

The cover features a collage of images: a cracked, dry earth with a small green plant growing from it; a close-up of a mechanical part; a hand holding a magnifying glass over a circular component; and a close-up of water ripples. The collage is overlaid with a dark teal semi-transparent box containing the title and subtitle.

ANNUAL REPORT

2015 | 2016

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



SUSTAINABILITY AS A RECURRING THEME

The subject area of sustainable energy and raw materials management is the focus of our work. Ever since 1990, our founding year, it has been our objective to carry out sustainable research in the areas of environmental, safety, and energy technology. At Fraunhofer UMSICHT, the sustainability strategy was created holistically and is anchored in the institute as a whole. The employees, management and the institute's directorate are equally involved in the implementation.

We would like to show all of our interested parties (customers, the public, job applicants) specifically which contribution our R&D products and services make to sustainable development. We want to get in touch with them in order to jointly further these objectives and to improve the quality of life of society as a whole.

We are looking forward to receiving your feedback!

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PREFACE



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



*Prof. Dr.-Ing. Gorge Deerberg,
Deputy Director of the institute.*

Photos: Fraunhofer UMSICHT/PR-Fotografie Köhring

Dear readers,

The energy and raw material transition moves people in Germany, Europe and worldwide. Fraunhofer UMSICHT is helping actively to form the energy and commodity transition - and it is becoming increasingly clear that this requires the joint efforts of different actors. Major projects, for example for the conversion of the energy industry to renewable sources are only possible to get off the ground in conjunction with powerful consortia, with strong industry partners and with partners from society and politics. The result is better, the closer the cooperation is: Who works alone, adds. Who cooperates, multiplies.

We know that the challenges of energy and raw material transition can only be tackled in strong alliances. At the present time, it is essential to look outside the box to get involved in subjects beyond one's own expertise and actively build strategic alliances and networks. The strengths of Fraunhofer UMSICHT are the ability to be a "catalyst" to generate such networks, and our expertise about which we inform you in this annual report. Our five business units - polymer materials, chemistry, environment, biomass and energy - illustrate the spectrum that makes us strong and with which we are furthering the advance of sustainable economic, environmentally friendly technologies and innovations. Look forward to read a success story for each business unit in recent years and to be inspired for projects with UMSICHT.

We look forward to working with you.

Cordial greetings



Eckhard Weidner



Gorge Deerberg

INSTITUTE

THE BASIC DATA OF FRAUNHOFER UMSICHT.

Profile, Key Performance Indicators,
Organizational Structure.

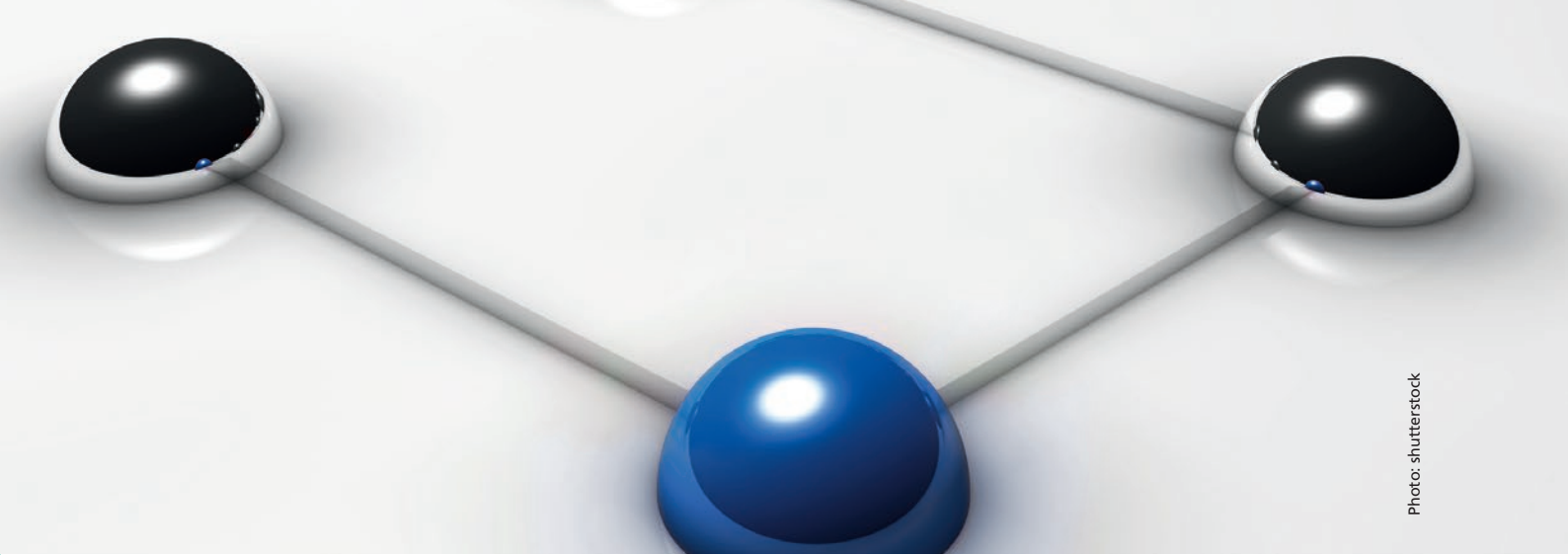


Photo: shutterstock

PIONEERS OF A SUSTAINABLE ENERGY AND RAW MATERIALS MANAGEMENT

In Germany, the energy system is switched to renewable sources. The set climate targets are ambitious. This requires great efforts in the coming years and the cooperation of all social groups. Fraunhofer UMSICHT is a pioneer of a sustainable energy and raw materials management, providing scientific results and transferring them to businesses, society and politics. The dedicated team researches and develops together with partners sustainable products, processes and services that are convincing.

Fraunhofer UMSICHT is situated in Oberhausen, has an institute branch in Sulzbach-Rosenberg (Bavaria) and a branch office (plastic technical shop) in Willich. As an institute of the Fraunhofer-Gesellschaft, we are part of a worldwide network and foster international cooperation.

As a pioneer in the energy and raw materials management, we develop innovations that provide critical contributions to a resource-saving society and industry. We do everything in our power to bring knowledge, methods, technologies, products and services in the business units of polymer materials, chemistry, the environment, biomass and energy all the way up to the application stage.

