in just three days."

Participant of the Talent School in Oberhausen in 2009

TRAINING CENTER/ FRAUNHOFER ACADEMY

Master's degree infernum

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 for environmental sciences infernum (www.umweltwissenschaften.de) – in 2005 assigned the label "official project of the United Nations Decade 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. 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. infernum thus lays the knowledge foundation for the integration of ecologic, economic and social aspects of sustainability. The master's degree program enables networked thinking and encourages creativity and innovation capability. Graduates are qualified to realize sustainable approaches to complex environmental tasks in companies and in the society and to act as promoters with managerial responsibility and strategic vision.

As a distance learning program infernum supports its participants in working independently and in a structured way and in acquiring specific knowledge. The information is imparted by manageable learning units in the form of "Studienbriefe" as

well as by internet-supported units. Class-room seminars and excursions focusing on current research results and practical examples complete the program and help to intensify the contact between the participants and the supervising scientists. After the successful completion of the accredited program graduates are awarded a Master of Science (M.Sc.). infernum is offered in cooperation with the FernUniversität in Hagen (Open University) and is part of the Fraunhofer Academy.

The Fraunhofer Academy bundles the career development offers 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.academy.fraunhofer.de

Fraunhofer Talent School

The talents of today are the scientists of tomorrow. It is an important basis for our innovations to get into contact with creative, team-oriented and highly motivated young people. Since 2009 Fraunhofer UMSICHT has been participating in the Fraunhofer Talent School. The Talent School is a program for talented and technically interested teenagers from high school. In three-day workshops the pupils committedly work on interesting scientific topics such as "biomimetics", "energy supply of the future" and "biofuels". The workshops are complemented by an additional program offering interesting insights into the researchers' day-to-day work as well as into international scientific life.

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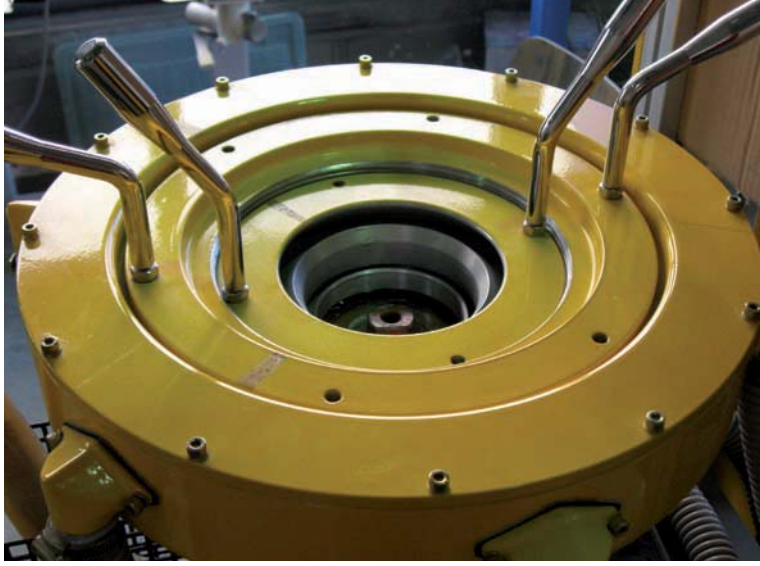

WILLICH BRANCH

At its site in Willich, Fraunhofer UMSICHT offers broad customer and future oriented services in the areas of plastics and recycling technology.

The properties of bioplastics available today must be adapted to the requirements of the industry. For this purpose UMSICHT's Willich branch puts the strategic focus on the development of tailor-made compounds on the basis of commercially available biopolymers. Utilizing natural fillers or reinforcement materials such as wood or mineral powders and natural fibers as well as further additives, materials based on renewable resources are developed according to the customers' requirements or geared to specific applications. Depending on the intended application the biodegradability of the materials can be adjusted in a broad range: from decomposition within a few hours in an aqueous environment over biodegrading within a couple of months under composting conditions up to long-term stability in normal usage. Another focus is the tailor-made design of resource-saving materials such as WPCs, nanocomposites and recycled plastics.

A number of different bioplastics has already been developed by Fraunhofer UMSICHT. They are used for various products such as injection molding compounds on the basis of cellulose acetate, a film compound with polylactic acid, carrier films for self-adhesive tapes, laminating films for biodegradable diapers, a highly transparent packaging film on the basis of polylactic acid, a hydrophobized starch foam to enhance the porosity of bricks and a film for special hygiene applications which decomposes quickly in an aqueous environment. Current research focuses on the foaming of biopolymers for different applications (find more on pp. 42/43).

Immediately after the compounds have been developed and optimized in our materials laboratory larger-sized sample quantities can be produced in the industrial-sized plants in our

BRANCH WILLICH

The Willich Branch of Fraunhofer UMSICHT is run as a service center. It adds to the R&D services of the institute in the field of plastics technology.

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You will find detailed instructions on how to get there at:
http://www.umsicht.fraunhofer.de/profil/anfahrt/

compounding facilities in Willich. Here, 5 twin-screw extruders with throughput capacities between 10 and 600 kg/h are available. Thus, short development times can be achieved and our customers can enjoy the advantage of having a competitive edge when launching the product on the market.

In parallel to process and material development mechanical and tribological material parameters are determined. Analyses on rheology, thermal behavior, chemical composition as well as on structure are carried out. Recycling concepts, market and feasibility studies complete the portfolio of the Willich branch.

The target is to generate proven and economical solutions which meet the customers' requirements. A broad range of technical facilities from laboratory to industrial scale and our know-how acquired in many years of research are available.

Materials laboratory:

- Hot-cold mixer, Labtech LMX-10-S-VSFJ
- 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
- Laboratory cast film line, Labtech LCR-300
- Laboratory thermoforming unit, Kiefel KFG 37

Testing laboratory:

- MFR tester, Meltflixer MVR MT
- MFR tester, CEAST TES-2
- Moisture analyzer, Sartorius MA-30
- Moisture analyzer, Aquatrac Brabender 3 E
- Vicat tester, Coesfeld HDT
- Dynamic differential scanning calorimetry (DSC), Mettler Toledo DSC 822
- Tear resistance tester, CEAST 6789

Extrusion lines:

- KM Berstorff ZE50A UTX
- KM Berstorff ZE50R UTXi
- 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 systems for the processing of powder, granulate and liquid raw materials

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ANALYTICS LABORATORY

Precise and reliable analytics are 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 standard procedures as well as the development of innovative, customized methods.

Examples from the analytics portfolio:

- Chromatographic methods: HPLC-MS, GC-MS, IC, GPC
- Thermoanalytical methods: DSC, TG (up to 1,000 °C and up to 1,600 °C)
- Spectroscopic methods: ICP-OES, IR (reflection and transmission, online coupling, TG-IR-coupling, film press), UV/VIS, IR databases
- Analytics of: plastics, refuse derived fuels (RDF), fats, oils, organic acids, alcohols, hormones, tar
- Elementary analysis
- Characterization of fuels and biofuels

The validation of the measuring results is conducted via comparison with external laboratories (ring testing).

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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.
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 EN 13432, DIN EN 14995, ASTM 6400 we offer:

- Microbiological analyses according to DIN, ISO, OECD-processes
- Testing of biodegradability under aerobic and anaerobic conditions
  (e.g. AT4 and GB21 according to "Abfallablagerungsverordnung" [Regulations concerning waste disposal])
- Development of biotechnological production processes
- Fermentation tests according to VDI guideline 4630

PHYSICAL LABORATORY

The portfolio for the characterization of dispersions, powders, polymeric compounds, hydrogels and specific nano and microparticles for material science and particle technology comprises:

- 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)

CHEMICAL LABORATORY

The chemical laboratory focuses on:

- Parallel reactor system, reaction calorimeter
- Biofuels: small-scale systems for the cleaning of biodiesel products (flash distillation, miniplant 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 the use of special gases.

Analytical problems are solved in co-operation with the analytics and physical laboratories.

HIGH PRESSURE LABORATORY

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

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

The fixed-bed reactor and the stirred tank reactor are fully automated and can thus be operated non-stop. An IR device including a probe which is laid out for high pressures and temperatures is available for the online monitoring of reactions.

RENEWABLE RESOURCES

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.

In biogas plants organic substances are digested in an air-free environment. Common raw materials include liquid animal manure, leftovers and by-products of food processing (e. g. distillery pulp) as well as fresh plants or plant parts (e. g. silage or sugar beet leaves). After insertion into the digester the raw materials are degraded by bacteria. The generated gas contains high amounts of methane and can be fed into combined heat and power plants for electricity production and district heating. The remaining digestate can be used as fertilizer.

LIQUID MANURE FOR BIOGAS PLANTS: WHAT ABOUT QUALITY?

Biogas plants convert biomass into biogas and liquid digestate. Typical end products include electricity, heat and fertilizer. If the fermentation process runs successfully, the biogas quantities and the methane content in the biogas are high. If liquid manure is used as raw material, the fermentation can be adversely affected by drug residues leading to reduced biogas yield and quality. Antibiotics, disinfectants and copper sulfate are frequently used in animal farming. Their effect on the biogas process was investigated within the framework of a research project.

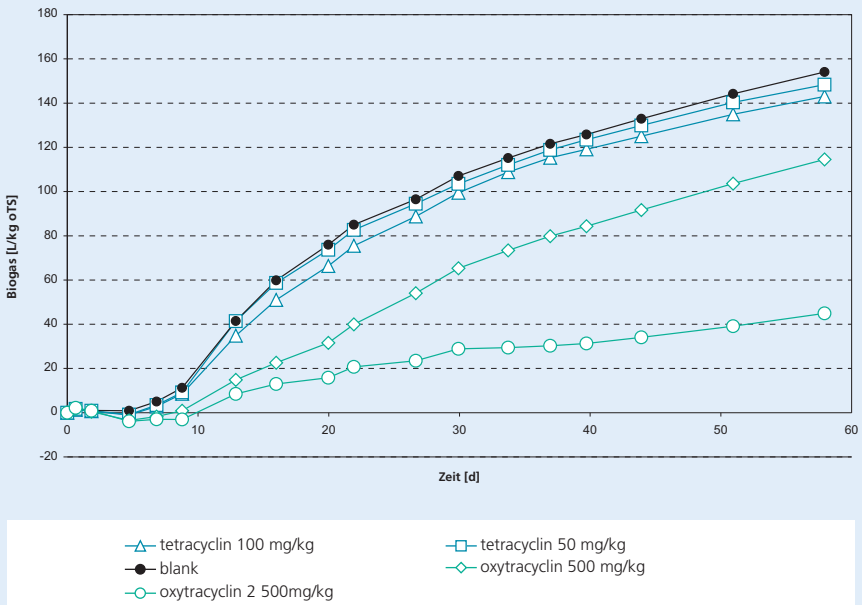
The investigation of the effects of potential inhibitors was carried out on a laboratory scale using batch fermentation systems in accordance with German standard VDI 4630. The figure illustrates the progression of biogas generation when liquid manure is contaminated by oxytetracycline and tetracycline, two major antibiotic substances. Biogas yield decreases with an increasing concentration of inhibitory substances. At various levels of concentration, the inhibitory effect was analyzed for different types of antibiotics and disinfectants. Additionally, copper sulfate was tested, which usually gets into the manure by feed containing copper or by spillage after claw disinfection. The results of this investigation were used to determine individual threshold levels for all substances considered. These levels specify at which concentration inhibitory effects are likely to occur. Operators of biogas plants can use these figures to determine the appropriate course of action – e. g. dilution or removal of the entire charge – in order to stabilize the production of biogas. For this decision-making process, the liquid manure must be analyzed unless type and dosage of the ingested medication are known.

If animals are treated with chlortetracycline or sulfamethazine, the production of biogas is likely to be impeded. When applied regularly, sulfadiazine should not inhibit biogas production. As opposed to sulfamethazine, this substance decomposes during the anaerobic digestion process. Disinfectants such as quaternary ammonia compounds and triclosan may have an adverse effect if the concentration of these substances within the manure is too high – for example after overdosing. A specific failure analysis during the project revealed that an improper application of copper sulfate was the reason for biogas yield decrease.

The final report of this research project[1] (AiF-FV 185 Z, Entwicklung eines mikrobiellen Schnelltests zur Identifizierung von Hemmstoffen bei anaeroben Gärprozessen) is available for download at: www.veu.de (Publikationen/Schlussberichte)

[1] Financial support by the Federal Ministry of Economics and Technology (BMWi) initialized by the German Federation of Industrial Cooperative Research Associations

Biogas generation in fermentation test with various concentrations of oxytetracyclin (OTC) and tetracyclin (TC)



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Prof. Dr. Gerd Hamscher, M. Sc. Dipl.-Ing. Siegrun Mohring, Institute of food toxicology and Chemical Analytics, University of Veterinary Medicine, Foundation, Hanover

Algae are rapidly growing organisms living in water. The carbon essential for their growth comes from carbon dioxide. Due to their ingredients like pigments, antioxidants and polysaccharides, algae rank among the more important raw materials for the food, cosmetic, and pharmaceutical industries.

Some algae contain high amounts of lipids and are of interest to the fuel industry. Lipids are hydrophobic organic substances, e. g. oils, that are necessary to produce biodiesel. Macroalgae are produced primarily for the food industry and have been irrelevant to the fuel sector up to now.

ALGAE FUELS: FOCUS ON COSTS

The fuel industry focuses on algae as suppliers of raw materials, ranging from microalgae starting at just four micrometers in size. Fuel production process options and fuel prices based on the cultivation of algae are currently under investigation worldwide. Algae offer several advantages: rapid growth, high oil content based on acreage, and cultivation without competing with food or feed in contrast to high production and harvesting costs.
A sensitivity analysis reveals the cost structure of algae cultivation and identifies the most promising potential savings.

Algae do not need fertile soils to grow. In contrast to oil-rich field crops they do not need arable land suitable for food or feed production. Furthermore, they grow rapidly and show acreage-based oil yields that exceed those of field crops (e. g. oil palm, rape seed or soybean) by far. Therefore, algae are viewed favorably as raw materials.

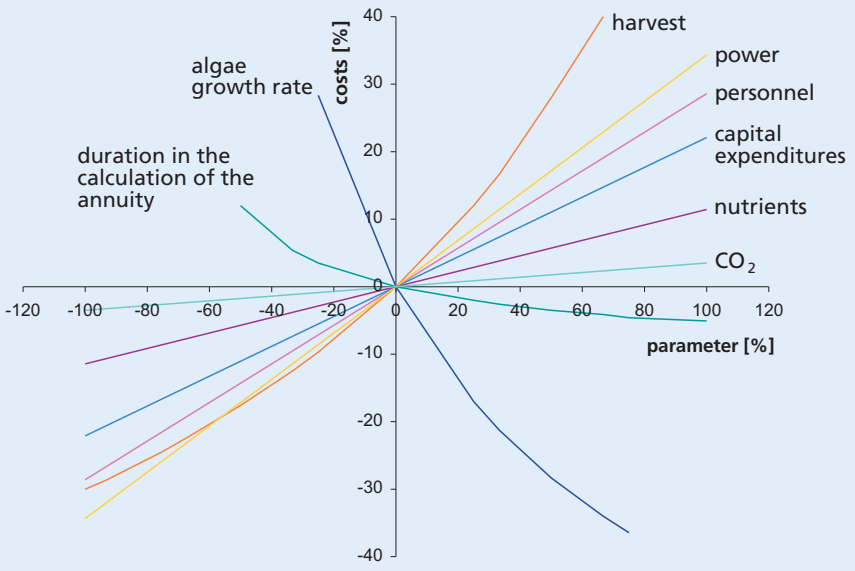
However, the apparently high production costs considerably dampen interest in commercial fuel production from algae. Currently algae oil is not able to compete with oil from field crops. A high portion of the oil costs is due to algae harvesting, which is complicated by small sizes and low concentrations of algae in the culture broth.

Common technologies for harvesting algae are sedimentation, filtration, and centrifugation. In sedimentation flocculation agents have to be added to the culture broth due to the small settling velocity of the cells. Algae filtration processes are tedious, too. They are used only for micro algae of larger sizes and small volumes of culture broth. Centrifugation enables the processing of large volumes quite rapidly, but it requires a high expenditure of energy.

Figure 1 shows the results of a sensitivity analysis regarding the cost structure of algae cultivation carried out by Fraunhofer UMSICHT. Starting from a base case shown in the point of origin, different parameters were applied. The diagram illustrates how the costs of production change with parameter variation. Considerable savings result primarily from maximization of the algae growth rate, minimization of power consumption, and optimization of harvesting processes.

The growth rate of algae can be increased by biotechnological methods or by developing appropriate photobioreactors. Along with these optimizations, energy-saving methods of harvesting have to be developed and existing processes must be optimized to enable future cost-efficient production of valuable substances and fuels from algae.

Results of the sensitivity analysis regarding the production costs of algae



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The term bioplastics is used in a variety of specialized areas:

1. For plastics that are derived from renewable resources (= biomass) the prefix "bio" indicates the origin of the raw materials and distinguishes bioplastics from conventional oil-based plastics.
2. For biodegradable plastics, the prefix "bio" describes, that the material can be broken down by micro-organisms. Biodegradable plastics can be based on either biomass or oil.
3. In the case of medical products, the prefix "bio" expresses the biological compatibility or the resorptive characteristic of the plastics in human or animal bodies and their application in living organisms.

Here the term "bioplastics" is used for plastics that are derived from renewable resources.

RESOURCE-EFFICIENT INJECTION MOLDING OF BIOPLASTICS

A great number of successful products and high growth rates prove the successful development of a range of competitive bioplastics in recent years. Fraunhofer UMSICHT contributes to this environmentally friendly innovation: Under the trade name Biograde® we developed, together with the FKuR Kunststoff GmbH, a series of bioplastics for injection molding applications based on cellulose. We also provide consulting services for the injection molding industry and mold makers concerning the technical application of bioplastics. If the specific properties of Biograde® are considered in the design phase of the plastic part and the mold and in the injection molding process itself, the efficiency of the production process increases and raw material use can be minimized.

Biograde®, the "Biomaterial of the year 2008", comes in different forms: transparent or filled, scratch-resistant, and colorable. Typical products are writing devices, cutlery, biodegradable burial articles, and technical molded parts for consumer goods. The injection molding compounds have a high stiffness from 3,500 to 4,500 MPa and thermal stability of more than 110 °C according to Vicat A. At low wall thicknesses, the materials are certified as compostable according to EN 13432.

The bioplastics of the Biograde® series can be used in a wide processing window between 190 and 220 °C on conventional injection molding machines. Even at low wall thicknesses of 0.5 to 1.0 mm a flow length of more than 150 mm is attainable. Special knowledge of the injection molding processor or specific periphery is not necessary when using

Biograde®. With consideration of the flow characteristics and the thermal degradability, hot runner systems can also be used. In practice these bioplastics are often processed on existing injection molds that were designed for conventional plastics, such as polystyrene, ABS, or polypropylene. Although this is possible in principle, it often leads to limited productivity.