TRADEMARKS OF FRAUNHOFER UMSICHT

- Expertise in chemical-biological-physical conversion, material development, component development, process technology, product development and product evaluation, energy systems, mathematical and analytical methods
- Creativity, quality and efficiency in idea generation and the implementation in applications and projects
- Market-oriented, long evaluation chains from the idea to the consumer
- Continuous evaluation of the innovations in terms of sustainability
- Contributing to the social discourse on the energy transition and raw materials shift

WHAT WE CAN DO FOR YOU

- Improve products
- Product developments – if necessary up to small series
- Market analysis and innovation consulting
- Introduce new technologies
- Licensing and license acquisitions
- Optimizing processes or organizational forms
- Characterize, examine and certify

2015

Fraunhofer UMSICHT
in figures

31.5

MILLION €
OBERHAUSEN

7.6

MILLION €
SULZBACH-ROSENBERG

33.6 %

INDUSTRY

39.1

MILLIONEN €
TOTAL BUDGET

46.1 %

PUBLICLY FUNDED
RESEARCH PROJECTS
INCL. EU

14

PROMOTIONS

77

MASTER-
AND DIPLOMA
THESIS

68 %

PUBLIC

354

OBERHAUSEN

135

SULZBACH-ROSENBERG

32 %

BUSINESS

489

EMPLOYEES
(AS OF 31/12/15)

440

PROJECTS

7

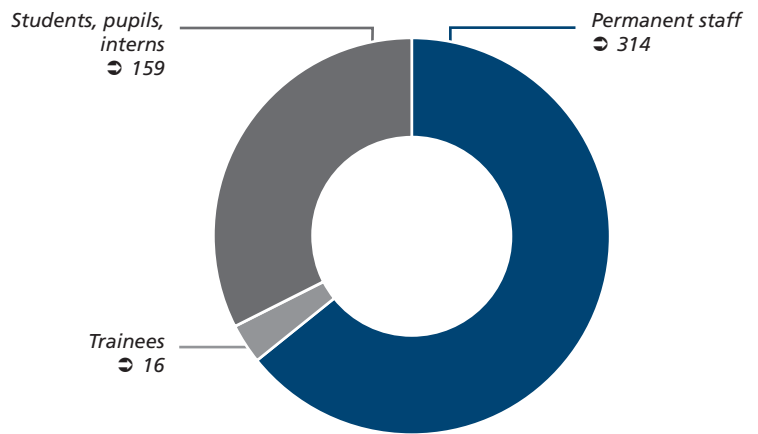
INTELLECTUAL
PROPERTY RIGHTS
REGISTRATION



Foto: sushi100/photocase.com

STAFFING STATISTICS 2015

	OB	SURO *
Permanent staff	237	77
Scientific	184	57
Administrative	53	20
Other staff	117	58
Trainees	14	2
Students, pupils, interns	103	56
Total staff	354	135

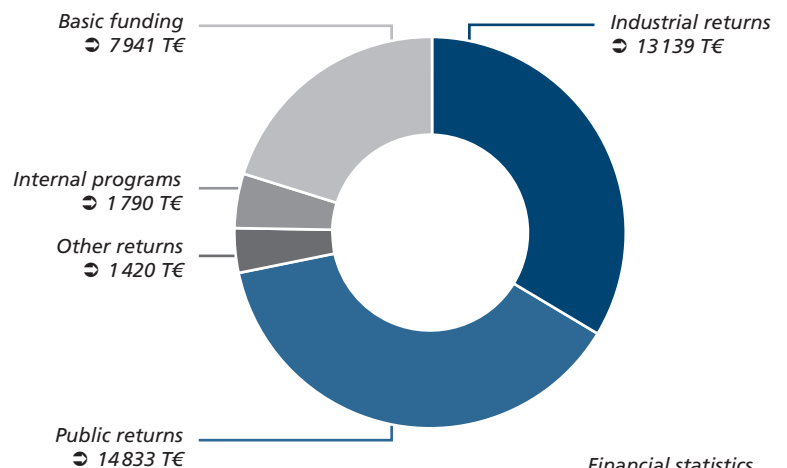


Staffing statistics
Fiscal year 2015; including all sites.

FINANCIAL STATISTICS 2015

[in thousand euros]

	OB	SURO *
Operating budget	29 385	7 079
Other costs	14 301	2 444
Staff costs	15 084	4 635
Investments budget	2 137	522
External project investments	1 510	520
Internal investments	627	2
Total returns	31 522	7 601
Industrial returns	12 149	990
Public returns	8 623	6 210
Other returns	1 019	401
Internal programs	1 790	0
Basic funding	7 941	0



Financial statistics
Fiscal year 2015; including all sites.

* OBERHAUSEN / SULZBACH-ROSENBERG

ORGANIZATIONAL STRUCTURE

As of March 2016

The organizational structure of Fraunhofer UMSICHT is based on the divisions of energy, processes and products in Oberhausen and the institute branch in Sulzbach-Rosenberg. The areas with their departments and groups comprise the scientific know-how of the institute by expertise criteria. The division organization unites the technical and administrative departments of the institute.



DIRECTORATE

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- Chemical Energy Storage
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- Process Intensification
- Information Technology
- Process Engineering
- Think Tank



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- Bio-based Plastics
- Material Systems and High Pressure Technology
- Sustainability and Resources Management
- Systemic Product Development



INSTITUTE BRANCH SULZBACH-ROSENBERG

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- Renewable Energy
- Thermal Process Technology
- Recycling Management
- New Materials
- Biological Process Technology

BUSINESS UNITS

further information see pg. 12

Five branch-oriented business units complement the organizational structure. They tailor the expertise and research and development competence of the divisions and departments to meet customer needs in the business fields.



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DIVISION ORGANISATION

Andreas Weber

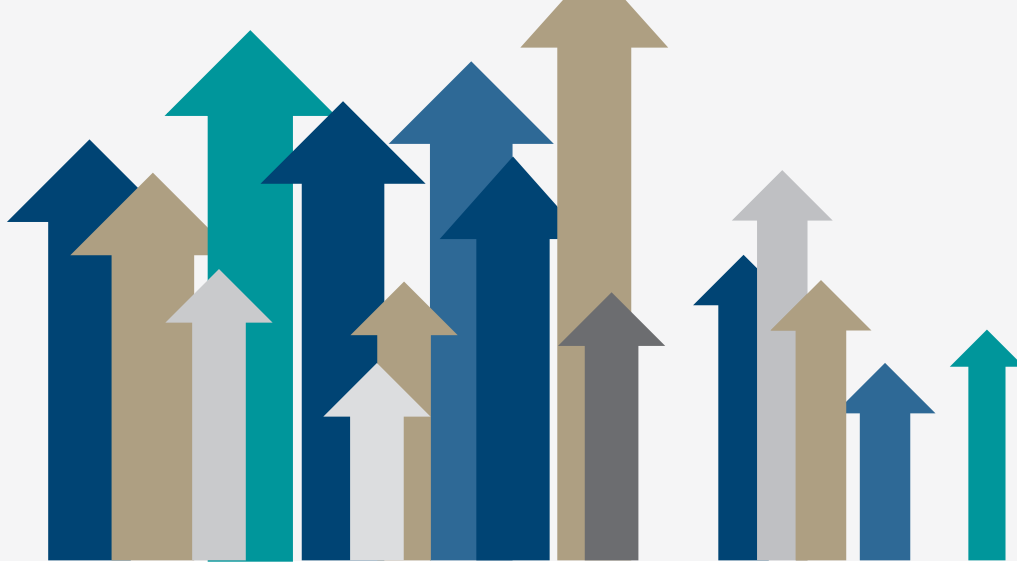
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- Administration
- Public Relations
- UMSICHT Academy
- Analytics
- Technics
- Occupational Safety and Environmental Protection
- IT-Security
- Library

BUSINESS UNITS

OUTSTANDING RESEARCH SERVICES.

Five business units meet the interdisciplinary needs of selected industry sectors.



OUR BUSINESS UNITS

Offer outstanding research services – In addition to outstanding performance, the declared goal of Fraunhofer UMSICHT requires a view of the big picture. Only then it is possible to assess topics, to provide individual solutions and to perform industry-oriented development. For a comprehensive understanding of markets and customer requirements in selected industry sectors, the departments of the institute's divisions are brought together to form five business units. This allows us to utilize resources more efficiently and to increase our productivity for the benefit of our customers.



P – POLYMER MATERIALS

- Bio-based plastics
- Plastics processing
- Leather / consumer goods
- Additive manufacturing



C – CHEMISTRY

- Petrochemistry
- Refineries
- Catalytic processes
- Biotechnology
- Cross-energy technologies



U – ENVIRONMENT

- Water, wastewater
- Supply and disposal
- Raw materials
- Infrastructure
- Safety



B – BIOMASS

- Bioenergy
- Waste materials
- Nutrients and nutrient recovery
- Agricultural technology



E – ENERGY

- Decentralised energy production and energy use
- Energy efficiency
- Energy storage

BUSINESS UNIT

POLYMER MATERIALS

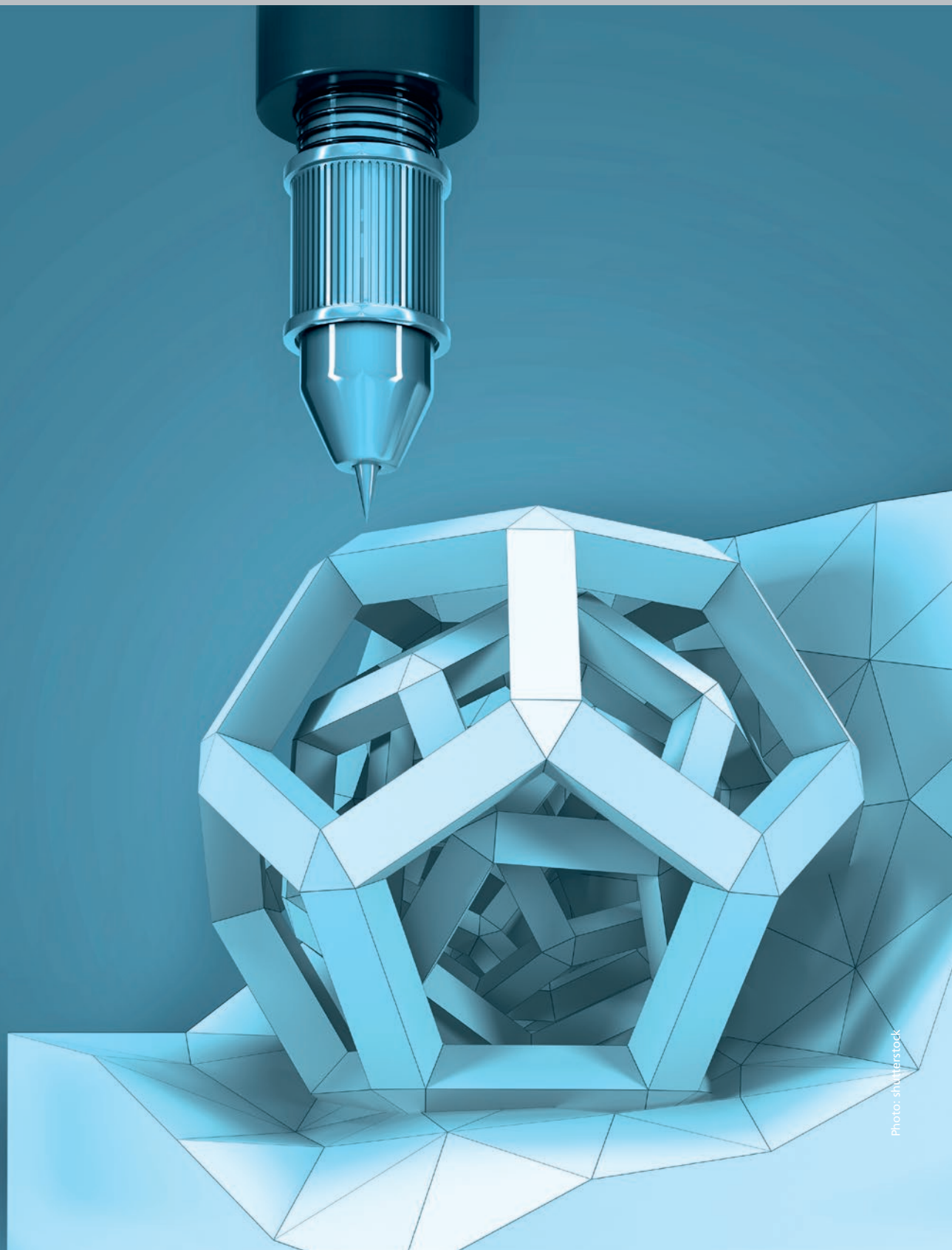


Photo: shuherstock

SERVICE PORTFOLIO

For decades, Fraunhofer UMSICHT has been a strong partner to small and medium-sized enterprises all the way up to large-scale industry in the areas of the development and processing of plastics. Our specialties include the development of materials of bio-based plastics and recycle-based plastics. We are representative of product and process developments, simulation, production scale-up and additive manufacturing of plastics. In the area of consumer products, we have proven expertise in high pressure technology and coating technology. As an application-oriented development partner, we also transfer our material, process, and product innovations to the construction and leather industries.

RESEARCH AND DEVELOPMENT SERVICES

- Materials development (focus on bio-based plastics)
- Product and process development, manufacturing processes
- Product design, CAD design, and sample production
- Surface modification and surface structuring
- Foaming of plastics
- Component and system development
- Coating development
- Studies and consultation
- Multiphysics simulations of components and products
- Technical and economic feasibility studies
- Sustainability assessments
- Analytics, chemistry, biology, environmental analysis
- Determination of the biodegradability of materials and products

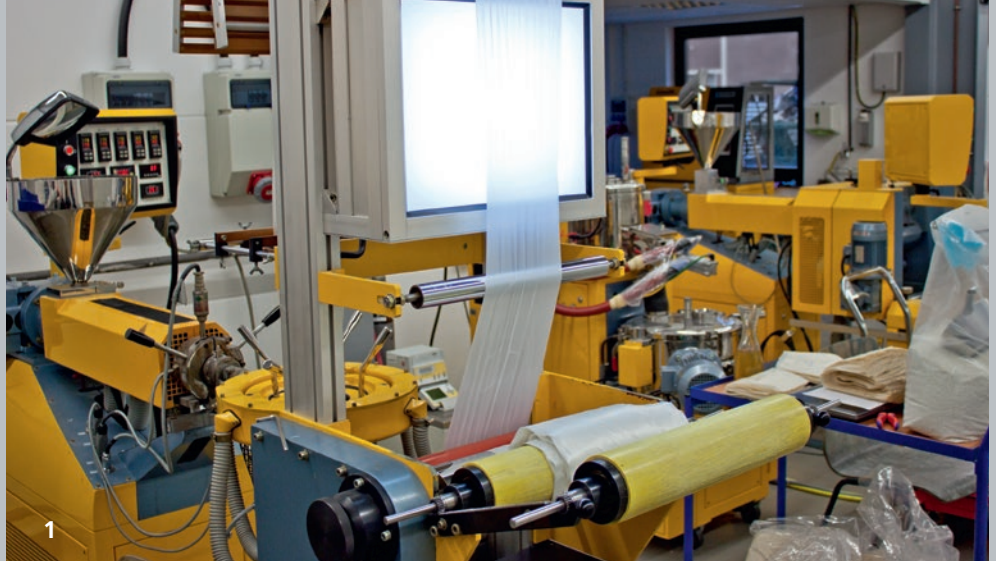
MARKETS AND INDUSTRIES

- Plastics and plastics processing industry
- Manufacturers of household articles, consumer care and clothing
- Leather and leather processing industry
- Manufacturers and users of additive manufacturing/ 3D printing
- Construction industry