Using the example of cutlery manufacture, the possible improvements gained by specific tool design suitable for bioplastics – such as optimization of runner system, gate, and mold venting – can be seen. The injection speed was increased while simultaneously decreasing injection pressure. Part weight and cycle time were reduced considerably. Furthermore, product quality, mold life, and machine energy consumption increased as well.

Considerable improvements in material and energy efficiency and process economics can be achieved by rigorous consideration of the specific properties of Biograde® in mold design and manufacturing processes. Fraunhofer UMSICHT's application consultancy for the injection molding industry and mold makers contributes to this sustainable development.

Improvement of cutlery manufacturing

	2001	2008
injection mould	PS-mould	mould designed for Biograde C 9550
mould availability	approx. 80 %	> 98 %
scrap rate	2 to 10 %	< 0,1 %
injection pressure	2,000 to 2,500 bar	1,700 bar
part wall thickness (fork)	1,0 to 1,5 mm	0,7 to 1,2 mm
moulded part weight (fork)	5,5 g	4,2 g
cycle time	17 s	6 to 8 s

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Cellulose acetate is a cellulose-based thermoplastic polymer. Cellulose is the most abundant and important renewable polymer in the world. Wood for instance contains approx. 45 % cellulose.

Like almost all plastics, cellulose acetate can be processed into foam, a material with a cellular structure and low density. Regarding the blowing agent, different foaming processes can be distinguished:

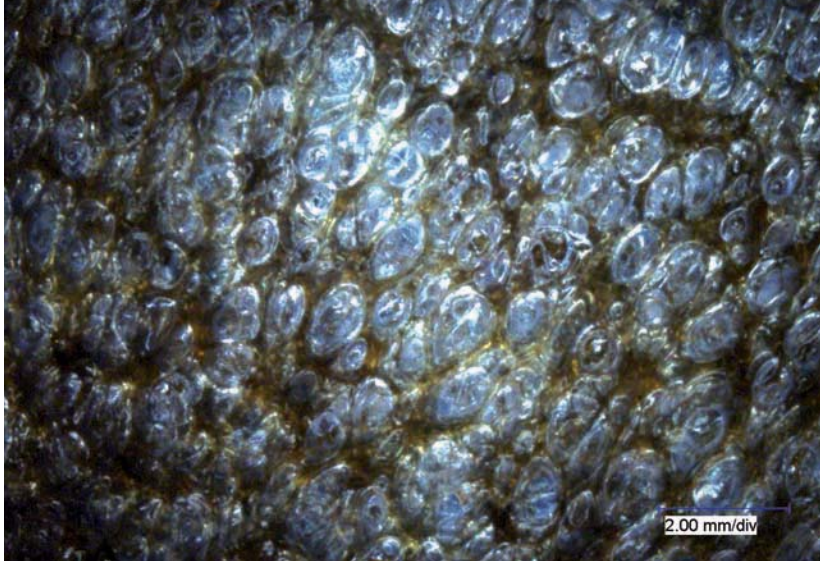
- Chemical foaming: a chemical blowing agent is added to the plastic granulate. During melting and dissipation it decomposes, releasing gas for polymer foaming.
- Physical foaming: a physical process is used to foam the material, such as vaporizing the blowing agent.
- Mechanical foaming: gas is stirred into the material. When cross-linking or gel formation is induced simultaneously, foam formation occurs.

ECOLOGICAL PACKAGING FOR HOT FOOD

Polystyrene (PS) has long been used as the standard material for hot food packaging. Fraunhofer UMSICHT is well known for its research on biopolymers to develop a portfolio of sustainable products for the packaging industry. A present co-operative project with FKuR Kunststoff GmbH and Inde Plastik GmbH focuses on thermoformable foam sheets based on cellulose acetate (CA) for hot food trays. This project is funded by the Federal Ministry of Food, Agriculture and Consumer Protection and the German Agency for Renewable Resources FNR (Fachagentur Nachwachsende Rohstoffe e.V.).

CA exhibits process and product properties comparable to PS. Especially high heat resistance and acceptable foamability in conjunction with good mechanical properties make CA a suitable replacement for petroleum-based PS in a number of applications. Since it is based on a renewable resource and is biodegradable, CA offers unique opportunities for alternative eco-efficient and competitive waste management and disposal routes for used catering articles such as composting.

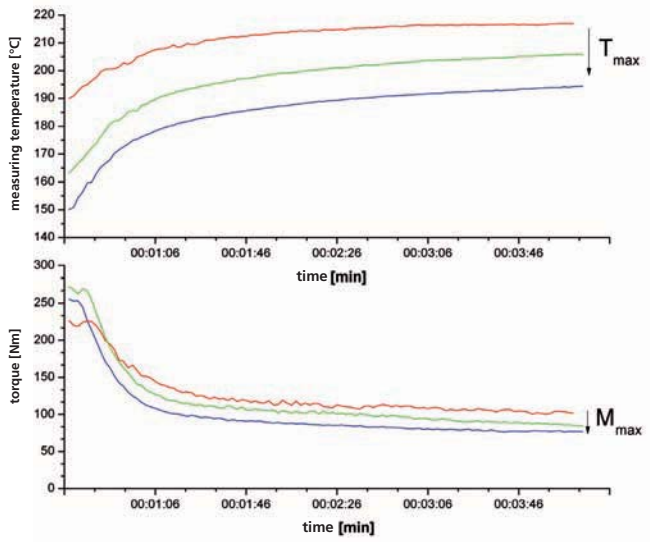
Generally, CA exhibits good foaming behavior, as proven in preliminary foam sheet extrusion tests with chemical blowing agents. These foam sheets also showed very good thermoforming properties. During thermoplastic processing and chemical foaming of biopolymers, several problems can occur, however, such as uncontrolled decomposition of the cellulose acetate. Thus, discoloration, poor foam properties (e.g. poor foam ratio) as well as poor end-use properties (e.g. loss of stiffness) are the consequences. Moreover, density reduction is limited by using chemical blowing agents.



For these reasons, Fraunhofer UMSICHT is currently researching bio-based foaming using physical blowing agents. Cellulose acetate has to be modified to achieve required rheological properties and high gas solubility in the polymer melt to induce good foaming. Furthermore, the mechanical and thermal properties must be specifically adapted to the product requirements. For example, the use of efficient plasticizers broadens the thermoplastic processing window of cellulose acetate significantly and reduces thermo-mechanical stress during processing, as the modification of cellulose acetate using physical and reactive plasticizers followed by characterization of the compound show.

The focus of research is on the investigation of foaming mechanisms and their optimization. The use of different physical blowing agents in different concentrations, the addition of nucleating agents, and the optimization of processing parameters are all being investigated.

Influence of the content of softening agent (triethylcitrate TEC) on the melt processing of cellulose acetate



CA 85wt-% + TEC 15wt-%
CA 80wt-% + TEC 20wt-%
CA 75wt-% + TEC 25wt-%

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Project partners:
Inde Plastik GmbH, Aldenhoven
FKuR Kunststoff GmbH, Willich

PROCESS TECHNOLOGY

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.

GAS HYDRATES: SOURCE OF ENERGY AND CARBON DIOXIDE STORAGE

USE OF ADSORPTION IN ENVIRONMENTAL AND ENERGY TECHNOLOGY

SUSTAINABLE USE OF PLANT-DERIVED RAW MATERIALS IN INDUSTRY

FOULING REPELLENT MICROSIEVES USING NANO-TECHNOLOGY

GAS HYDRATES: SOURCE OF ENERGY AND CARBON DIOXIDE STORAGE

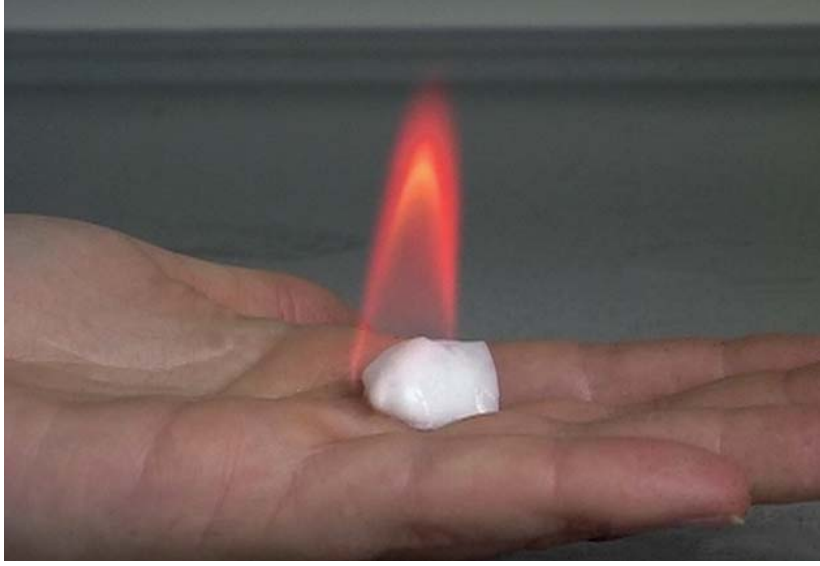
Elevated pressure and low temperature – those are perfect conditions for gas hydrates. These same conditions are present in permafrost regions of Siberia and on the ocean floor. Since natural gas hydrates were discovered, this resource has attracted interest worldwide. Hydrates are considered a potential energy source and promisingly means of future carbon dioxide storage. Fraunhofer UMSICHT does research in the area of hydrates and develops fundamental knowledge concerning the formation and destabilization of hydrates and investigates aspects of the exploitation process. In doing so, it contributes to the sustainable utilization of hydrates.

Gas hydrates are ice-like, solid compounds of water and gas, which are stable only at high pressure and low temperatures. The physical clathrate compounds consist of water molecules which form a crystalline lattice of cages filled with small gas molecules such as methane, propane, carbon dioxide or their mixtures.

Accidentally discovered by Sir Davy (1810), gas hydrates remained largely a laboratory curiosity and were given little attention. In the 1930s hydrates turned up as the cause of accidents during transportation of natural gas in pipelines. Investigations aimed at preventing the formation of hydrates launched a new field of research. With the discovery of natural hydrate deposits in permafrost regions of Siberia in the 1960s and subsequently in deep sea sediments, interest in utilization of that resource continues to grow worldwide.

According to estimates, the amount of carbon bonded in methane hydrates worldwide is two times larger than in all known conventional fossil fuels (coal, natural gas and oil). Gas hydrates are not only considered an interesting energy source, but also a means to store carbon dioxide. CO_2 can be stored as hydrates in the ocean sediment, while during its injection methane is released and becomes available as a source of energy. The exploitation of methane hydrates is difficult, however, since these reserves cannot be accessed easily.

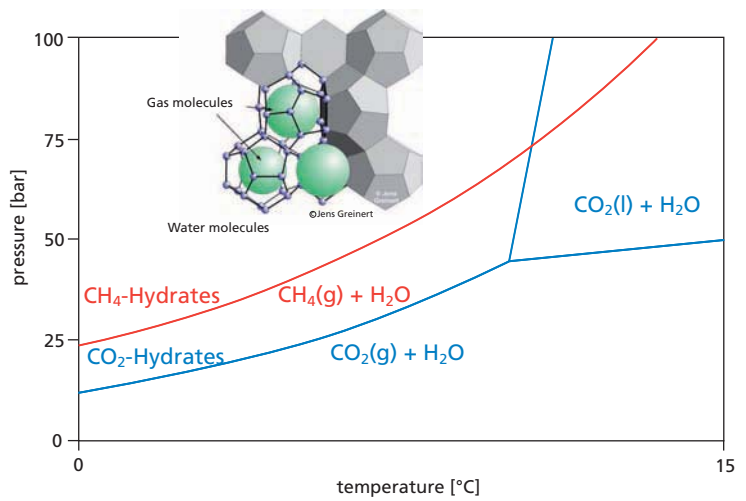
Within the scope of the "SUGAR" project, in which Fraunhofer UMSICHT is involved, new technologies for the exploration and exploitation of deep sea methane hydrates and the simultaneous sequestration of carbon dioxide are being developed and investigated, along with new concepts for the transport of natural gas. The SUGAR project is funded by the Federal



Ministry for Education and Research (BMBF), the Federal Ministry of Economics and Technology (BMWi) and private industry and aims to comprehensively cover relevant aspects of the extraction process.

Researchers are investigating various extraction techniques and components and refining, among others, a mammoth-pump principle for simultaneous gas production and CO_2 sequestration, which was developed at Fraunhofer UMSICHT. Under the coordination of Fraunhofer UMSICHT the exploitation of hydrates will be simulated and evaluated using numerical models and taking technical, economic and ecological aspects into account. Against the backdrop of different aspects of gas hydrate technology, fundamental knowledge of the formation and decomposition processes of hydrates is required. By investigating hydrates in a high pressure laboratory and in computer simulations, Fraunhofer UMSICHT is making its contribution to the development, utilization and establishment of hydrates in the field of process technology. The results of this research will provide deeper insights into gas hydrates, validate methods for calculating thermodynamical equilibria, and analyze and evaluate the feasibility of deep sea gas hydrates applications.

Phase diagram of two gas hydrates



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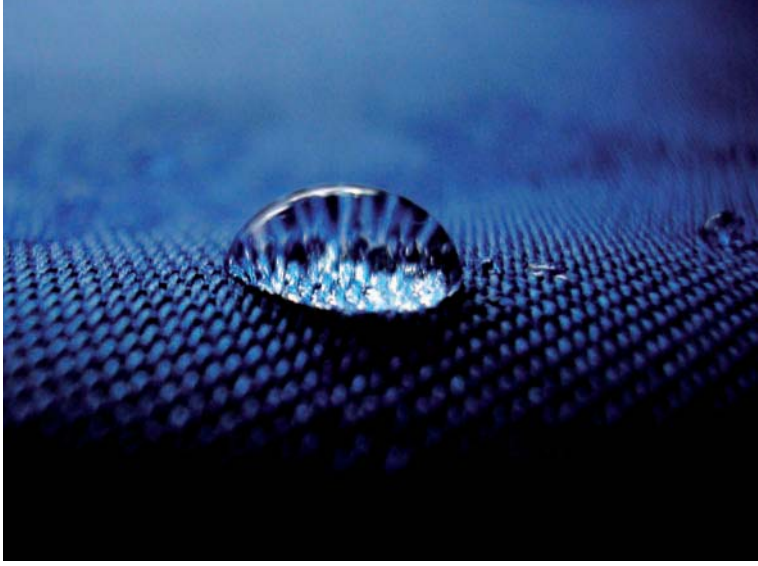


Adsorption is the process of attachment of molecules from the gaseous or fluid phase to a solid surface. Corresponding to the forces involved a distinction is made between physical adsorption (physisorption) and chemisorption (chemical bonds). Typical application areas are respiratory protection systems, water and air purification and gas separations. The storage of fuel by adsorption (Adsorbed Natural Gas ANG; hydrogen) will become more important for decentralized energy storage.

USE OF ADSORPTION IN ENVIRONMENTAL AND ENERGY TECHNOLOGY

Adsorption is one of the key technologies for separating and purifying materials in the chemical, petrochemical and pharmaceutical industries. Future environmental and energy technology and storage materials – (air and water purification, for example) will certainly feature a key role for adsorption as well. Fraunhofer UMSICHT advances these developments and uses its know-how in the field of adsorption to optimize this technology and to enlarge its scope of application.

Storage of CO_2 by adsorption

Since the beginning of the 20th century, the average global temperature has risen by nearly 0,6 °C. This increase is attributed to a great extent to human activities. In particular the combustion of fossil fuels releases carbon dioxide, a main anthropogenic greenhouse gas. Emission of anthropogenic carbon dioxide is considered one of the main causes of the global climate change. Since strategies to prevent carbon dioxide emissions aren't sufficient to stop climate change, methods of separating and storing carbon dioxide are increasingly under discussion.

In the European COALSWAD project the feasibility of carbon dioxide storage in abandoned coal seams is being investigated. Our research is targeted at improving knowledge of adsorption behavior of natural Czech, German and Spanish coal. This will include associated processes like swelling and shrinkage. COALSWAD is funded by the Research Fund of Coal and Steel.

Optimization of vapor restraint systems for bio-alcohol fuel blends

According to a publication of the Agency for Renewable

Resources (FNR), about 52 million tonnes of fuel were used in 2008. Along with diesel (55 %) and gasoline (39 %), the amount of biogenic fuel was minimal (5.9 %). Fuel vapor restraint systems used in vehicles to avoid emission of volatile hydrocarbons are well suited to fossil fuels, but in the case of bioalcohol fuel blends, their functionality must be investigated.

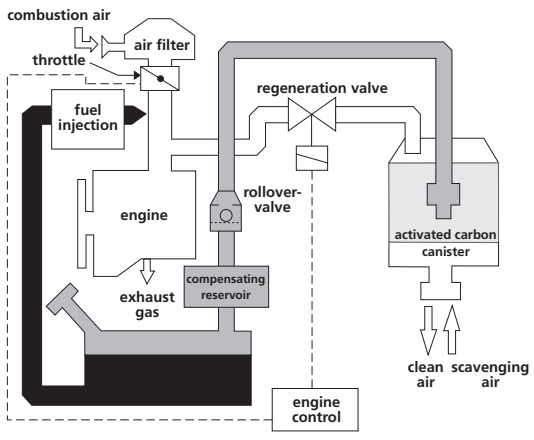
Fraunhofer UMSICHT investigates the functionality of fuel vapor restraint systems in relation to the composition of bioalcohol fuel blends, the influence of water and the adsorbents used. Our results and data measured serve as input for a mathematical model, the goal of which is to simulate performance of fuel vapor restraint systems depending on the composition of the specific bio fuel. As a consequence, longer development times in the industry can be shortened, enabling fast reactions to changes in fuel composition.

These investigations are funded by the Federation of Industrial Research Associations, Otto von Guericke e.V. (AIF) and by the Agency for Renewable Resources (FNR).

Fraunhofer UMSICHT provides long-term knowledge in a number of areas:

- Characterization of adsorbents (mechanical, physical and chemical parameters; pore structure, etc.)
- Development of customized activated carbons; doping or impregnation of activated carbons
- Production of carbon molecular sieves
- Investigation of fuel vapor restraint systems
- Investigation of the adsorption behavior of hard coal
- Dynamics of adsorption processes
- Modeling and simulation of adsorbers

Functional schematic of fuel vapor restraint systems



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Renewable raw materials are by definition agricultural and forestry generated products, which are not used as food or feed, but rather to produce heat, electricity, fuels or precursors for material applications. Biomass is the generic term and encompasses all organic matter.

Surfactants reduce the surface tension of a liquid or the interfacial tension between two phases. They promote the formation of dispersions, i.e. they allow the fine blending of two liquids that are generally mutually immiscible. Wash-active substances (detergents) belong to the group of surfactants.

Modern surfactants have widely replaced the traditional surfactant soap (fatty acid salts). In the food industry, surfactants are used as emulsifiers.

SUSTAINABLE USE OF PLANT-DERIVED RAW MATERIALS IN INDUSTRY

Sustainable development is a growing social need. There is hardly any area in which it is as widely accepted as in the field of raw materials and energy supply. Here the use of biomass is the trend. In addition to their main use as food and feed, biomass is put to industrial use to manufacture clothing, medicines, plastics and fuels. Taking into account the long-term and economic availability of biomass, the primary goal is to utilize the full potential of plants as food and feed as well as for technical applications. Fraunhofer UMSICHT rigorously pursues this goal. As part of one of its key research areas, Fraunhofer UMSICHT is developing biorefinery concepts to integrate recycling and use of renewable resources for energy.