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WORKING TOGETHER FOR BIOPLASTICS

1 *Film blowing machine for manufacturing biofilms.*

2 *Visual inspection of a blown film.*

Material recycling brought FKUR Kunststoff GmbH and Fraunhofer UMSICHT together. Today they jointly develop, produce and market bioplastics. Guaranteed confidentiality, continuity in key positions, reliable project management, professional agreements on usage rights and mutual understanding of the strategic goals of the respective other party are the permanent pillars of the collaboration.

MADE TO MEASURE PARTNERSHIP

Goal: Develop bioplastics

Coming from material recycling, in the early nineties the cooperation partners anticipated that the development of bioplastics on the basis of renewable raw materials could close a technological gap to the fossil-based plastics, with a prospective high market potential. Thus, the goals were defined: Develop bioplastic compounds to series production readiness and bring them to market.

Result: Product lines established in the market

Biodegradable compounds primarily consisting of natural raw materials were developed. The compounds provide a specific and often also new set of properties which is as good or better than that of fossil based polymer materials. Important material lines are BIO-FLEX® for film extrusion, BIOGRADE® for injection molding and FIBROLON®, natural fibre reinforced plastics.

Context, methods: Highly industry-related research

Research work, material development and quality assurance are part of Fraunhofer UMSICHT. FKUR Kunststoff GmbH contributes its knowledge of the market to the projects and is responsible for the implementation of the industrial process, production, sales and marketing of the bioplastics.

Customer benefits: Always a step ahead

Many aspects play a role in the development of innovative materials. Customers receive bioplastics which can be processed on conventional machines and which were developed with an eye on costs, market opportunities and raw material availability. Feasibility studies and profitability calculations help to determine trends and to position oneself for the future. FKUR Kunststoff GmbH expanded its product portfolio in this manner and established itself as a bioplastics manufacturer which operates around the world.



2

SMART STRUCTURING OF USAGE RIGHTS

Patent or know-how license?

With a few exceptions, we have decided against filing of patents in order to avoid disclosure of our formulas. The formulas are confidential know-how. We have entered into a licensing agreement with FKUR Kunststoff GmbH. It defines the terms under which the company is allowed to use the formula.

Which sectors do we support?

Our goal is to work in partnership with companies to develop processes or products, from the initial idea to small batch series. This sort of trust-based collaboration is of interest to many industries.

In addition to the plastics and plastics processing industries, our polymer materials business unit has outstanding industry knowledge of the leather and leather processing industry and the construction industry. We are particularly well versed in the interests and needs of these fields. This is helpful for the optimal combination of customer requirements and science.

Ecology/product responsibility:

The biggest advantage of bioplastics is that they are manufactured without crude oil or natural gas. Fossil sources of raw materials are untouched, and domestic value creation chains also secure jobs. The materials offer further advantages when it comes to disposal: The amount of climate-damaging CO₂ which is released is no greater than the amount which the plants - out of which the plastic was manufactured - have absorbed.



FACTS

Germany's plastics industry, the largest in Europe, achieved annual sales of Euro 93 billion in 2014. The packaging and construction industries are the industry's largest domestic customers. With a volume of 1.7 million tons in 2014, the share held by manufactured bioplastics in the worldwide plastics production (311 million tons in 2014) is still low.

NATIONAL INFORMATION CENTER SUSTAINABLE PLASTICS

The primary goal of the PLASTiCE program supported by the European Commission and the Central Europe Program is to promote new, more environmentally friendly and more sustainable plastics along the entire value creation chain. to market introduction of these materials.

A global network of national information centers provides information on sustainable plastics, in order to remove obstacles to market introduction of these materials. The national information centers are located in research institutes which have know-how in the field of sustainable plastics. Fraunhofer UMSICHT assumes this role for Germany and maintains an easy to understand website. It provides easy access to information on the topic of sustainable plastics to interested parties from research, industry and the public.

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BUSINESS UNIT **CHEMISTRY**



SERVICE PORTFOLIO

We offer process engineering research and development services as well as products and processes incl. industrial property rights. These help to meet the increasing demands for affordable sustainability and innovation in chemistry, petrochemistry and refinery. Our know-how encompasses the areas of fine and specialty chemicals (organic acids, peptides, sugars, tensides), polymers (monomer syntheses, polymerization, polycondensation) as well as chemical mass products (alcohols, naphtha) and biofuels (diesel, kerosene). Biomass, synthesis gas and selected residues constitute the portfolio of raw materials from which we suggest process-specific solutions. Know-how regarding the upstream and downstream processing as well as product formulation round out our expertise. We are points of contact for the whole value added and logistics chains, develop sustainability assessments and strategies. We are glad to bundle internal and external competences to fit the customer's project.

RESEARCH AND DEVELOPMENT SERVICES

- Synthesis routes from fossil and biogenic raw materials and residues incl. consulting regarding the sustainable shift in raw materials
- Optimization of process chains through integration of biotechnological and chemical-catalytic process steps
- Development and optimization of scalable processes incl. upstream and downstream processing
- Product development and formulation as well as production scale-up
- Development and screening of catalysts all the way up to kg scale
- Optimization of bioconversion steps with conversion of material by microorganisms, enzymes or enzyme systems
- Development, sizing, operation, provision as well as optimizations of laboratory and technical shop systems with capacities of up to 20 kg product per week
- Analytics service: analyses in accordance with standard processes, special analytics, development of methods
- Technological consulting: sustainability assessments, economic feasibility analyses, concept studies all the way to basic engineering, studies regarding the potential of utilizing alternative raw materials and residues, topic and trend scouting, strategic concepts for action, innovation road-maps

MARKETS AND INDUSTRIES

- Chemical industry
- Biotechnology
- Process engineering plant construction

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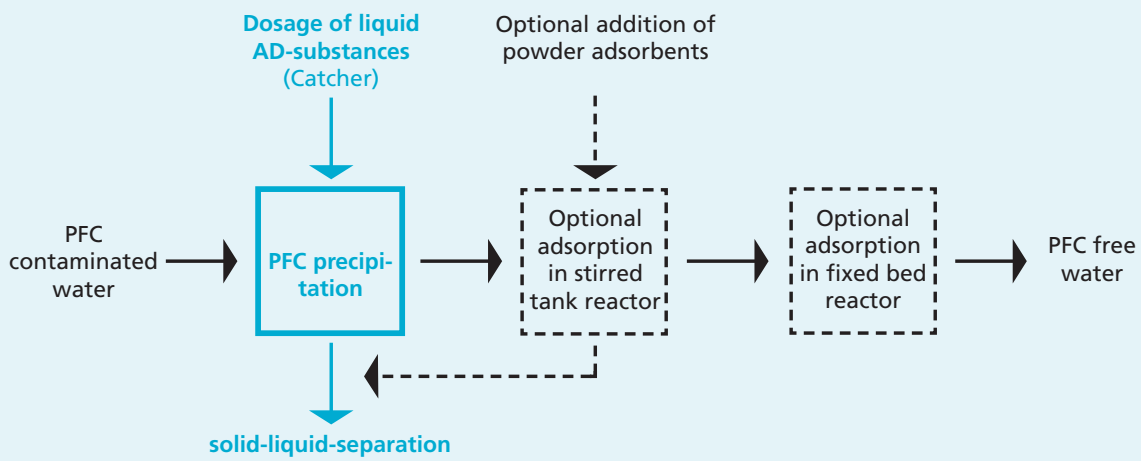


Diagram: Cornelsen Umwelttechnologie GmbH

1

INNOVATION THROUGH COMBINATION

1 The addition of PerfluorAd® takes place into the waterflow. Flocculation of the PFC compounds occurs within max. 30 minutes. The precipitate is separated via settling and/or filtration, dehydrated and routed to a proper disposal process. If necessary, activated carbon in powder form is added to the treated water at the same time, or the water receives subsequent further treatment in an activated carbon packed bed adsorber (safety filter).

2 Stirred tank reactor for scrubbing PFC contaminated water with PerfluorAd®.

Fraunhofer UMSICHT in collaboration with Cornelsen Umwelttechnologie GmbH has developed a process for flexible and cost-effective separation of perfluorinated and polyfluorinated chemicals (PFCs) from contaminated groundwater. The process is based on the combination of various process materials.

SUCCESSFUL IMPLEMENTATION

Goal: Effective removal of PFC

PFC are used as necessary additives, among other things in extinguishing systems. In certain applications, such as airport fire fighting, there is currently no alternative which achieves an effective extinguishing effect. However, these substances accumulate in the environment when they are released; certain compounds of this class also exhibit an elevated human toxicity. The collection of water contaminated with PFC is often impossible or inadequate. The currently established method for separating PFC compounds is adsorption using activated carbon. Due to the poor adsorbability of certain PFC structures, very large filtration systems are often required. This increases the investment and operating costs of treatment systems.

Result: New scrubbing stage

The new process (see diagram) combines activated carbon adsorption with an upstream scrubbing stage. In this pre-treatment step, a solution of PerfluorAd® is added to the contaminated water, causing the dissolved PFC compounds to precipitate.

Context, methods: Commercially used chemicals

Every case of PFC contaminated groundwater exhibits a unique pattern of contaminants and other substances. As a result, it is necessary to adjust the composition of the PerfluorAd® additive as well as the additional process substances (activated carbon, flocculant) used in combination on a case by case basis. Fraunhofer UMSICHT studied the suitability of environmentally compatible chemicals as process additives for water treatment. The chemicals used are commercially available products from the Care market and already registered by the European Chemicals Agency (ECHA). After these substances were shown to be effective in the laboratory, Cornelsen Umwelttechnologie GmbH tested the use of the additives in a scaled up process and successfully implemented it.



Customer benefit:

easy, adaptable process to minimize waste

The newly developed process can also be used for simple and flexible separation of PFC from aqueous media – from ground-water to wastewater or extinguishing water. It minimizes the amount of required process media and thus the amount of PFC contaminated waste to be disposed of. This leads to cost savings in comparison to conventional water treatment methods.

new combinations of substances and/or formula components. Fraunhofer UMSICHT sets the spotlight on the question: Which fields still hold potential for using established and preferably environmentally friendly chemicals? This creates added value for potential customers to placing their products in new applications and opening up new markets.

¹ www.umweltbundesamt.de/daten/chemikalien-in-der-umwelt/zahlen-fakten-zu-chemikalien-zur-chemischen (accessed on February, 12 2016)

DERIVING NEW PROPERTIES

Will the chemistry of the future put greater emphasis on utilization through combination?

To date, chemical manufacturers and importers have registered over 10 500 different substances with the European Chemicals Agency (ECHA) ¹ – This results in a virtually inexhaustible potential to create innovative product properties through

TEAM

Since 2009, Fraunhofer UMSICHT has been researching together with Cornelsen Umwelttechnologie GmbH in developing innovative adsorption materials for simple and cost-effective separation of PFC from contaminated water.

Dr. Stefano Bruzzano, project manager:

"The combined use of materials keeps the adsorption process used in practice uncomplicated, adaptable and minimizes the amount of PFC contaminated waste requiring disposal. This minimization is primarily the result of interactions between PerfluorAd® as the additive and the PFC contaminants by adding an additive solution to the contaminated water which causes precipitation of the PFC compounds."

Dipl.-Ing. Martin Cornelsen, project partner:

"PerfluorAd® is based on green chemicals which may optimize the scrubbing performance as well as reduce the operating costs of (activated carbon) treatment plants."



Ecology/product responsibility:

Thermal oxidation at high temperatures – i.e. greater than 1100 °C – is currently the preferred method for disposing of perfluorinated chemicals or rather PFC wastes, in order to destroy those safely for people and the environment. However, this process requires very high energy inputs. The use of lower amounts of the active substance PerfluorAd® in an upstream scrubbing or respectively precipitation stage is intended to minimize the total amount of PFC waste (from precipitation and contaminated activated carbon) requiring combustion. This contributes to the energy and resource efficiency of water treatment processes.

CONTACT

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BUSINESS UNIT **ENVIRONMENT**



Photo: shutterstock

SERVICE PORTFOLIO

Our service portfolio includes consulting, applied studies, innovative technology development up to pilot plant scale as well as support of the technical implementation at industrial scale. We provide clear communication paths with a central contact person who looks across our business units for the ideal solution for the customers' demands and who supports the joint realization. We deliver basics for strategic decisions; we improve competitiveness through optimization of energy flows, raw material flows and waste streams, through sustainability assessments and through optimization of processes and plants. We as a reliable and strong partner for our customers are willing to establish long-term business partnerships.

RESEARCH AND DEVELOPMENT SERVICES

- Preparation of eco-assessments and sustainability assessments in accordance with DIN EN ISO 14040/14044 for products, processes and services
- Analysis of complex energy and raw materials supply systems (systems analysis) in order to support business policy/political decisions
- State-specific, industry-specific and company-specific strategies and concepts for the supply with primary and secondary raw materials
- Technological consulting regarding strategic company decisions
- Concepts, processes, and products for
 - Recycling, utilization of residues – recovery and generation of reusable materials and critical raw materials
 - Removal of pollutants and recovery of reusable materials from (waste) water
 - Removal of pollutants from waste gases
- Development, engineering, erection and operation of plants and technologies for recycling, (waste) water treatment and reduction of emissions at various orders of scale (testing plants, demonstration plants, industrial scale implementation)
- Scientific-technical support in the implementation of new technologies in practice
- Customer-tailored safety and hazardous material management software

- Analytics services with problem-oriented assessment and action recommendations
- Economic feasibility studies for processes, methods and products

MARKETS AND INDUSTRIES

- Waste disposal, circular economy, and recycling
- Raw materials industry
- Energy supply (incl. the supply of heat and cold)
- Water supply and wastewater disposal
- Manufacturing industry and plant construction
- Industrial facility management
- Engineering and planning offices
- The public sector

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ELIMINATING HAZARDS TO PEOPLE AND ENVIRONMENT

¹ Fraunhofer UMSICHT assessed the hazards posed by gases in specific parts of the sewer system where entry for work was required.