In principle the success of petroleum technology is based on a simple formula: Low-cost mass products such as fuels are produced in association with high-priced and high-quality products for the chemical industry.

With the idea of biorefinery Fraunhofer UMSICHT takes this concept and applies it to the use of renewable raw materials. Because of the diversity of possible bio-materials and logistical constraints, however, there can never be one single type of biorefinery. Rather Fraunhofer UMSICHT develops specific process chains that take into account economic and ecological aspects.

In cooperation with project partners from industry and academia, Fraunhofer UMSICHT currently handles various projects that are focused on the industrial use of raw plant materials. These investigations take place along the entire value chain.

Based on the identification of product requirements and the selection of possible sources of raw materials, Fraunhofer UMSICHT analyses necessary bioconversion and downstream processing procedures for product recovery. Suitable laboratory and pilot plant facilities are available for these experiments. Comprehensive analysis can be drawn on to determine product and process-relevant parameters.

The main goal of one current research project is the development and production of novel surfactants based on renewable raw materials. The products should have a wide range of application and good biodegradability. Based on the results already achieved, Fraunhofer UMSICHT has been able to determine the amounts of enzyme needed for the substrate-enzyme combinations used, the degree of hydrolysis achieved, and the product's molecular size distribution.

In another research project, the changeover from petrochemical raw materials to renewable plant raw materials is the main target taking into account sustainable economic and ecological production of recyclables. Fraunhofer UMSICHT analyzes, optimizes, compares and evaluates extractive processes for the recovery of polyphenols as well as thermal and extractive processes for fatty acid extraction.

Polyphenols are aromatic compounds which contain two or more hydroxyl (OH) groups directly bonded to the aromatic ring. In plants, they appear as dyes, odorous substances and tanning agents. They protect the plants against the danger of being eaten or attract insects for pollination. Many polyphenols as well as some fatty acids are considered to have health benefits. The sodium or potassium salts of higher fatty acids are known in soaps and are used as surfactants. In the food industry they are mainly used as raw material for emulsifiers. In highly purified form, they also find application in polymer synthesis.

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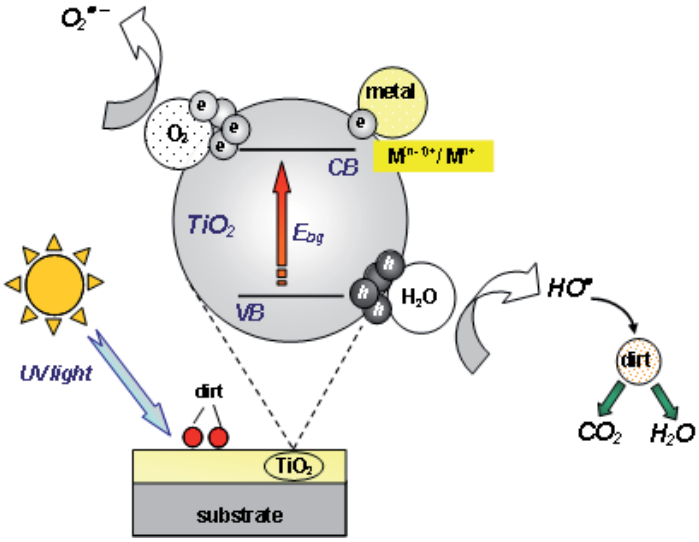

FOULING REPELLENT MICROSIEVES USING NANOTECHNOLOGY

70 percent of the earth is covered with water. World-wide water resources amount to about 1.3 billion cubic meters of water. However, despite of this large amount of water, many regions suffer from a lack of water. Only 3.5 % of global water is freshwater and some of that is ice and is bound at the poles, in glaciers and in permafrost soils. Freshwater is also unequally distributed around the globe. The inadequacy or even absence of drinking water for large parts of world-wide human population presents one of the most important challenges for the next decades.

In many regions of the world drinking water of high quality is a finite resource. According to the UN World Water Development Report No. 3 from 2009, it is estimated that within the next 20 years 47 % of the global population will live in areas with serious water shortages. Using membrane filtration processes which enable the precise separation of process streams in reusable components, water cycles can be closed, wastewater can be treated and drinking water can be generated. Fraunhofer UMSICHT is engaged in optimizing membrane processes and developing micro filters for water technologies that contribute to improving the quality of life.

Fraunhofer UMSICHT developed a novel type of micro filter that removes particles and microorganisms from water and wastewater. Specific characteristic of the filter are the billion isopores covering a filtration area of 15 cm². Filters with diameters varying from a size of 0.5 to 10 µm can be tailored. These high flux microsieves feature enormous water fluxes. However, when filtering particle loaded media, filtration efficiency is drastically decreased. Within a few minutes a filter cake is formed that can completely block the filter and totally compromises the high filtration capacity realizable with pure water in worst case. Corresponding to Cho* the annual economic damage resulting from fouling processes due to membrane clogging amounts to 0.25 of the gross domestic product, which represents around 2 billion euros for Germany.

Fraunhofer UMSICHT's research activities within the nano-efficiency project aim to develop advanced coating processes for microsieves that generate an antifouling effect. The coating layer will be anti corrosive, permanently adhesive, will not

Supervised by

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Projektträger Karlsruhe
im Karlsruher Institut für Technologie

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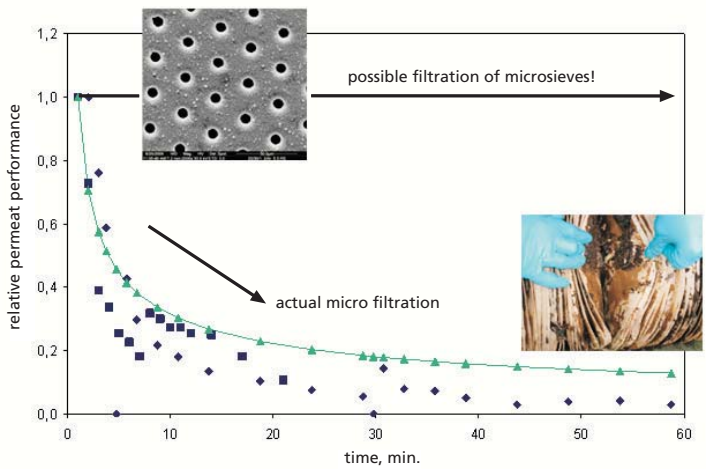
dissipate, and will be less than 100 nanometers thick. The surface of the microsieve is to be covered with reactive anti-fouling layers comprising titanium dioxide that meets these criteria. Titanium dioxide acts as a photocatalyst that destroys organic contaminants, including bacteria, when it is irradiated by UV light.

Since the beginning of the project in spring 2009, certain kinds of coating-based titanium dioxide nano particles have been applied using a dip coating process. Here, the microsieve is dipped in the coating dispersion and removed, while a thin titanium dioxide film adheres to the microsieve surface. This photocatalytic layer has proven to be highly resistant to abrasion and solving agents. Currently, further investigations at laboratory scale are being carried out to determine the anti-fouling effect of the coating. To that end, an experimental set-up has been installed for on-line examination of the photocatalytic degradation processes. The fouling repellent microsieves are to be implemented in a filter module that includes an integrated light source. The microsieve module is applied to a portable water treatment system for decentralized drinking water generation that is provided by one of the project partners.

The results of the BMBF Nanoefficiency project are reported continuously at www.nano-water.de.

Decline of the filtrate performance due to fouling processes



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[1] Cho, Y. I., Lee, S. H. and Kim, W., ASHREA Transactions 109, 2003

above left:
Principle photocatalytic action mechanism of titanium dioxide

BIOFUELS

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

We develop production processes for sustainable biofuels and bio-based products. Feedstock are renewable resources, bio-based intermediates and residues in various grades of purity.

FOSSIL FUELS FROM BIO-BASED RAW MATERIALS

ENVIRONMENTALLY BENIGN DE-ICING AND ANTIFREEZE AGENTS

BIO-BASED LONGER CHAIN ALCOHOLS AS FUELS AND CHEMICAL INTERMEDIATES

Parallel to the ongoing R&D the Institute strives for commercialization of the related patent portfolio together with Swiss-based "Founding Angel" Festel Capital. In that connection, a team of UMSICHT won fourth place in the national 11th Science4Life Venture-Cup competition, funded by the state of Hesse and Sanofi-Aventis Deutschland GmbH.
In 2009 greasoline® made it to place 3 in the business plan competition of the start-ups program BEST EXCELLENCE Rhein-Main of the F.A.Z. Institute.

Furthermore, the business unit plays an active role in leading the working group "sustainable resources supply" of the sevice and accompanying project of the BMU funding program mentioned in the text.

FOSSIL FUELS FROM BIO-BASED RAW MATERIALS

Every year nature produces a large amount of biomass. After feed and food products are consumed bio-based residues and wastes remain, among them materials such as cattle and pig manure, stalks, food residues, wood chips, domestic waste and sewage water. The supply of potential feedstock is therefore larger than the market for potential products. In that context Fraunhofer UMSICHT develops processes for converting residues from fat and oils into fossil-like fuels. With efficient utilization of these residues, the Institute supports a sustainable energy supply and the recycling of residues.

For many years, a major focus of the Biofuels business unit has been the conversion of used frying oils into long-chain hydrocarbons, which are identical to fossil fuels in the so-called greasoline®[1] process. Ongoing studies also concentrate on alternative residues and product lines. This work is funded by the German Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in two separate projects of the funding program "Energetische Biomassenutzung" (energetic utilization of biomass).

In order to keep the process simple, Fraunhofer UMSICHT investigates the conversion of fat and oil-based residues at temperatures between 450-550 °C at ambient pressure, employing activated carbon as catalyst. This method is the basis of the greasoline® process. Essentially it converts purified used frying oils and other related waste oils under inert gas, using activated carbon as catalyst.

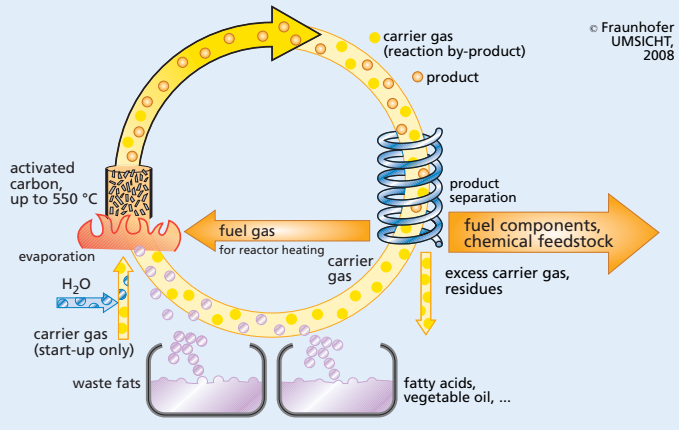
During catalytic conversion fats and oils are split in a way that all oxygen is detached from the feedstock molecules and a

so-called deoxygenation is achieved. Reaction products are cooled and separated. Gaseous products and inert gases, if present, are partially purged and are recycled as a source of energy to reduce the net energy consumption. Any remaining residues are separated and all liquid hydrocarbons are collected for use as biofuels.

The first project funded by the BMU, "Conversion of Bio-based Residues into Gasoline and Diesel Fuel via Catalytic Cracking", aims at expanding the greasoline® process for use with a broader range of bio-based raw materials. Feedstock like trap grease and residues consisting of fatty acids from vegetable oil processing as well as used bio-hydraulic fluids are converted at lab-scale to liquid hydrocarbons. A modified mini-plant can employ new raw materials and can also feed two raw materials simultaneously. The modified mini-plant also mimics an existing pilot plant in terms of materials of construction and processing in order to facilitate subsequent scale-up. This way it will be easy to re-produce the method and to supply larger amounts of fuels for engine testing.

During the Greasoline conversion process, gaseous hydrocarbons and a low-boiling naptha fraction are always produced. In the second project funded by BMU, "SNG und LPG from Bio-based Residues – Technical Feasibility and Exploitation Potential," the gaseous fraction is targeted as primary product. Potential applications include substitute natural gas (SNG) and liquefied petroleum gas, (LPG) or chemical intermediates.

Process scheme



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

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Road salt is used worldwide as de-icing agent and is used in large quantities. In the state of North-Rhine Westphalia, located in central Germany and home of 17 million people, peak consumption is up to 10,000 tonnes per day.

Due to the high environmental impact, use of road salt for de-icing and as an anti-freezing agent for private purposes is prohibited in many cities in Germany. However, many people disregard this ban because of their liability for accidents on their premises caused by snow and ice. Alternative de-icing agents with reasonable pricing are currently not available for private use.

ENVIRONMENTALLY BENIGN DE-ICING AND ANTIFREEZE AGENTS

Winter 2009/2010 kicked in very suddenly and a shortage of road salt triggered a gridlock on German roads. In 2005 about 3,1 million tonnes of road salt provided safe driving conditions in Germany. However, road salt has a negative impact on ground water, harms biological systems (e.g. trees alongside roads), and triggers severe corrosion on concrete, bridges and metal parts of cars. So the ecological and economic consequences resulting from commercial road salts are significant. Using inexpensive raw materials and residues, like glycerol and sugar-processing residues, Fraunhofer UMSICHT is developing an environmentally compatible line of products that can at least partially replace commercially available road salt.

Road salt is almost exclusively applied for de-icing of private premises, roads and public places of municipalities, cities and highways. It is used in liquid or solid form and consists of more than 95 % table salt, so-called sodium chloride. However, it can also consist of calcium and magnesium chloride, which are equally harmful to the environment and to many materials used in construction.

Fraunhofer UMSICHT banks on salts made from lactic acids, so-called lactates, and salts from sugar acids in developing alternative, environmentally friendly de-icing products for commercial and private use. Using a chemical catalytic process, alternative products can be provided in a cost-effective manner, preferably from bio-based residues. Preferred starting materials are aqueous solutions of glycerol resulting from biodiesel processing or fat splitting, residues from sugar processing (e.g. molasses) and from starch pro-cessing. In

contrast to fermentation-based processes, these raw materials can be mixed and converted in very high concentrations.

This means that, compared to fermentation, the resulting manufacturing process displays up to 20 times higher space-time-yields and requires a minimum of work-up. First trials demonstrated that concentrations ranging from 20-40 wt-% (aqueous) are easy to produce. Commercial non-precious metal catalysts can be employed and catalysts recycle tests were positive. Clean hydrogen is released as a by-product.

The product mixture is easy to use in several applications. Based on its anti-freezing properties, it can serve as an environmentally friendly product for private use and for especially demanding applications like de-icing of runways at airports. Airport service providers could replace the fossil based salts of formic and acetic acids currently used. When using these new product mixtures as an additive and anti-freeze for underground heat-pumps, no toxic substances would be released into the ground if leakage occurred. Moreover, applications of product mixtures for bio-remediation are conceivable since lactates are known to donate active hydrogen to bacteria into the soil.

Application of these new product mixtures allows the replacement of ecologically questionable salts with bio-based, bio-compatible salts.

Fraunhofer UMSICHT can now produce samples of one liter per day in a fully automated reactor. Samples can be provided for testing at the customer's request.

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Novozymes A/S, a world-leader in enzymes for converting lignocellulose to value-added intermediates, expects a sharp decrease in production costs for enzymes.

Hence production units for ethanol from ligno-cellulose will become competitive in 2011. This will simultaneously enhance the availability and attractiveness of ethanol as a chemical raw material.

BIO-BASED LONG CHAIN ALCOHOLS AS FUELS, CHEMICAL INTERMEDIATES AND SOLVENTS

Industrial utilization of biomass is gaining speed worldwide – in terms of use as material and as a source of energy. Renewable raw materials are high in demand but also compete with use for food. Hence the competition of food, feed and fuel and materials is intensively monitored and discussed in the public sphere. Over the long term, demand will exceed supply. In the fuel sector, this is already the case. Residues based on lignocellulose can help, since they are available in large quantities world-wide and do not compete with food. The bio-ethanol resulting from fermentation of lignocelluloses can be used to produce long-chain alcohols. These products offer enormous potential as fuels, intermediates and end-products for the chemical industry. They can be processed to coatings, solvents, plasticizers and similar products. Driven by the need for more sustainable raw materials, Fraunhofer UMSICHT promotes the use of ethanol from lignocellulose und actively works on the catalytic conversion of ethanol to long-chain alcohols.

Ethanol, a simple alcohol, is used as a solvent and as biofuel. Currently about 26,5 million tonnes of ethanol are produced worldwide. To date ethanol has been produced via fermentation of wheat and sugar cane. Both raw materials are, however, also used as food and feed.

In contrast, when ethanol is produced by fermentation of lignocellulosic material, two positive effects are achieved at once: on the one hand these raw materials are not suited for food and on the other hand almost twice as much greenhouse

gas savings can be realized compared to the fermentation of starch and sugar-cane based raw materials.

Ethanol is currently mixed in low concentrations with gasoline and represents the biofuel with the biggest market share. However, its ability to pick up water, its high volatility in terms of vapor pressure and its corrosiveness are disadvantages that make it less desirable. Additionally ethanol can only be mixed with gasoline, not with diesel or kerosene fuel. Long-chain alcohols, like butanol, hexanol or octanol, provide interesting alternatives to ethanol for the biofuel market. They do not display the disadvantages of ethanol mentioned above, and they can be mixed with diesel and kerosene fuel.

In addition to applications of long-chain alcohols for biofuels, the chemical industry is in need of alternative routes for chemical commodity products as well. Currently such alcohols are manufactured from fossil resources via the oxo-process. Typical applications of the resulting products, so-called oxoalcohols, are solvents, surfactants and intermediates for plasticizers. The world-wide market volume is eight million tonnes per year.

Driven by the need for sustainable raw materials, Fraunhofer UMSICHT strives to offer alternative pathways for chemical commodities and is developing a process for catalytic condensation of ethanol to long chain alcohols. In particular, Fraunhofer UMSICHT focuses on efficient processing and the selection and development of suitable catalysts, as well as on a concept for purification of the product mixture. The new process is expected to save about 1,5 tonnes of carbon dioxide per tonne of product compared to similar products from the oxo-process. This new process offers both good economical and environmental potential.

Right:
Pilot plant for the production of long-chain alcohols at Fraunhofer UMSICHT

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MATERIALS AND SYSTEMS

Dipl.-Ing. Jürgen Bertling,
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Materials and Systems

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.

BIOGENIC SULPHURIC ACID CORROSION: MATERIALS TEST RIG

MULTISCALE MODELING OF VISCOELASTIC MATERIALS

BIO-INSPIRED: ELASTOMERIC MATERIALS WITH SELF-HEALING ABILTY

IMPREGNATION OF SYNTHETIC MATERIALS WITH SUPER-CRITICAL FLUIDS

In 2000, expenditure for sewer overhauls (renewal, renovation and repair) in Germany amounted to around €1.64 billion. Around 53 % of the overhaul work took the form of renewals, while repairs were performed around 30 % of the time, and renovation around 17 %. Around €45 billion need to be spent for repair of damage that should be corrected in the short and medium term in the public sewer system.