Companies are legally obliged to protect the environment and their employees and to identify and assess potential hazards. External consultants are often hired for these tasks since extensive expertise is required. In some cases, however, additional independent expertise and/or experimental investigations become necessary which cannot be performed by the contracted company. Fraunhofer UMSICHT is available as a cooperation partner in these cases.

EXPERT AND COOPERATION PARTNER FOR ENVIRONMENTAL PROTECTION AND OCCUPATIONAL HEALTH AND SAFETY

Goal: Standard-compliant occupational health and safety and environmental protection

Companies and public facilities are subject to a large number of statutory regulations with regard to occupational health and safety and environmental protection. One of the challenges is to systematically classify the planned activities and conditions in the company according to the relevant regulations, in order to define and implement suitable protective measures with a risk-based approach. Last year, municipal wastewater services were in doubt of the reliability of their portable multi-gas detectors and contracted Fraunhofer UMSICHT. Potential cross sensitivities against hydrogen sulphide impeded the risk assessment for employees working in the sewers. In another case, an industrial company turned to Fraunhofer UMSICHT with the question of whether the risk to third parties from a plant requiring approval was reduced to a sufficient degree by distances and protective measures. In both cases, the goal was an objective risk assessment.

Result: Customer-oriented analysis and assessment

The contracted consultants lacked the required expertise and/or resources to provide a sufficiently well-founded answer in this particular regard: They brought Fraunhofer UMSICHT in as a partner. In the case of the wastewater services, Fraunhofer UMSICHT analyzed the exposure of employees working in the sewer, performed experiments to test the cross sensitivity of the portable detectors and recommended protective measures jointly with the external consultant: Building measures, ventilation, regular testing and calibration of the detectors, and supplementary training of the employees. In the second case, it was possible to verify the effectiveness of the existing measures at the industrial company through calculation of different dispersion scenarios.

Context, methods:**tailored, pragmatic cooperation**

A customized risk assessment often requires subject-specific expertise, which companies may lack and therefore obtain support from consulting firms. In turn, consulting firms know that Fraunhofer UMSICHT stands by as an independent partner who can support with scientific expertise in more complex cases. Fraunhofer UMSICHT can provide suitable experts, approaches and technical resources to match the requirements of the end customer and the partner's need for scientific consulting.

Customer benefits:**Broad expertise through interdisciplinary teams**

Fraunhofer UMSICHT offers a broad range of independent scientific expertise. Interdisciplinary teams are formed based on the project and provide reliable information on the given circumstances within a short timeframe. The institute's fully equipped laboratory and pilot-plant facilities allow for complementary investigations, so that sound answers to special aspects can be provided even on short notice. In-house research work in the corresponding fields forms the basis for well-founded and neutral consulting services.

**Ecology/product responsibility:**

Compliance with legal standards regarding occupational health and safety and environmental protection (legal compliance) is an important basis for sustainability within a company. While occupational health and safety focuses on the employees, environmental protection looks at preserving the environmental resources and persons within the sphere of influence of the company's activities. With their expertise, service providers from different fields make an important contribution in this regard.

 TRANSFER TO INNOVATIVE PROCESSES

How are the results presented?

Due to the multitude of successfully completed projects, Fraunhofer UMSICHT has a detailed understanding of how project results have to be presented depending on the respective customer and problem definition: whether as a report, a list of questions and answers, or a dialog with the public.

What aspect of these projects is still research and development?

Protective measures in the field of occupational health and safety and environmental protection must be defined and implemented according to the situation. This requires a well-founded assessment of the existing risks. The regulatory framework and the state of scientific knowledge are constantly changing. Fraunhofer UMSICHT keeps track of these and makes them available for use in practice in the form of the described partnerships.

To what extent do other partners of the institute benefit from this expertise as well?

The legal framework conditions are always part of research and development projects for the planning and development of new and optimized processes and materials. Thus, there is also expertise in the application of existing regulations during the implementation of innovative processes.

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BUSINESS UNIT

BIOMASS



Photo: shutterstock

SERVICE PORTFOLIO

Provision of bioenergy and biogas, utilization of residues, nutrient management and recovery as well as decentralized production and marketing of bio-based conversion products (biochar, synthesis gas, and pyrolysis condensate) are among our focal points. We develop and optimize thermochemical and biological conversion and distribution processes and the corresponding plant technology. With the objective to recover nutrients from municipal and industrial process chains and the conversion processes, we develop concepts and methods for nutrient management in biomass management. In this, we take into consideration raw materials potentials as well as logistic issues and integrate the technologies developed into established or novel value added chains.

RESEARCH AND DEVELOPMENT SERVICES

- Concept and system development for the provision of raw materials and energy from biogenic raw materials and residues, including process development, component development, and plant development – even by means of storable, carbon-rich intermediate products
- Concepts, construction, operation, and optimization of laboratory systems, technical shop systems and demonstration plants, incl. trace gas analytics
- Development of methods for reduction of emissions, flue gas purification
- Catalyst and bioprocess development
- Development of concepts and technical systems for nutrient management and for nutrient recovery (e. g. nitrate, phosphate) including (sustainability) assessments; treatment of fermentation residues
- Strategy development and techno consulting

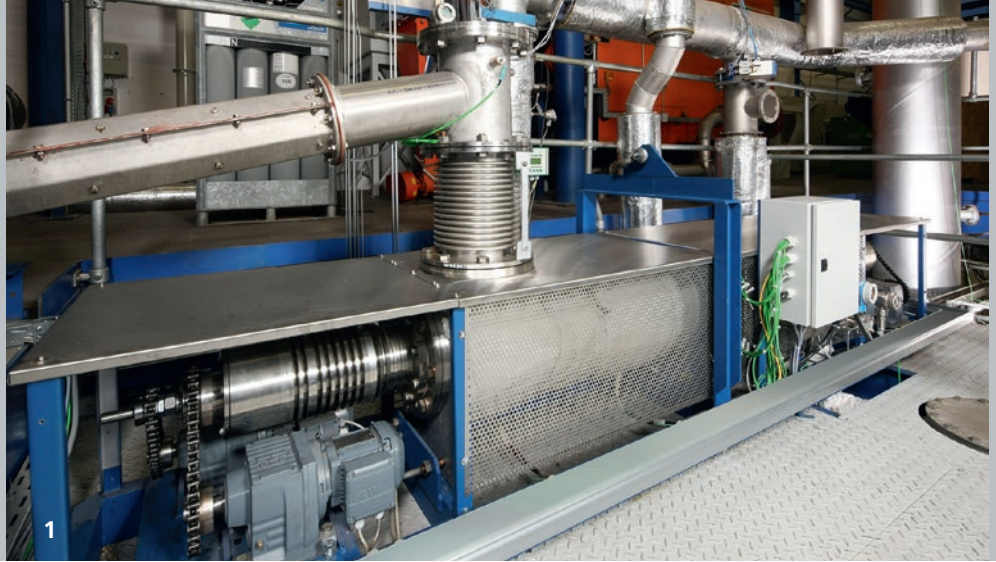
MARKETS AND INDUSTRIES

- Agriculture
- Energy supply (focus: bioenergy)
- Water supply
- Treatment/elimination of non-hazardous waste (focus: bioenergy)
- Agricultural engineering/agricultural machine construction

CONTACT

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THERMO CATALYTIC REFORMING TCR®

1 The developed TCR® plant is located at the Fraunhofer UMSICHT technical center in Sulzbach-Rosenberg.

2 Thermo Catalytic Reforming TCR® produces three high quality products: TCR® gas, TCR® oil and biochar.

The Institute Branch Sulzbach-Rosenberg has managed to create a unique process for using biogenic residues, called Thermo Catalytic Reforming TCR®. A new generation of plants was developed. Key advantages include the variability of the feedstock as well as flexible utilization of the generated products in the form of energy and materials.

PRODUCTS ALLOW FOR ATTRACTIVE RECYCLING OPTIONS

Goal: Accessing national and international markets

The TCR® technology will be introduced to the German and international markets progressively in the coming years as a means of utilizing primarily biogenic residues.

Result: Extremely high quality products

The TCR® process produces three products, which offer a previously unachievable level of quality and allow for attractive recycling options. The dust-free gas consists of hydrogen (up to 50 percent by volume), carbon monoxide, carbon dioxide, and methane as well as a small amount of higher hydrocarbons. In addition, the process produces very high quality oil with a high heating value and very low acid levels (comparable to vegetable oils) which is suitable for use as a sustainable fuel. The produced biochar exhibits a high carbon content and high potential as a fertilizer replacement.

Context, methods: Development of the TCR® technology to market maturity

The TCR® process uses excess electricity from renewable sources and feedstock consisting of organic residues to produce various types of high quality and storable energy carriers. The first plants have already been sold in collaboration with Susteen® Technologies GmbH (Fraunhofer Institute spin-off), and Robert Daschner, director of the energy technology department at the Institute Branch Sulzbach-Rosenberg, received the Fraunhofer award "Best Customer Acquisition" for the month of November 2015.

Customer benefits: High product quality without costly synthesis step

The products reach gasifier quality without a gasifier. The high oil quality makes it possible to use sustainable fuels made from biogenic residues directly – for the first time without a costly synthesis step.



2

HIGH OPERATING STABILITY

What distinguishes the process technology from other thermo-chemical processes?

The TCR® process exhibits a high level of operating stability by avoiding the formation of dust and tar. In addition, the feedstock can be processed at moisture levels of up to 30 percent without requiring additional pre-drying. At the same time, the process produces heat which can be used for pre-drying biomass with a moisture level of over 50 percent, and about 75 percent of the energy obtained from the calorific value of the feedstock is used in the products.

Thanks to the robust and containerized plant design, implementation of decentralized plants as small as 200 to 300 kW_{el} can be economically feasible. International projects in Canada, Chile, Great Britain, Italy and the Netherlands have already started up.



Ecology/product responsibility:

There is great demand around the world for sustainable and cost-effective technologies to provide a decentralised supply of energy based on biomass. This is why the TCR® process was developed and brought to market maturity. It allows for the sustainable use of gas and oil as energy sources directly at the site in high-efficiency combined heat and power plants. In addition, the produced biochar can also be used as a soil conditioner.

TEAM

The two departments Energy Systems Engineering and Biological Process Engineering are involved in the project, together with Professor Dr. Andreas Hornung.

Andreas Hornung, Project Manager

Professor Dr. Andreas Hornung, director of the Institute Branch Fraunhofer UMSICHT in Sulzbach-Rosenberg, has been researching intermediate pyrolysis for over twenty years. His research laid the foundation for the TCR® technology of today. He achieved the breakthrough together with his team in Sulzbach-Rosenberg at Fraunhofer UMSICHT.

Robert Daschner, Team Member

Dr. Robert Daschner is the head of the Energy Technology department and the contact on the topic of "thermo catalytic reforming" (TCR® process) for biogenic raw materials and residues.

Fabian Stenzel, Team Member

Fabian Stenzel is the head of the Biological Process Technology department and the contact on the topic of "using the TCR® char as activated carbon/soil conditioner".

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BUSINESS UNIT **ENERGY**



Photo: shutterstock

SERVICE PORTFOLIO

The new energy system is formed by the increased use of renewable and decentralized sources of energy in the energy supply networks as well as increased use of storage systems, smart technologies and services. We are researching efficient solutions for the energy supply of the future. We specialize in applied research, application-oriented technical development and pilot projects using innovative energy technologies. We support companies on technical and systems analysis matters in municipal, regional and industrial supply systems (e. g. combined energy generation, cross energy technologies, operation of energy storage systems). With a pragmatic view of what is technically, economically and organizationally feasible, we take an active role in shaping the necessary changes in the energy sector.

RESEARCH AND DEVELOPMENT SERVICES

Energy system analysis and design

- In municipal, regional and industrial structures: Energy concepts, optimization, implementation of energy storage system, implementation of cross energy technologies, modelling of energy load balancing technologies.
- Optimized sizing and mode of operation of energy generation and storage systems in future electricity markets.
- Municipal storage systems, energy-efficient municipal buildings, energy load balancing requirements, residual loads (analysis and optimization) in complex energy supply systems (e. g. hospitals)

Technical development

- Thermal, electrical and chemical energy storage technologies: large-scale redox flow batteries, compressed air energy storage systems, phase change materials and slurries
- Cross-energy technologies: Power-to-gas, power-to-chemicals, catalytic and bioelectric processes
- Customer-specific, innovative, large-scale, flexible, weldable bipolar plates
- Performance tests of battery systems up to 120 kW_e
- Pilot plant construction for bio energy plants, electricity generation from waste heat, ORC, small steam power plants, innovative chillers

Studies, consulting

- Strategy and scenario development, meta studies
- Conception, customer-specific calculation, economic feasibility studies, design, planning and integration of energy

systems and/or preparation and assessment of technical concepts

- Energy storage systems, use of storage systems, electricity from waste heat, power-to-X, decentralised bio energy (conversion) processes
- Improving the flexibility of CHP systems, heat demand forecasts
- Management of decentralised energy systems within the network

MARKETS AND SECTORS

- Energy services provider for electricity, gas, heating and cooling, compressed air
- Municipal or regional corporations
- Operators of decentralized energy systems, coupled energy production plants and energy storage systems
- Industrial customers with high energy demands/energy balancing demands
- Raw materials industry and processing industry (e. g. chemicals, steel, cement, paper, food)
- Developers, plant construction, project developers and suppliers of innovative energy technology
- Users of new analysis and planning tools

CONTACT

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STORAGE TECHNOLOGIES FOR THE MARKETS OF TOMORROW

- 1 Test laboratory for redox flow batteries at Fraunhofer UMSICHT.
- 2 Manufacturing process for bipolar plates out of graphite.