It is estimated that the condition of private pipelines is much worse than the public lines. At around 900,000 km they are almost twice as long as the public sewer system. According to operators, an estimated 40 % of private drainage lines need to be overhauled in the medium term.

BIOGENIC SULPHURIC ACID CORROSION: MATERIALS TEST RIG

Industry and private households are reducing their consumption of fresh water almost on annual basis. While this is certainly positive, the long-term trend also has a catch: sparing use of the resource water decreases the flow speed in pipeline systems and leads to longer dwell times there. Unwanted microbiological and chemical processes are the consequence. These processes cause materials to corrode and the resulting repair and overhaul work entails high costs. Thiobacteria are responsible for a specific form of such corrosion. They convert sulphur compounds into sulphuric acid and lead to biogenic sulphuric acid corrosion (BSA). Fraunhofer UMSICHT is investigating the resistance of materials to BSA on a test rig.

According to information from the Federal Statistical Office, the total length of the public sewer system in Germany is around 540,000 km (as of 2007). This sewer system is exposed to a variety of harmful mechanisms.

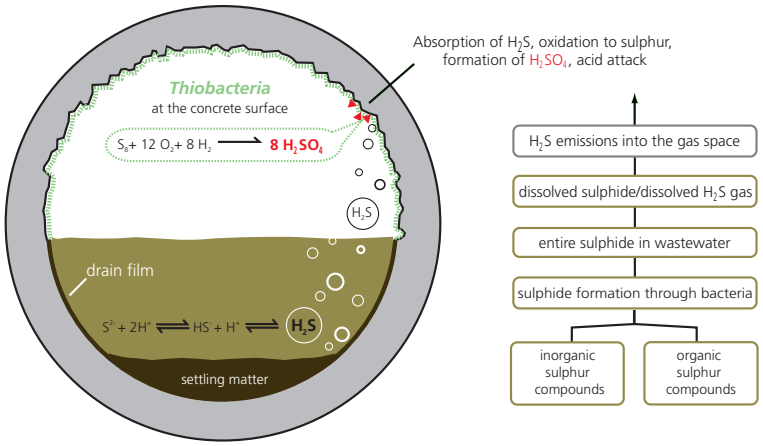
As water consumption declines and leaching of rainwater is targeted, waste water flow speed in the sewer systems and adjacent infrastructure is decreasing. The construction of systems with ever-greater catchment areas and related longer flow distances also leads to longer waste water dwell time in pipeline systems. Thus unwanted microbiological and chemical processes occur.

One such process is the conversion of sulphide compounds into hydrogen sulphide and the formation of organic acids. Bacteria are mainly responsible for these processes (e.g. acidithio-

bacillus thiooxidans). The bacteria are situated on the pipe walls as a biofilm and convert the hydrogen sulphide that is set free by rotting processes in the pipeline system into sulphuric acid. This starts the material destruction. Damage found in the gas space, i.e. above the water surface, is characteristic for this type of corrosion, which occurs especially in partialy filled sewers.

A materials test rig has been established at Fraunhofer UMSICHT to assess materials against BSA (see illustration above). In cooperation with the University of Duisburg-Essen (Faculty of Chemistry, Biofilm Centre – Aquatic Biotechnology, Prof. Wolfgang Sand) weathering trials are being carried out on resistance of materials to BSA. The test results are delivering information on targeted optimization and further development of the materials.

Development of biogenic sulphuric acid corrosion in the sewer system



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The elasticity of polymers dependent on time, temperature and frequency is called **viscoelasticity**.
The movement of a large number of particles can be calculated with the **discrete element method**.
The **elasticity module** describes the relationship between stress and strain in the deformation of a solid body with linear elastic behavior.
Shore hardness is a material constant for plastics and elastomers. A high number indicates a high hardness.
The **shear modulus** is a material constant which describes the linear elastic deformation of a component due to a shear force or shear stress. The theory of friction, wear and lubrication is called **tribology**.

MULTISCALE MODELING OF VISCOELASTIC MATERIALS

Wear is caused by abrasion, set rolling, beating, scratching, chemical and thermal stresses on surfaces and usually causes undesirable changes in the surface geometry. Wear damages components, leads to failure of machinery and equipment and causes immense economic damage every year. In some applications polymers wear out less than metallic hard materials. To optimize polymeric materials their properties during manufacturing, processing and loading must be understood better. To that end, Fraunhofer UMSICHT is developing multi-scale simulations of the micro processes of viscoelastic materials which are experimentally difficult to access.

In machinery and equipment, wear is a major problem. In some applications, plastics are superior to metals. The increased use of friction and wear-optimized polymeric materials is a major possibility to extend the life cycle of machines and equipment. For a better understanding of the behavior of polymeric materials during manufacturing, processing and loading the dominant micro processes in the interior must be studied. However, these are experimentally difficult to access. The simulation of different operating conditions allows the description of the microprocesses and helps to optimize polymeric materials.

Based on the discrete element method, Fraunhofer UMSICHT is developing a simulation program focused on the wear and fracture behavior of viscoelastic materials. The material is discretized by individual elements (usually spheres) which interact through spring-damper systems or bending beams. Recent work is aimed at discovering calibration laws so that the models' parameters can be directly determined from ma-

terial parameters as Young's modulus, shore hardness and shear modulus.

To map wear with sufficient precision within the program, a multiscale approach with regard to space and time has been developed. Models are developed for the following scales:

- Molecular range (adhesion)
- Nanometer range (abrasion)
- Micro-millimeter range (disruption)
- Milliseconds (moment of contact)
- Hours/days (lifetime)

Two approaches were developed to bridge the scales: coarse graining, i.e. replaying many small elements by larger units, or time scaling, i.e. introducing fatigue models for the interaction parameters in the simulation.

To ensure simulations could be performed in a reasonable time period, the use of graphic card processor (GPU) workstations was considered. The simulation approach offers a cost and time-saving possibility that could develop viscoelastic materials with optimized abrasion behavior at an early point in time.

Tension rod profile for polymers

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Until now, the huge volume of self-healing concepts found in nature has rarely been used in a technical context. This transfer requires a highly inter- and trans-disciplinary methodology. Fraunhofer UMSICHT thus provides ideal conditions. Experts in biology, system analysis, materials sciences and application technology are organized in efficient project teams and develop innovative bio-inspired approaches and technical solutions.

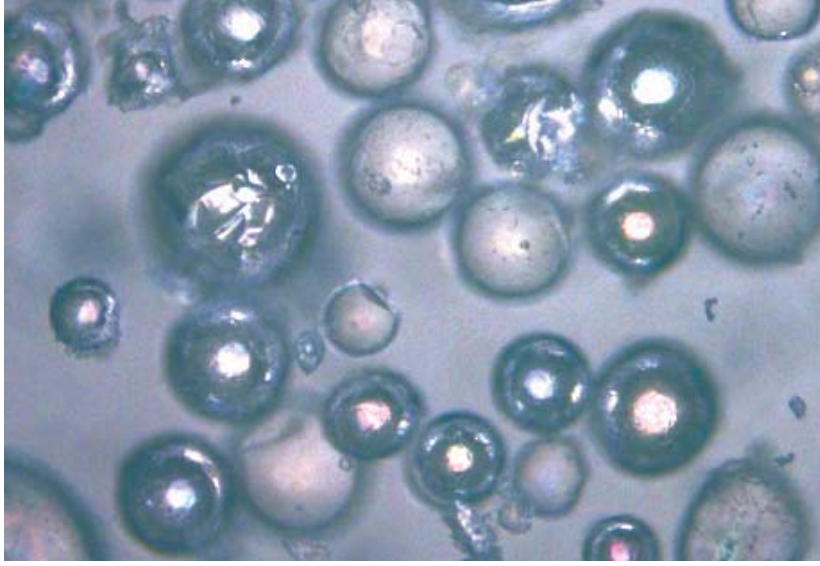
BIO-INSPIRED: ELASTOMERIC MATERIALS WITH SELF-HEALING ABILITY

Polymers are increasingly used in applications affording high mechanical resistances, which they often withstand better than some metallic materials (see p. 64/65). Polymeric components tend to spontaneously generate fractures although the mechanical stress has not reached the average maximum load. These fatigue fractures are caused by microcracks that are formed inside the polymer matrix. Fraunhofer UMSICHT develops elastomeric materials that are able to heal themselves by stopping or – in the best case – repairing microcracks without any external stimulus. Self-healing concepts found among botanical species show the way ahead.

When a material fails spontaneously, the consequences may be far-reaching. Microcracks might result in a tire or a sealing that fails during use. Embedding a self-healing functionality in polymeric compounds would be a sophisticated solution to reduce the amount of spontaneous failures as well as troubling outages.

In a project funded by the Ministry of Education and Research (BMBF), Fraunhofer UMSICHT is developing self-healing elastomers that are able to repair microcracks autonomously. Initial prototypes include sealing gaskets equipped with a self-healing functionality that will be developed in a subsequent step. In this project the focus will be on botanic models, especially on their secretion and corresponding transport and storage tissues that exhibit intrinsic and self-activating healing mechanisms.

For example, damage to *Hevea brasiliensis* (rubber tree) leads to a release of secretions that build a stable closure by



cross-linking. Other promising approaches to biomimetic innovations are based on botanic models like spherical reservoirs in acacia, filled capillary systems in dandelions, and different types of wood spurge.

A detailed characterization with respect to chemical, physical and structural properties of the model plants forms the basis for comparative analysis and subsequent transfer to technical applications at Fraunhofer UMSICHT. To realize self-healing components, experiments concentrate on the formation of storage/transport systems based on microcapsules and capillaries respectively or on solid emulsions.

The figure on the right illustrates crack repairing in a purely self-healing component that is suitable in particular for non-polar elastomers and has already been successfully encapsulated. These microcapsules, which have an average diameter of 30 µm, are embedded in elastomeric materials via compounding (figure on the left). Blends were also developed by compounding the non-encapsulated component. Self-healing behavior could be shown in specimens from these materials: after a macroscopic cut and an appropriate healing time, a recovered elongation at break of up to 40 % was found.

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The critical point marks a thermodynamic condition of an agent at which the densities of the fluid and gas phases adapt so that the two aggregate states no longer differ. Supercritical fluids connect the high dissolving power of liquids with the low viscosity of gases. By lowering the pressure they are completely removable due to evaporating.

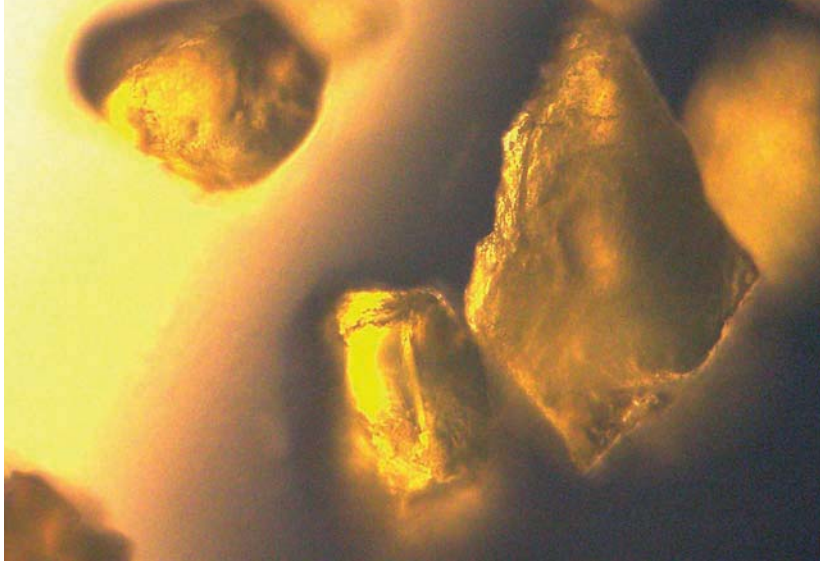
This makes them an ideal solvent the only disadvantage of which is high pressures during the process.
Carbon dioxide reaches its critical state at temperatures above 31 °C and pressures above 73.7 bar.

IMPREGNATION OF SYNTHETIC MATERIALS WITH SUPERCRITICAL FLUIDS

Use of fossil fuels necessarily generates carbon dioxide (CO_2). When the CO_2 penetrates the atmosphere it has a negative impact on the climate. One way to protect our climate is to absorb and isolate CO_2 from the atmosphere. While storing CO_2 permanently in deep rock beds has been attempted, Fraunhofer UMSICHT is involved in the industrial use of this gas which accrues for the most part as a waste product. In a high pressure laboratory, CO_2 is brought to its supercritical phase and analyzed to determine how it can qualify for impregnation of synthetic material.

Carbon dioxide is a colorless, incombustible gas that smells and tastes slightly sour. In free condition, it is a natural element of air (0.03 – 0.036 vol.-%) and mineral springs. Carbon dioxide is a greenhouse gas. 60 % of the additional greenhouse effect caused by human activity is a result of CO_2. However the gas has positive properties as well.

CO_2 exhibits a particularly interesting property when it is set under high pressure. In its so-called supercritical phase it has solvent-like characteristics without the unpleasant side effects of known organic solvents like unpleasant odors, damage to health and to the environment, as well as explosive vapors. During pressure release, the inert gas volatilizes in the atmosphere. This phenomenon is familiar from a bottle of mineral water. Procedurally the evaporating CO_2 can be absorbed and put in circulation. Thereby it is an ideal solvent which has the sole disadvantage that high pressure is needed during the process.



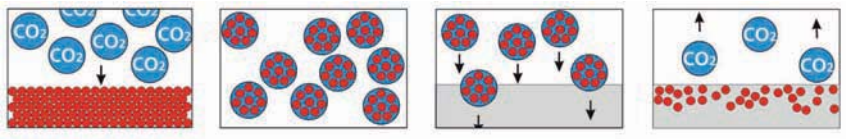
In its newly constructed high pressure laboratory, Fraunhofer Umsicht is showing how supercritical CO_2 can qualify for the impregnation of synthetic materials. Impregnation may offer the ability to modify synthetic components for specific customer needs. In the process colors, additives or active agents are brought into the surface – and finally it is precipitated in the surface. Because impregnation takes place at low temperatures, far below the melting point of polymers, the energetic effort is low. As the graphic shows, there are in principle two impregnation functions that can be distinguished:

1. Impregnation of polymers with in CO_2-soluble additives:
A CO_2-soluble substance, for example a dye, is soluted in carbon dioxide which under high pressures in turn solutes in polymers – including dye. By depressurization the carbon dioxide passes off while the dye stays in. In reference to polymer and process parameters penetration depths of 40 till 400 µm under 20 min can be noted. The picture on the left shows a laser sintering fan wheel which was additionally dyed by this process.

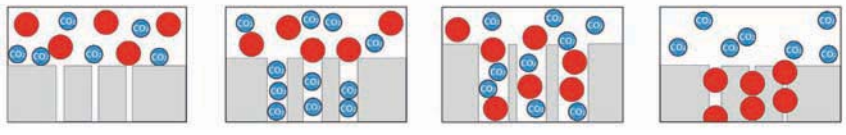
2. CO_2-supported impregnation with dissoluble additives:
It is possible to impregnate synthetic materials with agents which are dissoluble in CO_2, for example nanoparticles. The mechanism for transport is not understood completely yet. The carbon dioxide widens the inner polymer structure and carries the particles into the material. At relaxation a nano composite substance occurs near the surface. The picture on the right shows a micrograph of a matrix from a polyamide powder in which a dye (dispersion dye) was imported.

Modification of polymer powders and components

Impregnation of polymers with CO_2-soluble additives, e.g. dye



CO_2-supported impregnation with inscluble impregnation substances, e.g. NP



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INFORMATION TECHNOLOGY IN PROCESS ENGINEERING

Dipl.-Phys. Thorsten Wack,
Business Unit Manager Information
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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.

EVALUATION OF ENERGY SAVED BY SERVER CONSOLIDATION

IT SERVICE MANAGEMENT

ENERGY EFFICIENT DATA CENTERS THROUGH SERVER VIRTUALIZATION

EVALUATION OF ENERGY SAVED BY SERVER CONSOLIDATION

A company with multiple locations usually has a server at each that is part of a network. This network provides employees with information at their work place. More and more often these local servers are replaced by central servers at one location. The reasons for this move are multifaceted. Often it is the wish to reduce costs: personnel and/or energy. When the decentralized servers are no longer up-to-date, they will often be replaced even though they still perform very well. Fraunhofer UMSICHT is evaluating when replacement actually results in energy savings.

Bigger companies or institutions provide their employees with information via computers, servers and other infrastructure. Besides workstation computers they increasingly need servers, which are set up and connected at one location.

If a company has multiple locations and server at each of them to provide its employees with information, they more and more often are replaced by central servers at one location. The reasons can differ, but it is generally driven by a need to reduce personnel costs because the know-how to administer and manage the hardware doesn't have to be available locally anymore. Or replacement is supposed to save energy because few computers can do the work of many local PCs. This aspect has grown in significance as part of "Green IT." And if the local hardware is out of date, replacement may be called for. But what if the servers can still perform as required and don't have to be exchanged? When does replacement in fact result in energy savings?

In this article, load on a computer refers to power consumption. A computer consumes power when users are working on it or when programs are running. An artificial load means that a program is executed which simulates many other programs or users on that computer so that it operates at full capacity.

The idle load of a server is the minimum load required when it is switched on and is waiting for tasks. Different loads can be measured outside of normal work hours; this does not take much time.

Fraunhofer UMSICHT is answering these questions and determining power consumption to date, measured in watts (W), and the energy consumption, measured or calculated in watt-hours (Wh). For this, both the old local and new central servers have to be compared. New ones bought off the shelf should provide manufacturer's data that can be used. In the ideal case such data can be verified through testing.

Specific measurements of power consumption are best taken on meaningful, complete days (24 hours) and used to calculate energy consumption. For this, the power supply must be put into an adapter of the measurement device. But since ongoing operations should not be unnecessarily disrupted, which can happen if the server doesn't have redundant power supplies, it may be sufficient to create an artificial load on the servers to identify an assumed maximal-load.

If multiple 24 hours measurements aren't possible, an analysis of the number of users on the corresponding servers and so their processing load are very important. That means that a diagram with the number of users at a certain point in time can be created. With this diagram or curve, an approximation of the servers' processing load is possible so that, with the aid of the minimum and maximum loads, a resultant load curve can be calculated. This result load curve begins and ends with the minimum working load of the particular server and its shape is a result of the processing load, which is generated by the users. On the basis of the values that form this curve, energy consumption can be calculated and with this an extrapolation for a complete year can be made.

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Service Management – Service Management is the interplay of specialized organizational capabilities that can deliver value to the customer in the form of services.

Service – A service is a way to provide added value to customers by supporting the achievement of desired results more easily. The customer has no responsibility for certain costs and risks. Results will be achieved through performance and are subject to a number of restrictions. Services improve performance and reduce the limitations.

Value – Value is the core of the concept. From a customer perspective, value consists of two core components: utility and warranty. Utility is what the customer wishes to receive, warranty is how it is delivered.

IT SERVICE MANAGEMENT

ITIL as the guiding principles in central hosting of application software

Companies today are often dependent to a critical degree on the availability of their IT services. It is expected that IT not only supports the company's core business but also contributes to its competitive advantage. For example, IT can facilitate the use of new technologies, thus allowing the company to open new market opportunities. Ultimately IT should help to achieve the objectives of the entire company. To do that, it must be flexible in responding to changing needs regarding IT services over time. As an IT service provider Fraunhofer UMSICHT does not limit its focus to technology and its organization, but deals with the quality of services as well. That is the job of IT service management (ITSM). The focus is always on the added value that IT service delivers to the customer.

IT Service Management is concerned with all processes of an IT organization that support achievement of a company's business objectives. Therefore IT Service Management includes all kinds of methods and measures to optimize all relevant IT processes. The standard in this is the IT Infrastructure Library™.

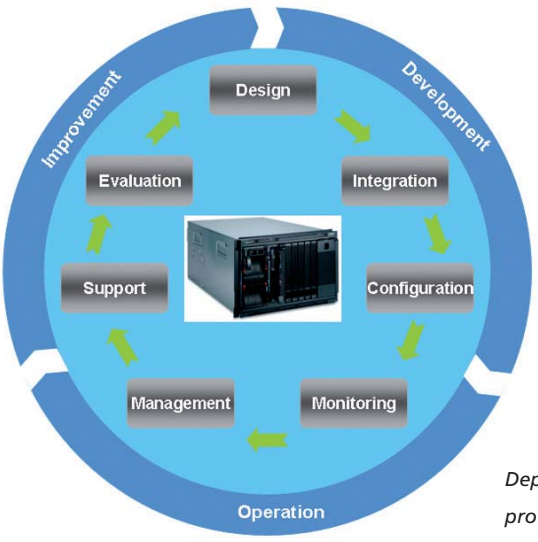
The Information Technology Infrastructure Library™ (ITIL) provides a systematic introduction to promoting the quality of IT services. ITIL was developed at the behest of the UK Government in the 1980s and 1990s by the CCTA (Central Computer and Telecommunications Agency, now Office of Government Commerce, OGC). Since then, ITIL has provided not only a system-based Best Practices framework, but the attitude and philosophy shared by the people who work with it in practice. ITIL has been updated twice in the meantime, first in 2002 (V2), and then again in 2007 (V3).

ITIL is regarded as good practice, an approach or method that has proven itself in practice. Such good practices can be a huge support for organizations that want to improve their IT services.

The ITIL Service Lifecycle, which is based on the core concept of "Service Management" and related concepts of "Service" and "Value" provides the basis for systematic monitoring of IT processes and their documentation. The IT system landscapes become more transparent, and IT's added value within the business process is documented through selective reporting. This in turn forms the basis for systematic improvement and optimization of processes.

Fraunhofer UMSICHT provides applications such as the GEVIS II hazardous materials management and information service or the project inspector for the Fraunhofer-Gesellschaft, made available centrally as a service. The operation of these hosted applications is governed by SLAs (Service Level Agreements). For example, a SLA defines the maximum downtime of a service. To offer the operation of these applications on a professional and customizable level, ITIL serves as the foundation in terms of guiding principles.

The goal is to make the assured performance as transparent as possible to the customer, that is, scope, reaction time and speed of processing. ITIL embodies what has been common in the technical information arena for some time: cooperation across business structures and geographical boundaries. The concept of service and the IT life cycle are increasingly the center of attention.



Depiction of the applications provided in form of an IT service management process

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In 2001, the amount of energy consumed by information and communication technologies in Germany was around 38 TWh or 7.1 % of total electric energy consumption. In 2007, ICT-related energy consumption had grown to 55.4 TWh, or 10.5 % of total electricity consumption in Germany. Unless action is taken, energy consumption is expected to increase by more than 20 %, to about 66.7 TWh[1], by the year 2020.

[1]Estimates of energy requirements regarding the further development of the Information Society in 2009, Fraunhofer IZM, ISI

ENERGY EFFICIENT DATA CENTERS THROUGH SERVER VIRTUALIZATION

According to surveys by the Federal Statistical Office, 27 million households in Germany had access to the Internet in 2008. By 2009 that number had risen to 29 million. German households have more and better information and communication technologies (ICT) every year, and increased ICT-related power consumption too. Fraunhofer UMSICHT has compared conventional client/server environments with an operating model based on terminal servers and Thin Clients and identified significant energy and CO_2 saving potential. These results will now be applied to the practice of small and medium-sized enterprises.

This project, funded by the Federal Ministry of Environment, is a complete environment for application delivery with all the necessary server roles realized within a Blade Center. The servers are virtualized to the greatest extent. On client side, energy-saving Thin Clients are used.

The concept of virtualization was introduced in 1960 and is the generic term for a series of technological approaches. In general, it refers to the imitation of features of apparently existing hardware or systems. The goal here is the abstraction of the logical IT systems of the physical hardware. A "virtual machine" or "guest system" here is a concrete expression of virtualized hardware. It behaves as physical, dedicated hardware, and it is also configurable and flexible (behavior, resources, priorities) and allows you to install an operating system.

Although the concept is not new in principle, it took recent technological progress to open up extensive possibilities and reveal existing potential. The key event was the virtualization of standard hardware based on x86 architectures (1999).

Today Server Virtualization allows for simultaneous delivery of different operating systems (Windows, UNIX, Linux, etc.) and several instances of the same OS on the physical hardware. This results in the following advantages, in comparison to dedicated hardware: the performance potential of modern CPUs is used much better, which is accomplished only selectively in conventional operation. Furthermore, the hardware can be saved and operational costs reduced. Finally, the entire life cycle management is simplified.

Although the complete consolidation of server landscapes is not entirely unproblematic, for example regarding potential incompatibilities, the advantages are clear. In particular, this approach has great energy and environmental balance.

Fraunhofer UMSICHT realizes virtualization projects for its customers. Architectures and safety aspects are developed, such as concepts to ensure the operation of complete consolidated server environments.

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ENERGY TECHNOLOGY

Dr. Thomas Marzi,
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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" in order to successfully position our customers in the dynamic energy and waste market.

A COMPREHENSIVE APPROACH TO ELECTROMOBILITY: BATTERY RECYCLING

STUDY: GAS GRID OF THE FUTURE

Recycling is the general term used to describe the processing of waste in such a manner that it can be reused in the production process as secondary raw material. In the area of electromobility, recycling of raw material with limited availability or high extraction costs is particularly important. These include a number of metals used in energy storage devices, such as lithium, cobalt, etc. as well as conducting salts used in electrolytes, for instance.

Lithium ion batteries are characterized by very high power compression. They are viewed as thermally stable suppliers of constant power during the discharging period and are subject to almost no memory effect.
All components are currently the object of intensive enhancement efforts.

A COMPREHENSIVE APPROACH TO ELECTROMOBILITY: BATTERY RECYCLING

If Germany is to maintain its economic competitiveness, especially in automobile manufacturing and in the areas of power generation and storage, and play a substantial and lasting role in shaping international developments, electromobility must be systematically and comprehensively developed in Germany. More than 30 institutes within the Fraunhofer-Gesellschaft combine their expertise and research solutions for the electromobility of the future. Fraunhofer UMSICHT investigates the recyclability of new, innovative battery systems with the goal of recycling and/or reusing most or all raw materials from the battery systems and/or to reuse it. The focus is on lithium-ion energy storage and linking recycling and product development.

The Fraunhofer-Gesellschaft's Electromoblity System Research project is designed to provide effective support for the change to a sustainable all-electric economy of the future. What distinguishes the Fraunhofer approach is its broad perspective that encompasses all value-creating stages of electromobility and researches them in coordination, starting with energy generation, through power transmission and distribution on the power grid, interfaces between the power grid and vehicles, energy storage, up to new vehicle concepts with a new infrastructure and utilization and billing concepts. System research covers issues of vehicle design; power generation, distribution and conversion; power storage technology, and issues of technical system integration and social policy.

A foundational element of any vision for the future – from electromobility to reconverting storage units – is a reliable, efficient and long-lasting storage system. Lithium batteries with their specific features, most especially high energy and capacity densities and high achievable service life, represent a possible basis for such systems. However, there are many open issues related to both materials and systems.

With regard to energy storage technology, innovative battery systems are being built and adapted for use in two demonstration vehicles. Safety requirements, reliability, durability and not least the electric requirement profile for battery systems are all quite high in vehicles. Mastering the required energy content and capacity under given environmental influences requires substantially improved battery safety, not only on the level of battery chemistry but also that of the battery system.

In this context, Fraunhofer UMSICHT is working with other Fraunhofer Institutes on the potential to recycle new, innovative battery systems. Along with researching existing recycling processes and their suitability for the composition and construction of lithium ion energy storage devices, possibilities of linking recycling to product development is examined. The goal of theoretical process analysis is to recycle or reuse most or all raw materials from battery systems.

The German Federal Ministry of Education and Research (BMBF) provides EUR 30 million support for the entire Electromobility System Research project as part of its economic development program II (ID 13N10597 – 13N10600).

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The raw material basis for generating biogas is broad and rich, from cut grasses to fuel crops and biogenetic waste material. When properly processed, biogas can be fed into the existing natural gas grid. Gas processed into biomethane can be used in all natural gas applications without any problem, for instance in stationary combined power and heat plants, at gas stations as fuel, or in residential applications. This decouples the supply of biomasses from the demand for energy and helps open up a significantly larger share of the potential of biomass to protect the climate.

STUDY: GAS GRID OF THE FUTURE

Projects that involve feeding biogas into natural gas grids are currently enjoying huge popularity. Fraunhofer UMSICHT is examining the technical and economic impacts that feeding more biogas into natural gas grids might have, as part of a research project supported by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, together with Balance VNG Bioenergie GmbH, Leipzig, and E.on Avacon Netz GmbH, Braunschweig.

The 2008 amendment to the Gas Grid Access Act (GasNZV) and the 2009 Renewable Energies Act (EEG) provide legal certainty and make feeding biogas into the natural gas grid an attractive option for the utilization of biomasses.

There are now 4,780 plants in Germany that generate biogas by fermenting biomasses. Currently more than 10 plants in Germany feed biomethane into the natural gas grid. Many other projects are in the planning and construction stages.

One project supported by the Federal Ministry of the Environment is investigating the technical and economic impact that more biogas will have on the natural gas distribution grid.

The financial effects of connecting biogas plants to the grid will be specified and solutions to minimize costs suggested by developing specific suggestions and comparative calculations. The goal is an optimal balance between minimal financial burden on the end customers and developing as wide a use of biogas as possible. The scenarios for projecting possible impacts of grid supply are therefore oriented to climate policy objectives as well.

The prognosis for development of supply will have considerable economic and technical impacts on the operation of the gas grid, on gas quality, and on the technology of gas processing. As part of this investigation, quality, quantity and general development tendencies are illustrated, and model applications at various grid levels and in various grid structures are examined.

One focus of the investigations is the analysis of technical and economic possibilities for creating gas grid compatibility according to DVGW G 685. Along with the impact of supplying biogas on gas compatibility and grid operations, possibilities for optimizing biogas processing and supply are considered, as well as possible conflicts with quality requirements from the perspective of the gas customer. The investigations are structured according to characteristic grid levels and typical plant sizes.

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ENERGY EFFICIENCY TECHNOLOGIES

Dr.-Ing. Christian Dötsch,
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The goal of our efforts is the development of new technologies that will improve energy efficiency and the integration of these new technologies within existing systems. To accelerate this development, we combine our experience and research results from our laboratories and test stations with simulation tools. Our focus is always on market realities and creating real value, with an eye to technological possibilities and the individual customer's necessities.

We are dependent on a stable power grid. The energy mix of the future will feature a growing role for renewable energies. But these are more difficult to handle than fossil fuels. Reserve storage devices can compensate for these fluctuations. Fraunhofer is working on economically and environmentally responsible solutions that will keep sufficient reserves on hand.

ENERGY STORAGE IN POWER GRIDS

One goal of the Fraunhofer project for the future titled Energy Storage in Power Grids is to make it as easy to plan the supply of wind and solar energy as it is for conventional power plants. Fraunhofer UMSICHT is coordinating the issue throughout Fraunhofer, as well as carrying out technology and system research itself.

Fraunhofer UMSICHT is developing a progressive method for the technological design and dimensioning of compressed air energy storage (CAES) plants, as well as advanced energy management systems for redox flow and lithium-ion batteries in the area of battery technologies.

While measurement and characterization are the focus of work with lithium-ion batteries, technical design issues involved in building battery stacks of redox flow batteries with respect to process and electrical technology are being addressed. Several test laboratories are available for this. The lab for redox flow batteries comprises several test benches where battery stacks can be tested individually, in parallel or as a system with a capacity of up to 80 kW. A detailed characterization for multi-cell battery stacks is also possible using impedance spectroscopy.

Another lab is designed to test lithium-ion batteries with respect to the issue of electromobility. These batteries are tested with simulated driving cycles, up to a capacity of 120 kW. In doing so, the batteries can be operated with voltages of up to 850 volts and currents up to 600 A, and stressed in a temperature chamber from minus -40 to +85 °C. The experience provided by these tests offers a foundation for developing adapted energy management systems for energy storage in vehicles or power grids.

Investigations on the energy systems level also play a role, along with technological enhancements and test procedures for electricity storage. One central element is investigating storage services for their technical feasibility and economic assessment of revenue that it generates. The GOMES® optimization model for storage operation and dimensioning was developed for this purpose. Along with technical and economic aspects, various political and regulatory frameworks (such as future developments in the Renewable Energy Sources Act) can also be factored in. The generic model facilitates mapping a variety of storage technologies and to compare their performance with respect to the targeted storage capacity. The focus was previously on storage with medium to large capacity that was operated centrally on the grid or in connection with a generator, e.g. in a wind park. The future should see the development of electromobility and a number of small storage devices used by end consumers, which is why Fraunhofer UMSICHT is expanding its systemic research and model development in this area to find answers to these questions posed by the future.

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Instead of water, the ORC steam-powered process uses organic matter as its working medium. Organic fluids are adjusted to the temperature regime of the thermal process and the source of the heat. For instance, paraffin, aromatics, alcohol, and silicon oils have all been used. To date, ORC processes have been offered worldwide for wood-fired power plants and geothermal power plants primarily in the output range of 300 to 2,000 kW_{el}. Coupling them with biogas CHPs is an innovation. But the number of smaller, decentralized plants that use biogas to generate electricity is growing steadily and with it the demand for smaller ORC plants that cover the range below 300 kW_{el} for generating electricity from (waste) heat.

USING SMALL ORC PROCESSES TO TURN WASTE HEAT INTO ELECTRICITY

Anyone who generates electricity or operates high-temperature industrial processes produces waste heat, and not quite a bit of it. But all too often this waste heat is not utilized because no efficient utilization options are available. Operators of biological plants are very familiar with this problem. Small Organic Rankine Cycle (ORC) plants promise to remedy this situation. It makes waste heat usable in the form of electricity, without limitations; they increase economic efficiency; and they reduce CO_2 emissions. Fraunhofer UMSICHT is one of the leading developers of small ORC processes.

The energy efficiency market has shown a great deal of interest in new energy-efficient technologies that can turn smaller streams of heat or waste heat at relatively low temperature levels into valuable energy for use. The Organic Rankine Cycle process (ORC) is a steam-powered process that works with organic matter and has proven to be quite competitive for generating electricity from waste heat at low levels. Small ORC processes are the subject of a lot of market interest, as are commercial applications for biomass, geothermal and industrial heat, but they are not yet established in the market below 200 kW_{el}.

Partnering with medium-sized companies, Fraunhofer UMSICHT is developing small, scalable ORC plants that can utilize flue gas and engine waste heat from biogas engines.

Since the end of 2007, an ORC process developed in cooperation with Cyplan Ltd. to utilize flue gas heat from two biogas engines has been in operation at agri.capital GmbH's Wasmerslage site. By December 2009, this equipment had already logged

15,000 fully automated operating hours with very little unscheduled downtime. It is also CE certified and has been accepted by the customer. Based on this initial success, Fraunhofer UMSICHT has launched work to develop models and field testing of two high-temperature (HT) ORC modules and one low-temperature (LT) ORC module, with the support of the Federal Ministry of Economics and Technology.

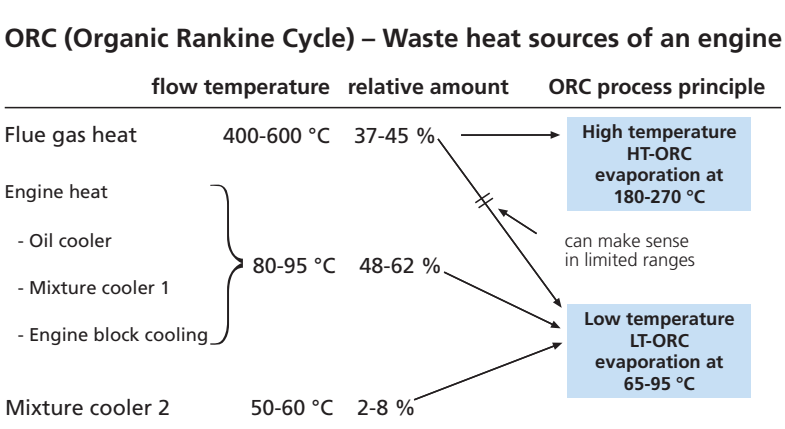
Here these processes undergo further development with the primary aim of improving their efficiency, reliability and manufacturing cost. Designs of HT ORC processes driven by flue gas are being reconfigured, and a first prototype of a low-temperature ORC process fed by engine heat is developed.

A project supported by the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety involves work on concepts for the deployment of these small ORC process in other applications, such as power/heat coupling in small wood firings with outputs of about 400 to 1 000 kW_{th}.

In a preliminary project, Fraunhofer UMSICHT is investigating whether more decentralized solar thermal electricity generation, off the grid, using concentrated collectors, heat accumulators and HT ORC process could be worth further exploration.

With the initial success of ORC using heat emitted by engines, the institute is receiving inquiries on a daily basis asking about other applications, such as for MCFC[1], micro gas turbines, and for industrial emissions (e.g. in the areas of non-ferrous metal processing, paper, glass and ceramics). These inquiries are carefully analyzed to find promising new areas of deployment.

Waste heat sources of a gas piston engine and main variants of connected ORC processes



[1] *MCFC = Molten Carbonate Fuel Cell*

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According to the German Federal Statistical Office, there were 2,083 hospitals in Germany in 2008, with 503,000 beds. Energy costs play a significant role in the competitive position of a hospital, in light of growing market pressures and increasing energy costs. Energy consumption in hospitals is huge: annual usage per bed averages about 2,700 liters of oil and around 8,000 kWh electricity. That is significantly higher than the energy requirements of a family in a modern single-family home.

But anyone who wants to save energy must know what factors actually influence energy consumption. Until now, there were no standards of comparison for hospitals. The final report, Energy Efficient Hospitals, solves that problem (http://tiny.cc/rw9qf [available in German])

KEY DATA ON ENERGY – A COMPARISON OF 20 HOSPITALS

There are innumerable opportunities to save energy. Only a few of them are economical, however. According to the Pareto principle, 20 % of the effort made results in 80 % of the savings. This relationship is apparent in the realm of energy efficiency too. Energy consumption and costs can be reduced with targeted efforts and reasonable expenditure. Savings beyond that can require significantly higher expenditures. From an economic perspective it is obvious that the potential savings that will have the biggest effect must be precisely identified. Fraunhofer UMSICHT examined the energy use of 20 hospitals in a research project. The comparison that resulted provides significant key data for plant operations and planning.

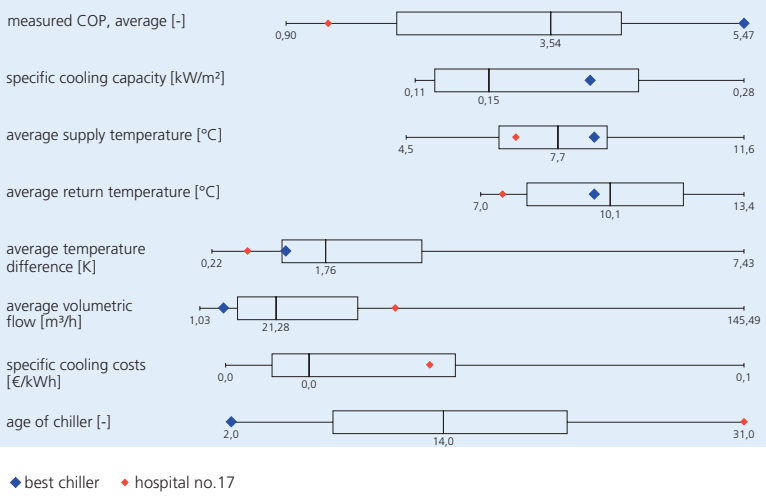
Using this energy key data, energy use can be evaluated and worthwhile savings potential identified. But with complex supply and usage structures, such data based on global, corporate-wide parameters will not suffice. Energy consumption figures must be linked to characteristic features and represented in compressed form with the aid of key data in order to arrive at clear information about the efficiency of energy usage. This will facilitate identifying the greatest saving potentials and analyzing the causes of increased energy costs. Key data on energy also offer an opportunity to select suitable measures and to define specific savings targets. A precisely formulated target, jointly arrived at, will assist in the efficient implementation of those measures and significantly improve the motivation of everyone involved. Finally, comparison of key data allows proof of the success of such measures in realizing savings.

In a project supported by the Deutsche Bundesstiftung Umwelt (DBU), the energy usage of 20 hospitals was analyzed. The examination concentrated on energy-relevant sectors where consumption could be measured and influenced by technical measures.

First, the energy consumption was extensively to obtain detailed information about operation modes and energy consumption. The measured data revealed opportunities to optimize operations and formed the basis for evaluating energy efficiency of the energy supply. Next the annual energy usage of the sectors examined was determined and energy usage costs calculated. A comparison of key data for the usage sectors examined was then made, which allowed for a comparison of the hospitals' energy use in relation to characteristic determining variables. With this method, each hospital can be compared to the totality of hospitals in the investigation and with the best of them.

Savings options were also developed for the various sectors along with best practices solutions that facilitate especially effective savings and that can be instituted in most of the hospitals. Estimates were made of anticipated costs and the savings that could be achieved. Key data and simple tools were also developed for approximate calculations of costs and savings. Based on statistical figures, this hospital comparison resulted in key data for energy usage and energy costs of the areas investigated that can be used for comparison purposes.

Charakteristics at a glance – boxplots to compare one hospital with the results of a universe



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Germany and Egypt are linked in many different respects through long years of cooperation and exchanges in the fields of education and science.

The "German-Egyptian Year of Science and Technology" is providing an outstanding platform for demonstrating the priority of science and research in both countries, for honouring and intensifying the cooperation, for encouraging exchanges of scientists, and for shaping the future through the process of learning from one another.

SOLAR COOLING – A GERMAN/EGYPTIAN JOINT DEMONSTRATION PROJECT

83 million people live in Egypt. About 90 % of the population is concentrated in the Nile delta, which comprises just 5 % of the country's surface area. Urban migration has increased in recent years. New housing developments require new, energy-efficient and sustainable technologies for climate control and cooling. Within the German/ Egyptian Joint Research Initiative, Fraunhofer UMSICHT cooperates with the Egyptian University of Asyut in a demonstration project of solar cooling. To meet growing demand for air conditioning, thermally driven sorption chillers that can be powered by the abundant solar energy of North Africa are to be used instead of conventional electrically driven chillers.

New housing projects are being established in other parts of the country because of population growth, high population density in major Egyptian cities and growing infrastructure problems. These new projects will require use of new, energy-efficient and sustainable technologies for climate control and cooling. Rather than electricity or primary energy consuming conventional air conditioners respectively, thermal-powered sorption cooling devices offer an alternative that can be operated using the abundance of solar energy that is readily available.

The first sorption chillers for building climate control in the low capacity range are being developed primarily in Germany or are already being introduced. The German Federal Ministry of Education and Research is providing support for a German/Egyptian joint research project that is performing

a demonstration project on solar cooling, together with an Egyptian university. The aim is to install, operate and evaluate a complete system under real structural and climatic conditions in the upper Nile valley. The task of Fraunhofer UMSICHT is to design a demonstration plant adapted to local conditions, with 5-10 kW cooling capacity, as well as assisting in the construction, operation and optimization of the plant. The plant will be operated on an experimental basis and analyzed over a two year period. The results of the plant monitoring and optimization will be presented in workshops, publications and at conferences.

The new solar powered adsorption chiller, the high efficiency pumps, the cooling tower, the measuring sensors and the data collection system as the central components of the system originate in Germany. The solar collectors are produced under a German license. All other piping components, the buffer tanks and some accessories are procured on the Egyptian market.

The solar cooling system is connected to the existing HVAC infrastructure in the laboratory of the Engineering Department at the University of Asyut, where it feeds several test areas. The performance and reliability of the system, its operating costs and electricity savings, along with other relevant environmental factors, will be evaluated and compared with a conventional compression chiller. After the system has been optimized, guidelines for practical and cost-effective solar air conditioning units for residential use will be created.

This joint research project will provide a significant contribution to environmental protection by reducing primary energy consumption and CO_2 emissions, and furthermore demonstrate an efficient cooling technology that is free of ozone-depleting chlorofluorocarbons (CFC).

[1] CHC = Chlorhydrocarbons

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RESOURCES MANAGEMENT

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We examine the use of materials, energy, goods and knowledge 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.

CARBON FOOTPRINT OF PRODUCTS FOR SMALL AND MEDIUM-SIZE ENTERPRISES

SUSTAINABLE SITE DEVELOPMENT THROUGH BIOMASS ENERGY REGISTERS

BIOCOUPLE – COMBINED ENERGETIC AND MATERIAL UTILIZATION OF BIOMASS

SAVING CARBON DIOXIDE WITH THE YELLOW BIN

The English company PricewaterhouseCoopers interrogated 700 corporate groups in 15 countries on the topics climate change and compliance to environmental rules and regulations for enterprises. The result is significant: executive staff is readily willing to support environmental measures in favor of climate protection, however, without standardized frame conditions and reliable rules their input is not worth it. A new highlight is expected with the international norm ISO 14067 of the carbon footprint (CFP).

PwC-Study: http://tiny.cc/fbfwy

The carbon footprint of a product (CFP) in the sense of DIN EN ISO 14040 und 14044 covers the documentation of greenhouse gas emissions which are emitted over the entire life cycle of a product (production, utilization, disposal, transport).

CARBON FOOTPRINT OF PRODUCTS FOR SMALL AND MEDIUM-SIZE ENTERPRISES

Over its entire life cycle, a product is associated with greenhouse gas emissions, which are summed up in the carbon footprint of products (CFP). An increasing number of small and medium-sized enterprises (SME) want to identify the carbon footprints of their products and services in order to give clients a comparison to competing products and to support climate-friendly buying decisions. A scientifically reliable, transparent and internationally harmonized calculation basis for the CFP is being prepared. Fraunhofer UMSICHT is currently involved in the development of guidelines and minimum standards of how the implementation of the expected uniform CFPs may be efficiently performed in SMEs.

Small and medium-sized enterprises are confronted with specific challenges when carbon footprints are to be prepared. The German Institute for Standardization (DIN Deutsches Institut für Normung) in Berlin has therefore commissioned the DQS GmbH (German Society for Certification of Management systems, Frankfurt) and Fraunhofer UMSICHT to identify these challenges and work out solutions. The study was completed in the framework of the INS project (Innovations with norms and standards) of the DIN and provides input for the elaboration of the international norm ISO 14067 "Carbon Footprints of Products". For this project, products of the food and packaging industries were selected in order to calculate their carbon footprints.

The main task consisted in the development of guidelines and minimum standards for the implementation of standardized

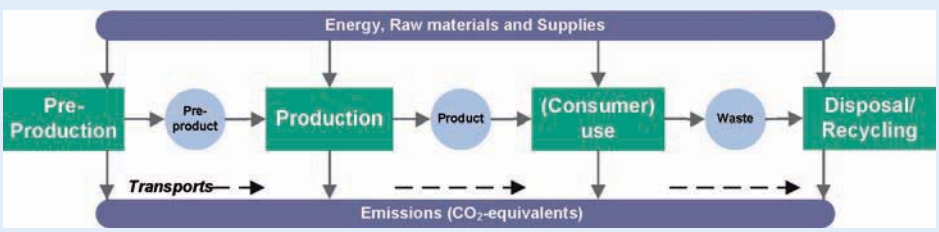
CFPs in SME as efficiently as possible. The challenge here was to harmonize the complex situation that underlies the elaboration of CFPs with the manageability of verification. Thus, special focus was put on the user-friendly processing of norm contents. A checklist and questionnaires were prepared for the assessment in order to verify CFPs.

Enterprises that are striving to receive a certification of CFPs for their products have to meet similar requirements as called for environmental management systems. A central responsible person, who is familiar with the internal processes and the relevant prior treatment and utilization phases, must be designated for the elaboration of the CFP. From the experiences gained, the enterprise is able to assess its own time input as feasible. This input, however, increases as the product becomes more complex, which leads to the conclusion that the completion time strongly depends on the individual case.

The results of the enterprises investigated make evident that an existing quality management or environmental management system provides the required traceability and transparency of the production process. Among the other requirements on the enterprise are the documentation of the basic production steps of the product that has to be balanced as well as the clear allocation of the relevant emissions to a process step. The data have to be prepared in a way that an auditor may be able to reconstruct the balances.

To enterprises the elaboration of a CFP offers advantages in the fields of marketing, client information, process optimization and cost reduction. SMEs are not able to use these tools, since the elaboration costs exceed their financial possibilities. If this hindrance is not overcome, some smaller enterprises will be threatened by competition disadvantages against larger enterprises with which they are competing. The fast development of standard norms and the preparation of checklists combined with the introduction of audits, comparable to the introduction of environmental management systems according to ISO 14001 or ISO 9001, is therefore a crucial measure in order to strengthen the competitiveness of SMEs.

Generalities process chain for a production process



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SUSTAINABLE SITE DEVELOPMENT THROUGH BIOMASS ENERGY REGISTERS

The Projekt BEn – Biomass Energy Register for Sustainable Site Development for European Regions is funded by the European Union in the framework of the Program Intelligent Energy – Europe II (IEE).

Further to the coordinator Fraunhofer UMSICHT, the following partners participate in the project: the European Center for Renewable Energies (Austria), Rural Development Initiatives (UK), the WiN Emscher-Lippe Gesellschaft zur Strukturverbesserung mbH (Germany), the Biomass Research Center (Italy), the Institute for Ecology of Industrial Areas (IETU, Poland) and the Gostynin Lake District Tourist Communes Association (Poland).

The utilization of biomass as a renewable resource that is locally available and storable offers the opportunity to regional authorities to initiate a future-safe energy planning and act as a model for sustainable energy regions. Fraunhofer UMSICHT develops – in collaboration with European partners – a user-friendly planning tool that provides geo-information system applications via the internet. The objective is to depict the real conditions of a region through geographic data, to transfer these data into an internet map, to make first estimates and to support the decision-making process on the energetic use of biomass with the help of regional networks and specific guidelines. The project is co-funded by the European Commission under the program IEE – Intelligent Energy Europe.

Sustainable thinking and sustainable acting is of increasing importance for society in times of scarce resources. Regionally occurring biomass for instance should be used in the most efficient way, e. g. using combined generation of heat and power. The basis of any long-term planning is an adapted planning tool with the help of which the real conditions are described, potential planning steps are simulated and decisions may be made. With the project "BEn" we have set out to meet these requirements developing a user-friendly planning tool for regional energy planning to be provided to municipal and regional authorities.

The centerpiece of the project is the biomass energy register that creates a link between regional energy sinks and regional

Intelligent Energy Europe

biomass energy potentials for one region. The locally available data will be collected, standardized and transferred into an internet-based geo-information system. Building upon this register the local authorities, in collaboration with further actors brought together in local networks, develop a regional master plan for the sustainable use of bioenergy. In addition to strategies and sustainability indicators, this plan also includes a list of potential measures that has been harmonized with the local actors and will be implemented in the short or long-term. The realization of these measures will be supported by guidelines on management, technology and financing instruments.

With the biomass energy register, the actual state of the energetic utilization of biomass in the region and significant actors in the bioenergy sector can be made visible. The register also permits to identify and present the technical potential in the region. Another benefit is the actor-related approach, which offers active planning participation on part of regional players.The biomass energy register thus acts as a strategic instrument supporting decisions on site development for public authorities, for biomass producers, planning actors and consultants as well as for private, commercial or industrial energy consumers.

Besides the planning aspects, the biomass energy register offers a first contact and service point for both regional and external investors and project development agencies, as it provides an overview on responsible persons and stakeholders from various fields in addition to spatial data. The open overall architecture and the use of open-source technologies allow a transfer of the energy register to other European regions and a further enlargement of the contents, e. g. by integration of additional renewable energy resources.

The project activities will be implemented and realized in four model regions, North East England, the Emscher-Lippe region (Germany), the Umbria region (Italy) and the Gostynin Lake District (Poland).

above left: straw firing system in the village of Trebki in the Polish model region

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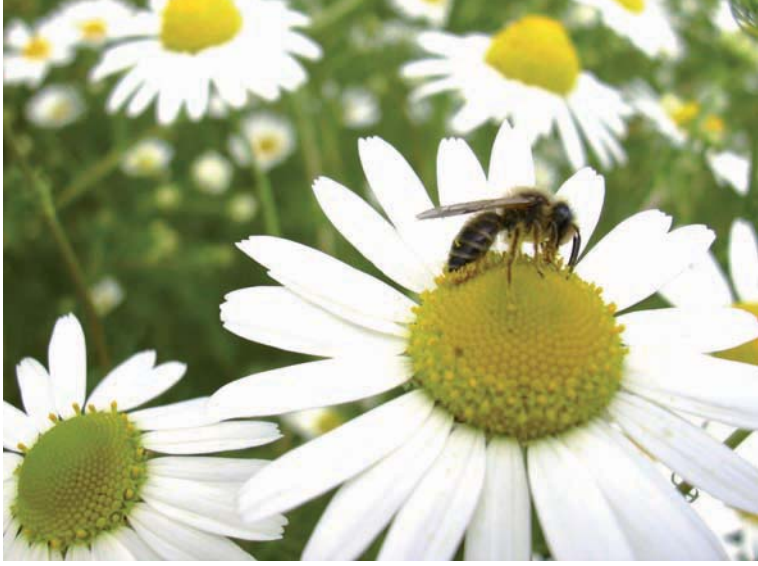

BIOCOUPLE – COMBINED ENERGETIC AND MATERIAL UTILIZATION OF BIOMASS

In the project BioCouple, the focus is laid upon the following topics:

Material flow analysis: Data collection on ecological and economic impacts of products from a biorefinery (Öko-Institut)

Analysis of conversion techniques: technical-economical investigation of existing and future biorefinery concepts (Fraunhofer UMSICHT)

Energy system analysis: Assessment of impacts on the climate and energy policy and possibilities of system integration (Wuppertal Institut)

Development of a partial strategy: Derivation of success factors and the integration of concepts for the combined utilization into an overall biomass strategy

Supported by:

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Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

ptj Projektträger Jülich Forschungszentrum Jülich

Numerous studies deal with the issue in which technological fields biomass may be utilized best. Still, not all utilization possibilities of biomass have been investigated completely, such as the connection of non-food sectors, i. e. the material and energetic use, or the connection of combined utilization concepts to already existing raw material supply systems. Fraunhofer UMSICHT, the Wuppertal Institut for Climate, Environment and Energy and the Öko-Institut are presently working on the problem as to which extent the supply of electric power, substances and materials may be combined efficiently and how to optimize the integration into already existing energy systems.

Against the background of global climate change and diminishing non-renewable resources, increasing attention has been paid in particular to the energetic utilization of biomass, whilst material recovery has been less discussed so far. It is expected that this sector will also gain in importance, especially under the aspect of a sustainable supply of chemical products, for instance from co-products from bioenergy production. On the other hand, critical voices arise which point to the feed and animal food production sector as competitors for energetic and material use of biomass, referring to the limited space available and to the impact on the protection of species and nature.

The further development of bioenergy production is afflicted with complex issues, as a decision on the preferred utilization pathways depends on various factors. The selected present and

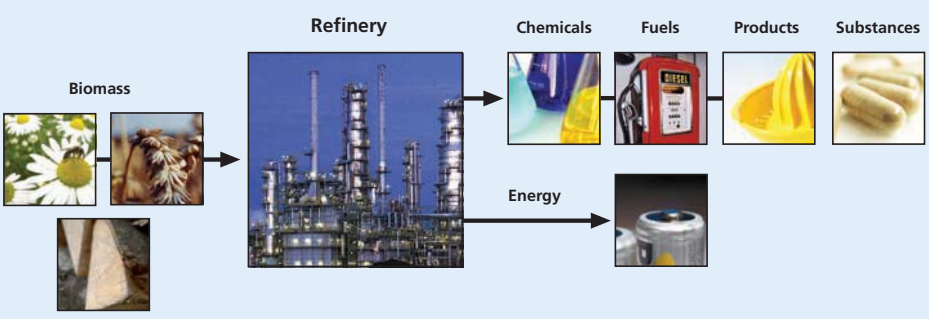
future conversion technologies should yield the maximum possible efficiency and the related material flows should be equally manageable and controllable in order to achieve an overall higher benefit with the bioenergy system resulting (so that the resulting bioenergy system will have an overall higher benefit in contrast to the compared system). Basically it will not be sufficient to optimize single utilization pathways alone. Considering the range of diverse byproducts and posterior utilization possibilities, an integrated assessment of the energetic and material use is required, as has been explicitly laid down in the biorefinery concept.

Under the designation BioCouple – "Combined material and energetic utilization of biomass – Analysis and assessment of concepts and integration into existing supply and utilization scenarios", a strategy for the integration of biorefineries as part of a super-ordinate biomass strategy that involves the acceptance and active participation of local actors is being developed.

The objective of the project is to verify to which extent a concept is suitable to provide the combined generation of energy, substances and materials and furthermore, to identify the optimum integration of a concept into existing energy systems.

A kick-off project workshop brought together representatives from industry, biorefinery technologies, the scientific community and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, who have worked out a first working hypothesis: Biorefineries shall have, besides a higher competitiveness, a positive impact on the greenhouse effect compared to sole energetic biomass use. The method is to be held open with regard to the outcome and marginal conditions for a possible confirmation or refutation are to be analyzed as well. As a further result of the meeting it was determined to engage external consultants in an advisory board.

The Principle of Biorefinery



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According to the Packaging Ordinance, enterprises from industry, trade and crafts are obliged to regularly collect used packaging materials, and to recycle and recover them in an eco-friendly way. Specific legislative rules and regulations are laid down for the disposal of packaging materials in order to reduce the negative impacts of packaging wastes on the environment. Packaging that occurs in private end consumer households, is collected and disposed of via privately organized dual disposal systems. Currently, nine private enterprises are certified across Germany to provide these services. In contrast to the municipal collection and disposal systems financed by fees, in this case the producer of the packaging material, i. e. the one that first feeds it into the economic cycle, has to finance the dual disposal systems. This regulation takes the stipulation of product responsibility (producer responsibility obligations) into account.

SAVING CARBON DIOXIDE WITH THE YELLOW BIN

There are numerous forms of and reasons for packaging. Packaging materials made from glass, paper, card and cardboard are thrown into specifically provided public containers, while lightweight packaging materials (plastics, metals, Tetra pak, compound materials, polystyrene) are disposed of in yellow bins or sacks. This collection saves resources and refeeds valuable materials into the production and the economy.

In compliance with the amended Packaging Ordinance sales packaging that ends up in private end consumer house-holds has to be registered in a dual disposal system. On behalf of the company Duales System Interseroh, Fraun-hofer UMSICHT has performed a study on carbon dioxide (CO_2) balances for the recycling of packaging materials from the yellow bin.

In this investigation, the production of primary materials (e. g. plastic materials from crude oil) and the generation of products from secondary materials (e. g. plastic from regranulate), referring to one tonne of registered material of each type, were compared against each other.

The study covered the single material flows of glass, paper and lightweight packaging materials (LWP). Components of the LWP fraction are: tinplate, aluminium, plastic or compound materials from the household waste collection. Calculations were made on the basis of the company-specific data of Interseroh.

The annual savings per tonne of waste glass amounted to approx. 170 kg CO_2 in 2007. Main impact parameters can be found in the glass color (white glass yields higher savings

than green glass), the amount of shards in the product, the energetic efficiency and the energy supply (CO_2-intensity of the energy sources in the glass production).

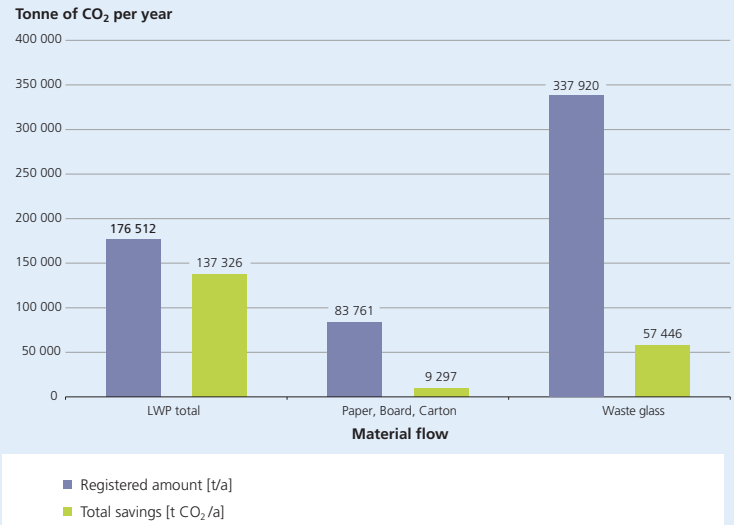
The savings per tonne of waste paper came to approx.111 kg per year in 2007. This value strongly depends on the CO_2-trading credits, due to the fact that cellulose or paper does not have to be made from primary material (trees) any more. These values vary very widely, depending on the energy supply of the paper industry (renewable or fossil sources) and the paper production method used. Further impact factors are to be found in the collection and transport processes.

The most complex material flow is found for lightweight packaging. Among other, the logistic processes for collection and processes for the sorting plants have to be balanced for the calculation. The allocation of environmentally bene-ficial and detrimental effects is significant to the fractions/products generated in the waste sorting plant. For this procedure, a distribution key which also includes impurities and the pre-product of refuse-derived fuel was used. Environmental benefits and negative impacts of these two material flows are allocated to the lightweight packaging products in a second step. In total, savings of an average of 778 kg CO_2 per tonne of registered material were achieved.

The result of the comparison is as follows: With the present fractions of glass, paper and lightweight packaging registered, the Duales System Interseroh was able to save about 341 kg carbon dioxide per tonne of packaging material.

In total, the Duales System Interseroh is saving an annual amount of nearly 204 000 tonnes of carbon dioxide emissions through the recycling of packaging materials. This is equivalent to the CO_2 emissions of a town like Hockenheim with roughly 21 000 inhabitants. The absorption of this amount of carbon dioxide would require a forest area of 204 square kilometers – a size that is encompassed by the city of Hanover for example.

Survey on total CO_2 emission savings (average values; reference year: 2007)



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NAMES, DATA, EVENTS

JAN 01

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NOV 11

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27	28	29	30	31		

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. Fraunhofer publications can be found online at: http://publica.fraunhofer.de

Bauer, G.; Nellesen, A.; Sengespeick, A.; Speck, T.:
Fast self-repair mechanisms in plants: biological latices as role models for the development of biomimetic self-healing, mechanically loaded polymers
(Plant Biomechanics Conference (PBM) <6, 2009, French Guyana>)
In: Thibaut, B. (Ed.):
Proceedings of the 6th Plant Biomechanics Conference: November 16th - 21st, 2009, Cayenne, French Guyana, Franch
Kourou: Unité Mixte de Recherche Ecologie des Forêts de Guyane -UMR ECOFOG-, 2009, p. 367-373

Bechthold, I.; Bretz, K.; Springer, A.; Kabasci, S.:
Succinic acid esters as intermediates for the synthesis of polyamide 44
(Biorefinica <4, 2009, Osnabrück>)
In: Biorefinica 2009: International Symposium Biobased Products and Biorefineries; January 27 and 28, 2009, Osnabrück
Potsdam: biorefinery.de GmbH, 2009, 1 p.

Bringezu, S.; Schütz, H.; Arnold, K.; Merten, F.; Kabasci, S.; Borelbach, P.; Michels, C.; Reinhardt, G. A.; Rettenmaier, N.:
Global implications of biomass and biofuel use in Germany: recent trends and future scenarios for domestic and foreign agricultural land use and resulting GHG emissions
In: Journal of cleaner production 17 (2009), Supplement 1, p. 57-68

Deerberg, G.; Lyko, H.:
Boost biorefineries: future concepts for efficient energy production
In: CHEManager Europe (2009), 3 (exclusive online article), 3 p.

Dötsch, C.:
Energy storage
In: Bullinger, H.-J. (Ed.):
Technology guide: principles, applications, trends
Berlin et al.: Springer, 2009, p. 362-367

Dötsch, C.; Huang, L.; Pollerberg, C.:
Latent heat storage media for cooling applications
(International Renewable Energy Storage Conference (IRES) <4, 2009, Berlin>)
In: 4th International Renewable Energy Storage Conference (IRES 2009): 24 - 25 November, 2009, Representation of the Federal State of North Rhine-Westphalia, Berlin/Germany
Bonn: EUROSOLAR, Europäische Vereinigung für Erneuerbare Energien e.V., 2009, 34 p.

Dudlik, A.; Prasser, H.-M.:
Water hammer and condensation hammer scenarios in power plants using new measurement system
In: Forschung im Ingenieurwesen 73 (2009), 2, p. 67-76

Dudlik, A.; Koutnik, J.:
Water hammer 2 phase analysis hydraulic system with a Kaplan turbine
(International Meeting of the WorkGroup on Cavitation and Dynamic Problems in Hydraulic Machinery and Systems (IAHRWG) <3, 2009, Brünn>)
In: Rudolf, P. (Ed.):
Proceedings of the 3rd IAHR International Meeting of the WorkGroup on Cavitation and Dynamic Problems in Hydraulic Machinery and Systems: Brno, Czech Republic, October 14 - 16, 2009
Brünn: Brno University of Technology -BUT-, 2009, p. 613-624

Erhardt, B.; Fischer, K.; Kasbohm, J.; Keuter, V.; Ngân, L. D.; Oanh, L. T. K.; Lài, L. T.; Hông, Nguyên T.; Schlüter, S.; Steingrube, W.:
Wastewater treatment for Nam Đinh city: the »NDcitylineiaks«-concept
Discussion II (September 2009)
(Final Workshop on the IWRM Project NAM DINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM DINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 22 p.

Erhardt, B.; Fischer, K.; Kasbohm, J.; Ngân, L. D.; Lài, L. T.; Wessel, H.; Hông, N. T.; Oanh, L. T. K.; Vu, D. M.; Schlüter, S.; Keuter, V.:
»NDcitylineiaks«-system: a module-like decentralized wastewater treatment concept for Nam Đinh city
(International Workshop on Integrated Water Resources Management in Nam Đinh Province <2009, Nam Đinh>)
In: Journal of geology/Series B 49 (2009), 33, p. 107-123

Erhardt, B.; Kasbohm, J.; Keuter, V.:
Heavy metal waste water treatment: technical scale in Tông xá
(Final Workshop on the IWRM Project NAM DINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM DINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 13 p.

Gehrke, I.; Keuter, V.:
Cleaner production management for metal working industries as example of metal pickling waste-water
(International Workshop on Integrated Water Resources Management in Nam Đinh Province <2009, Nam Đinh>)
In: Journal of geology/Series B 49 (2009), 33, p. 76-83

Gehrke, I.; Keuter, V.:
Development of advanced nano-engineered membranes for water purification
(EuroNanoForum (ENF) <4, 2009, Prag>)
In: Fantechi, S. (Ed.) et al.:
EuroNanoForum 2009: nanotechnology for sustainable economy; European and International Forum on Nanotechnology; proceedings of the forum, held in Prague on 2-5 June 2009 as an official event of the Czech Presidency of the Council of the European Union; book of abstracts
Luxemburg: Office for Official Publications of the European Communities, 2009, p. 51

Gehrke, I.:
CP – cleaner production: A: Concept of CP; B: CP measures in metal working industries (MWI)
(Workshop »Decision-Making Process in WWT on the Example of Metal Working Industries« <2, 2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 2nd Workshop »Decision-making process in WWT on the example of metal working industries«; 14-15 May 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 18 p.

PUBLICATIONS

Gehrke, I.:
Industrial wastewater treatment in metal working industry (MWI): end of pipe treatment ; A: Best practice treatment, B: Specific treatment processes
(Workshop »Decision-Making Process in WWT on the Example of Metal Working Industries« <2, 2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 2nd Workshop »Decision-making process in WWT on the example of metal working industries«; 14-15 May 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 18 p.

Glasner, C.; Robert, J.; Deerberg, G.:
Drying of transformer oil with different filter techniques
(International Conference & Exhibition for Filtration and Separation Technology (FILTECH) <2009, Wiesbaden>)
In: FILTECH 2009: conference proceedings; October 13-15, 2009, Wiesbaden, Germany; volumes I + II
Meerbusch: Filtech Exhibitions Germany, 2009, p. II-579 – II-586

Glasner, C.; Robert, J.; Deerberg, G.:
Purification of transformer oil using adsorption onto cellulose
(International Exhibition – Congress on Chemical Engineering, Environmental Protection and Biotechnology (ACHEMA) <29, 2009, Frankfurt/Main>)
In: Book of abstracts: ACHEMA 2009, 29th International Exhibition-Congress on Chemical Engineering, Environmental Protection and Biotechnology: Frankfurt am Main, 11 - 15 May 2009
Frankfurt/Main: DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V., 2009, 1 p.

GreenTech made in Germany 2.0: Umwelttechnologie-Atlas für Deutschland
2. Aufl. München: Verlag Franz Vahlen, 2009
ISBN 978-3-8006-3637-2
GreenTech made in Germany 2.0: environmental technology atlas for Germany. 2nd ed.
München: Verlag Franz Vahlen, 2009
ISBN 978-3-8006-3638-9

Huang, L.; Dötsch, C.:
A novel phase change slurry (PCS) paraffin/water-emulsion for cold applications
(International Renewable Energy Storage Conference (IRES) <3, 2008, Berlin>)
In: Third International Renewable Energy Storage Conference (IRES 2008): November 24 - 25, 2008, Representation of the Federal State of North Rhine-Westphalia, Berlin/Germany
Bonn: EUROSOLAR, Europäische Vereinigung für Erneuerbare Energien e.V., 2009, 1 p.

Huang, L.; Petermann, M.; Dötsch, C.:
Evaluation of paraffin/water emulsion as a phase change slurry for cooling applications
In: Energy <Oxford> 34 (2009), 9, p. 1145-1155

Huang, L.; Dötsch, C.; Pollerberg, C.:
Low temperature paraffin phase change emulsions
(IIR Conference on Phase Change Materials and Slurries for Refrigeration and Air Conditioning (PCM) <8, 2009, Karlsruhe>)
In: Kauffeld, M. (Ed.):
8th IIR Conference on Phase Change Materials and Slurries for Refrigeration and Air Conditioning: PCM 2009; international conference; 3 - 5 June 2009, Karlsruhe, Germany
Paris: International Institute of Refrigeration -IIR-, 2009, p. 98-106
(Science et technique du froid ; No 2009-4)

Huang, L.; Pollerberg, C.; Dötsch, C.:
Paraffin in water emulsion as heat transfer and storage medium
(Effstock - Thermal Energy Storage for Energy Efficiency and Sustainability <2009, Stockholm>)
In: Abstract book & proceedings: Effstock 2009; thermal energy storage for efficiency and sustainability; 11th International Conference on Thermal Energy Storage, June 14-17 2009, Stockholm, Sweden
Stockholm: Swedvac, the Swedish Society of HVAC Engineers, 2009, 8 p.

Huang, L.; Dötsch, C.; Pollerberg, C.:
Latent heat storage media for cooling applications
(International Renewable Energy Storage Conference (IRES) <4, 2009, Berlin>)
In: 4th International Renewable Energy Storage Conference (IRES 2009): 24-25 November, 2009, Representation of the Federal State of North Rhine-Westphalia, Berlin/Germany
Bonn: EUROSOLAR, Europäische Vereinigung für Erneuerbare Energien e.V., 2009, 5 p.

IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province)
3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM DINH; 17-18 September 2009/Nam Đinh (Final Workshop on the IWRM Project NAM DINH <2009, Nam Đinh>)
Oberhausen: Fraunhofer UMSICHT, 2009

IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province)
2nd Workshop »Decision-making process in WWT on the example of metal working industries«; 14-15 May 2009/Nam Đinh (Workshop »Decision-Making Process in WWT on the Example of Metal Working Industries« <2, 2009, Nam Đinh>)
Oberhausen: Fraunhofer UMSICHT, 2009

Jelen, E.; Wiedemann, G.; Püschner, K.:
Laser cleaning of contaminated wooden objects
(International Conference on Wooden Cultural Heritage <2009, Hamburg>)
In: Evaluation of deterioration and management of change: International Conference on Wooden Cultural Heritage; Hamburg/Germany, October 7-10, 2009
Brussels: European Cooperation in Science and Technology -COST-, Action IE0601 »Wood Science for Conservation of Cultural Heritage« -WoodCultHer-, 2009, p. 35

Jelen, E.:
3D-confocal-microscopy: New advantages for non destructive measurements
(International Conference on Wooden Cultural Heritage <2009, Hamburg>)
In: Evaluation of deterioration and management of change: International Conference on Wooden Cultural Heritage; Hamburg/Germany, October 7-10, 2009
Brussels: European Cooperation in Science and Technology -COST-, Action IE0601 »Wood Science for Conservation of Cultural Heritage« -WoodCultHer-, 2009, p. 59

Jelen, E.:
Application of supercritical fluids replaces organic solvents
In: Keeping the blue planet green: German ideas for sustainable solutions in environmental technologies; research in Germany - land of ideas
Berlin: Bundesministerium für Bildung und Forschung -BMBF-, 2009, p. 43

Jelen, E.; Ghosh, S. C.:
Modification of domestic timbers by impregnation using supercritical carbon dioxide: a comparison

PUBLICATIONS

(European Conference on Wood Modification (ECWM) <4, 2009, Stockholm>)
In: Englund, F. (Ed.) et al:
The Fourth European Conference on Wood Modification: Proceedings; Norra Latin City Conference Centre, Stockholm, Sweden 27 - 29th April 2009
Stockholm: SP Technical Research Institute of Sweden, 2009, p. 111-116

Kabasci, S.:
Boosting biogas with heat bonus: how combined heat and power optimizes biogas utilization
In: Renewable energy world 12 (2009), 5, p. 101-106

Kabasci, S.; Bechthold, I.; Bretz, K.; Michels, C.; Springer, A.:
From plants to polymers – biopolymer research at Fraunhofer UMSICHT
(International Conference on Renewable Resources and Biorefineries (RRB) <5, 2009, Ghent>)
In: Cukalovic, A. (Ed.):
RRB5: Fifth International Conference on Renewable Resources and Biorefineries: 10 - 12 June 2009, Bijloke, Ghent, Belgium; book of abstracts
Ghent: Ghent University -UGent-, 2009, p. 24

Kanngießer, A.; Wolf, D.; Theofilidi, M.; Bruckner, T.:
Optimierter Einsatz von Druckluftspeicherkraftwerken unter Berücksichtigung von Restriktionen im Verteilnetz
(Fachtagung Optimierung in der Energiewirtschaft <8, 2009, Ludwigsburg>)
In: 8. Fachtagung Optimierung in der Energiewirtschaft: Ludwigsburg, 24. und 25. November 2009
Düsseldorf: VDI-Verlag GmbH, 2009, p. 251-265 (VDI-Berichte; 2080)

Kanngießer, A.; Wolf, D.; Theofilidi, M.; Bruckner, T.:
Commitment optimization of adiabatic compressed air energy storages considering grid restrictions
(International Renewable Energy Storage Conference (IRES) <4, 2009, Berlin>)
In: 4th International Renewable Energy Storage Conference (IRES 2009): 24 - 25 November, 2009, Representation of the Federal State of North Rhine-Westphalia, Berlin/Germany
Bonn: EUROSOLAR, Europäische Vereinigung für Erneuerbare Energien e.V., 2009, 1 p.

Keuter, V.; Krause, S.:
Renewable energies from waste water: a chance for Vietnamese regions
(International Workshop on Integrated Water Resources Management in Nam Đinh Province <2009, Nam Đinh>)
In: Journal of geology/Series B 49 (2009), 33, p. 100-106

Keuter, V.; Deerberg, G.:
Challenge water reuse: Akzeptanz, Betriebssicherheit und Medikamentenrückstände
(Abschlusstagung KOMPLETT <2009, Kaiserslautern>)
In: Schmitt, T. G. (Hrsg.):
KOMPLETT: ein innovatives System zur Schließung von Wasser- und Stoffkreisläufen
Kaiserslautern: TU Kaiserslautern, 2009, p. 163-187
(Schriftenreihe des Fachgebietes Siedlungswasserwirtschaft der Technischen Universität Kaiserslautern; Bd. 28)

Keuter, V.:
Wastewater management in the food industry: cleaner production; example: milk industry/brewery
(Final Workshop on the IWRM Project NAM DINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM DINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 36 p.

Keuter, V.:
Wastewater management in the textile industry: cleaner production, water re-use
(Final Workshop on the IWRM Project NAM DINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM DINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 36 p.

Klosowski, V.; Schaffrath, A.; Seifert, U.:
Plant safety
In: Bullinger, H.-J. (Ed.):
Technology guide: principles, applications, trends, Berlin u. a.: Springer, 2009, p. 536-539

Knerr, H.; Büttgen, S.; Engelhart, M.; Keuter, V.; Legrix, J.-C.; Rechenburg, A.:
Black water recycling and nanotechnology combined
(Fachtagung »nANO Meets... Water and Energy« <2009, Oberhausen>)
In: nANO Meets... Water and Energy: Nanotechnologie in der Wasser-, Abwasser- und Energietechnik; Innovationen auf den Gebieten Materialien, Anwendungen und Analytik; Fachtagung; 26. November 2009, Fraunhofer UMSICHT, Oberhausen
2009, 1 p.

Körner, H.-J.; Deerberg, G.:
Separation and purification of 1,18-octadecenedioic acid
(Biorefinica <4, 2009, Osnabrück>)
In: Biorefinica 2009: International Symposium Biobased Products and Biorefineries; January 27 and 28, 2009, Osnabrück
Potsdam: biorefinery.de GmbH, 2009, 1 p.

Krause, S.; Schlüter, S.:
Waste water treatment in Germany: a review of the training course in Oberhausen/Duckwitz/Sonthofen October 2008
(Final Workshop on the IWRM Project NAM ĐINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM ĐINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 18 p.

Krause, S.; Schlüter, S.:
Xu lý nuóc thai tai Đúc: Điêm lai nhung nét chính vê khóa dào tao tai
Oberhausen/Duckwitz/Sonthofen Tháng 10, 2008
(Final Workshop on the IWRM Project NAM ĐINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM ĐINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 18 p.

Krause, S.; Krassowski, J.; Kabasci, S.:
BEn – Biomass energy register for sustainable site development for European regions
(Symposium Bioenergie - Festbrennstoffe, Bio-

PUBLICATIONS

kraftstoffe, Biogas <18, 2009, Bad Staffelstein>)
In: 18. Symposium Bioenergie - Festbrennstoffe, Biokraftstoffe, Biogas: Grundlagenseminar; 19./20. November 2009, Kloster Banz, Bad Staffelstein
Himmelkron: Energiefachbuchhandel, 2009, p. 169-173

Lyko, H.; Deerberg, G.; Weidner, E.:
Coupled production in biorefineries: combined use of biomass as a source of energy, fuels and materials
In: Journal of biotechnology 142 (2009), 1, p. 78-86

Mac an Bhaird, S.; Devlin, G.; McDonnell, K.; Owende, P.; Mevißen, N.; Schulzke, T.; Unger, C.:
Quality of producer gas from different biogenous fuels
(European Biomass Conference & Exhibition (EBCE) <17, 2009, Hamburg>)
In: De Santi, G. F. (Ed.) et al.:
17th European Biomass Conference & Exhibition: from research to industry and markets; proceedings of the international conference held in Hamburg, Germany, 29 June - 3 July 2009
Florence: ETA-Renewable Energies, 2009, p. 614-620

Mevißen, N.; Schulzke, T.; Unger, C.; Mac an Bhaird, S.:
Thermodynamics of autothermal wood gasification
(International Conference on Thermochemical Conversion Science (TC Biomass) <2009, Chicago/Ill.>)
In: Environmental progress & sustainable energy 28 (2009), 3, p. 347-354

Pollerberg, C.; Heinzel, A.; Weidner, E.:
Model of a solar driven steam jet ejector chiller and investigation of its dynamic operational behaviour
In: Solar energy 83 (2009), 5, p. 732-742

Pollerberg, C.; Jaehnig, D.; Dötsch, C.:
Prototype of a solar driven steam jet ejector chiller
(International Conference Solar Air-Conditioning <3, 2009, Palermo>)
In: Solar air-conditioning: 3rd international conference; Palermo, Sicily, Italy, September 30th - October 2nd, 2009
Himmelkron: BOXER, 2009, 7 p.

Renner, M.; Weidner, E.; Brandin, H. G.:
High-pressure carbon dioxide tanning
In: Transactions of the Institution of Chemical Engineers / A 87 (2009), 7, p. 987-996

Renner, M.; Weidner, E.; Geihsler, H.:
Intensified and environmentally friendly tanning of animal skin
(EQUIFASE <2009, Praia da Rocha>)
In: Book of abstracts: EQUIFASE 2009; VIII IberoAmerican Conference on Phase Equilibria and Fluid Properties for Process Design; 17-21 October 2009, Praia da Rocha, Algarve, Portugal
Porto: Universidade do Porto, 2009, p. 39

Schlüter, S.:
Hôi thao tông kêt du án IWRM Nam Đinh: 17. & 18. Tháng 9, 2009; Tông quan
(Final Workshop on the IWRM Project NAM ĐINH <2009, Nam Đinh>)
In: IWRM research Vietnam: integrated water resource management (IWRM) Vietnam (Nam Đinh province); 3rd Workshop »Waste Water Treatment in the Key Industries of Nam Đinh«/»IWRM Concept for Nam Đinh City«; Final Workshop on the IWRM Project NAM ĐINH; 17-18 September 2009/Nam Đinh
Oberhausen: Fraunhofer UMSICHT, 2009, 3 p.

Springer, A.; Bechthold, I.; Bretz, K.; Kabasci, S.:
Succinic acid: a new platform chemical for biobased polymers from renewable resources
(European Biomass Conference & Exhibition (EBCE) <17, 2009, Hamburg>)
In: De Santi, G. F. (Ed.) et al.:
17th European Biomass Conference & Exhibition: from research to industry and markets; proceedings of the international conference held in Hamburg, Germany, 29 June - 3 July 2009
Florence: ETA-Renewable Energies, 2009, 24 p.

Springer, A.; Bechthold, I.; Bretz, K.; Kabasci, S.:
Polyamides based on biotechnological succinic acid
In: Bioplastics magazine 4 (2009), 04, p. 32-33

Springer, A.; Bechthold, I.; Bretz, K.; Kabasci, S.:
Succinic acid esters as intermediates for the synthesis of polyamide 44
(International Conference on Renewable Resources and Biorefineries (RRB) <5, 2009, Ghent>)
In: Cukalovic, A. (Ed.):
RRB5: Fifth International Conference on Renewable Resources and Biorefineries: 10 - 12 June 2009, Bijloke, Ghent, Belgium; book of abstracts
Ghent: Ghent University -UGent-, 2009, p. 112

Stahl, E.; Robert, J.; Deerberg, G.:
Removal of fine particulate matter from exhaust gases by metallic microsieves
(International Conference & Exhibition for Filtration and Separation Technology (FILTECH) <2009, Wiesbaden>)
In: FILTECH 2009: conference proceedings; October 13-15, 2009, Wiesbaden, Germany; volumes I + II
Meerbusch: Filtech Exhibitions Germany, 2009, p. II-67 – II-73

Stahl, E.; Robert, J.; Deerberg, G.:
Application of innovative metallic micro sieves for particle removal from gases
(International Exhibition-Congress on Chemical Engineering, Environmental Protection and Biotechnology (ACHEMA) <29, 2009, Frankfurt/Main>)
In: Book of abstracts: ACHEMA 2009, 29th International Exhibition-Congress on Chemical Engineering, Environmental Protection and Biotechnology: Frankfurt am Main, 11 - 15 May 2009
Frankfurt/Main: DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V., 2009, 1 p.

Stahl, E.; Robert, J.; Deerberg, G.:
Characterization of innovative metallic microsieves as a new filter medium for fine particulate matter removal from gases
(World Congress of Chemical Engineering (WCCE) <8, 2009, Montreal/Québec>)
In: Montréal 2009: Challenges for a changing world; 8th World Congress of Chemical Engineering (WCCE8); incorporating the 59th Canadian Chemical Engineering Conference and the XXIV Interamerican Congress of Chemical Engineering; August 23-27, 2009, Montréal, Quebec, Canada
Montreal/Québec: École Polytechnique de Montréal, 2009, 4 p.

Türk, J.; Sayder, B.; Vitz, H.; Kiffmeyer, T. K.; Kabasci, S.:
Efficiency, costs and benefits of AOPs for removal of pharmaceuticals from the water cycle
(IWA Specialist Conference on Oxidation Technologies for Water and Wastewater Treatment <5, 2009, Berlin>)
In: Sievers, M. (Ed.) et al.:
Oxidation technologies for water and wastewater treatment: 5th IWA Specialist Conference, 10th IOA-EA3G Berlin Conference; Berlin, March 30 - April 2, 2009; executive summaries
Clausthal-Zellerfeld: Papierflieger-Verlag, 2009, p. 86 (CUTEC-Schriftenreihe; No. 72)

PUBLICATIONS

SELECTED CLIENTS AND CONTACTS

Urban, W.; Salazar Gómez, J. I.; Lohmann, H.:
Catalytically upgraded landfill gas as a cost-effective alternative for fuel cells
(Conference »Fuel Cells Science & Technology« <4, 2008, Copenhagen>)
In: Journal of power sources 193 (2009), 1, p. 359-366

Urban, W.; Lohmann, H.; Salazar Gómez, J. I.:
Performance assessment of a long-time field-test with catalytically upgraded landfill gas
(International Exhibition-Congress on Chemical Engineering, Environmental Protection and Biotechnology (ACHEMA) <29, 2009, Frankfurt/Main>)
In: Book of abstracts: ACHEMA 2009, 29th International Exhibition-Congress on Chemical Engineering, Environmental Protection and Biotechnology: Frankfurt am Main, 11-15 May 2009
Frankfurt/Main: DECHEMA Gesellschaft für Chemische Technik und Biotechnologie e.V., 2009, 1 p.

Urban, W.; Lohmann, H.; Salazar Gómez, J. I.:
Catalytic purification process for the upgrading of landfill gas to fuel cell quality
(Jahrestreffen Deutscher Katalytiker <42, 2009, Weimar>)
In: 42. Jahrestreffen Deutscher Katalytiker: 11.-13. März 2009; congress centrum neue weimarhalle, Weimar 2009, 1 p.

Urban, W.; Salazar Gómez, J. I.; Lohmann, H.:
Challenges of biogas upgrading to fuel cell quality
(European Fuel Cell Forum (EFCF) <2009, Luzern>)
In: European Fuel Cell Forum 2009: 8th European SOFC Forum; 29 June - 2 July 2009, Kultur- und Kongresszentrum Luzern, Luzern/Schweiz; proceedings
Oberrohrdorf: European Fuel Cell Forum -EFCF-, 2009, 12 p.

Wack, H.; Ulbricht, M.:
Effect of synthesis composition on the swelling pressure of polymeric hydrogels
In: Polymer 50 (2009), 9, p. 2075-2080

Weidner, E.:
High pressure micronization for food applications
In: The journal of supercritical fluids 47 (2009), 3, p. 556-565

Wolf, D.; Berthold, S.; Dötsch, C.; Span, R.:
Heat management of decentralized adiabatic compressed air energy storage plants
(International Renewable Energy Storage Conference (IRES) <3, 2008, Berlin>)
In: Third International Renewable Energy Storage Conference (IRES 2008): November 24 - 25, 2008, Representation of the Federal State of North Rhine-Westphalia, Berlin/Germany
Bonn: EUROSOLAR, Europäische Vereinigung für Erneuerbare Energien e.V., 2009, 6 p.

Wolf, D.; Berthold, S.; Dötsch, C.; Lopez, J. U.; Erkan, T.; Span, R.:
Dynamic simulation of possible heat management solutions for adiabatic compressed air energy storage
(Effstock - Thermal Energy Storage for Energy Efficiency and Sustainability <2009, Stockholm>)
In: Abstract book & proceedings: Effstock 2009: Thermal energy storage for efficiency and sustainability; 11th International Conference on Thermal Energy Storage, June 14-17, 2009 Stockholm, Sweden
Stockholm: Swedvac, the Swedish Society of HVAC Engineers, 2009, 8 p.

Wolf, D.; Dötsch, C.; Span, R.:
Evaluating plant configurations for adiabatic compressed air energy storage by dynamic simulation
(Biennial International Conference »Electrical Energy Storage Applications and Technologies« (EESAT) <2009, Seattle/Wash.>)
In: EESAT 2009: electrical energy storage applications and technologies; biennial international conference; Renaissance Seattle Hotel, October 4 - 7, Seattle, Washington, USA
Albuquerque/N.Mex.: Sandia National Laboratories -SNL-, 2009, 6 p.

Selected Clients and Contacts

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

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BKW FMB Energie AG, Bern, Switzerland
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Bundesministerium für Wirtschaft und Technologie, Berlin
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin
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Enrichment Technology Company Limited (ETC), Jülich
Entsorgungsgesellschaft Steinfurt mbH, Altenberge
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E.ON Energie AG, Munich
E.ON Energy from Waste GmbH, Hanover
E.ON Ruhrgas AG, Essen
Europäische Kommission, Generaldirektion Energie und Verkehr, Brussels, Belgium
European Center for Renewable Energy (EEE) Güssing, Austria
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Innovene Deutschland GmbH Köln, Cologne
Institut für Nichtklassische Chemie e.V., Leipzig
Institute for Ecology of Industrial Areas (IETU) Katowice, Poland
INTERSEROH Dienstleistungs GmbH, Cologne
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ITProtect, Gevelsberg
IZEG Informationszentrum Entwässerungstechnik Guss e.V., Bonn
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nova Institut GmbH, Hürth
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Österreichische Akademie der Wissenschaften - Institut für Biophysik und Nanosystemforschung, Graz, Austria
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Ritter-Pen GmbH, Brensbach
rmp rapid prototyping and manufacturing rpm GmbH, Helmstedt
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Ruhr-Universität Bochum, Bochum
Ruhr-Universität Bochum, Lehrstuhl für Energieanlagen und Energieprozesstechnik LEAT, Bochum
Rural Development Initiatives Ltd (RDI), Northumberland, Great Britain
RWTH Aachen, Aachen
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Stadtwerke Gronau GmbH, Gronau
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Wuppertal Institut für Klima, Umwelt, Energie GmbH, Wuppertal
Zwiesel Kristallglas AG, Zwiesel

PATENTS

SPIN-OFFS

Patents 2009

Issued Patents:

Process and bioreactor for the production of a biofilm (Wack, H., Pape, Hintemann, Merrettig-Bruns) – Germany

Method and device for producing nanocomposites (Bertling, J., Rechberger, Weidner, Petermann*) – Europe

Use of hydrophobized silica gel as a selective sorbent for removing organic silicon compounds (Urban, Unger) – Europe

* = external inventors

Registered Trademarks:

Fuexpress (word trademark)
polymero (European word trade mark)
euCEP (European word trade mark)

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
www.as-itcon.de

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
www.carbon-tf.com

DataPool Engineering GmbH, Oberhausen
Softwareentwicklung, Systemanalyse, EDV-Beratung
www.dp-e.de

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

FKuR Kunststoff GmbH, Willich
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www.fkur.de

SOLid Composites GmbH, Voerde
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www.solidcomposites.de

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www.ventax.de

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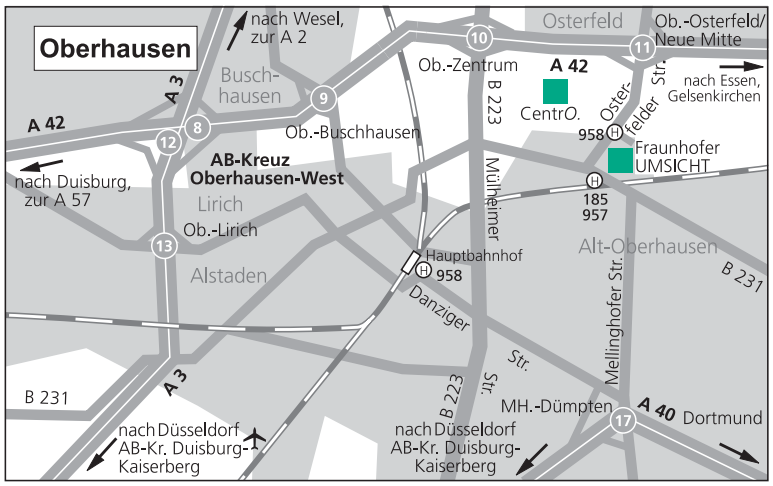

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Coming from Dortmund:
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Exit Mülheim-Dümpten. Turn left at the end of the exit. At the next intersection turn left onto Mellinghofer Strasse. To continue please follow the instructions above.

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From Oberhausen central station to Fraunhofer UMSICHT, either with bus number 185 (towards Essen Borbeck Bf.) 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

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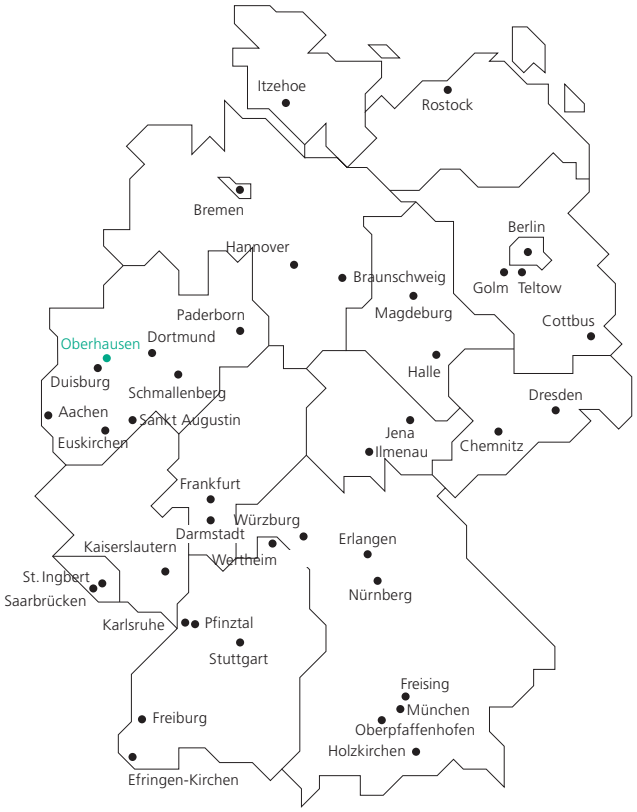

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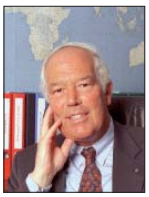

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