The result of a Fraunhofer strategy study in 2008: the market is lacking high-capacity batteries for storing electricity. Fraunhofer UMSICHT focused on developing an innovative redox flow battery and established a separate laboratory for this purpose. Today, the battery is available in a variety of capacity versions, a spin-off is producing and marketing a version for home use under license, and an innovative bipolar plate material is also suitable for other types of batteries.

AVOIDING CAPACITY BOTTLENECKS WITH REDOX FLOW BATTERIES

Goal: Develop variable, cost-effective storage technologies

The proportion of renewable energies in the energy mix demands new technologies. Electrical energy storage systems, with which capacity bottlenecks in the electricity grids can be avoided, are one answer to fluctuating sources of energy such as solar and wind. They should offer high capacity, be cost effective to produce and adaptable for flexible use in different applications.

Result: Redox flow batteries with scalable capacity and power ratings

To meet these requirements, redox flow batteries with a cell size of up to 0.5 square meters and a stack capacity of up to 25 kW_{el} were developed. Further scaling up of cells and stacks is in planning – stack capacities up to 100 kW_{el} and battery capacities up to several MW_{el}. At the same time, small-format redox flow batteries for decentralised storage were developed, with a capacity range of 1-2 kW_{el}/4-10 kWh_{el}. These are marketed by the spin-off Volterion GmbH. They are designed for use with residential photovoltaics systems (see pg. 47).

Context, methods: Innovative stack design with new, flexible bipolar plate

Researchers developed a completely new stack design for batteries. The key innovations of the technology are the innovative flexible bipolar plates, the fully welded stack design and the external electrolyte distribution. The redesign allowed for a significant increase in the capacity of the batteries. In addition, the stack manufacturing process can be made more economical and automated.

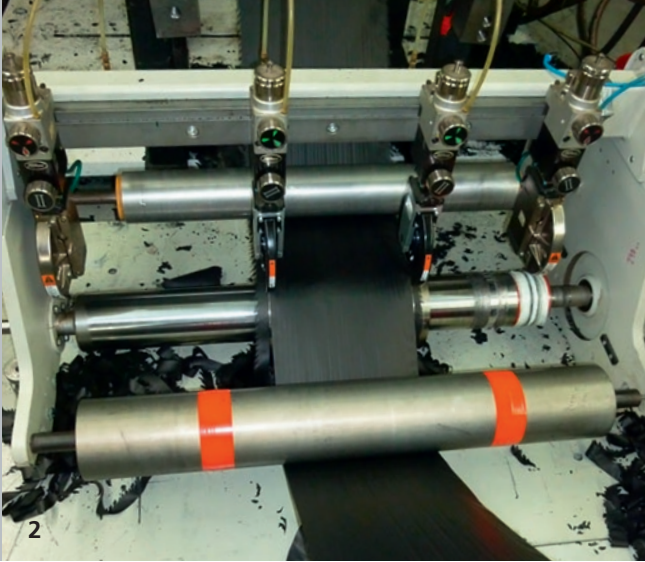
Customer benefits: Flexible and cost-effective storage systems

Redox flow batteries feature a very high efficiency and, due to the underlying storage technology, are highly scalable to the corresponding application with regard to capacity and power ratings. The materials and newly developed production technologies allow for cost-effective production.

MORE INFO

battery-lab.umsicht.fraunhofer.de





SUCCESS FACTORS AT A GLANCE

Exactly what advantages does the new bipolar plate material of the redox flow batteries have?

The redox flow batteries for storing electricity available on the market to date exhibit a limited maximum stack size, while lithium batteries are relatively expensive, have a short service life and require expensive cell and cell monitoring technology. One important component in the batteries are the bipolar plates, which are used to make the electrical connection between cells connected in series.

The material of the innovative bipolar plates developed by Fraunhofer UMSICHT has the following advantages: It is flexible, less breakable, weldable and more economical. The fact that it is weldable eliminates sealing surfaces and expensive stack materials. The stack can be more compact and leak proof, and most importantly can be manufactured at a significantly lower cost. The bipolar plate material meets extensive requirements: It is impermeable, electrically and thermally highly conductive, as well as flexible, mechanically stable, chemically resistant and can be ready-made from different materials and in different thicknesses.



Ecology/product responsibility:

Redox flow batteries primarily consist of plastic, graphite and electrolyte and can be handled by the normal waste disposal stream. The part of the battery containing metal can be separated from the primarily plastic power unit simply by pumping out the fluid. The electrolyte can be re-used in new plants since it doesn't age.

What capacity version of the redox flow battery is Fraunhofer UMSICHT currently testing?

The Volterion GmbH redox flow batteries are currently undergoing testing. They are primarily intended to be marketed for use in single and multi-family residential buildings with photovoltaics systems. They will allow one or more households to be supplied with electricity from the combined PV/battery system. Then the percentage of PV electricity which can be used on-site is no longer limited to approx. 30 percent, can be as high as 80 percent.

Fraunhofer UMSICHT is planning the construction of an external pilot plant with a capacity of approx. 300 kW_{el}/1200 kWh in the near future. Such a battery would be able to supply all of the electrical energy demand for a single-family house for 60 to 120 days, or alternatively buffer the solar energy from 150 to 300 houses with a roof-mounted PV system for use in the evening or at night. It is intended for use in municipal utilities or industrial plants.

FACTS

Redox flow batteries (RFBs) have a high level of efficiency and a significantly longer service life than conventional batteries. Due to the storage principle, the power and capacity can be scaled independently as necessary. They store electrical energy in electrolyte solutions, which flow from tanks through a stack in which electricity is generated by a chemical process.

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FUTURE OUTLOOK

FRAUNHOFER LIGHTHOUSE

PROJECT

ELECTRICITY AS A RESOURCE

ELECTRICITY
AS A RESOURCE



The Fraunhofer lighthouse project "Electricity as a Resource" unites ten Fraunhofer Institutes under the leadership of Fraunhofer UMSICHT. Their aim is to develop and optimize processes that enable the use of low CO₂ electricity to synthesize important base chemicals.

Plants show us how it's done: they can synthesize a wide range of chemical substances from the carbon dioxide (CO₂) in the atmosphere. This could also be achieved with electrochemical reactions. But nobody in industry has seriously pursued this idea to date, because the underlying chemical reactions require large amounts of energy. However, the energy transition and the weather-dependent decentralized generation of power mean that cost-effective and low carbon power will now be available in the medium term. This will allow for the production of chemical products which today are still made from crude oil.

FRAUNHOFER: FULL SERVICE PROVIDER OF ELECTROCHEMICAL SERVICES

The energy transition and the resulting renewable electricity provide the opportunity to establish electricity-based production systems. Ten Fraunhofer Institutes, coordinated by Fraunhofer UMSICHT, have partnered to develop the foundation for this and to develop electrochemistry as a technology platform and export product.

The goal is to develop new electrochemical processes as well as demonstrating the technical feasibility of these and integrating them in the German energy system. The institutes plan to establish permanent value-creation chains in the market, so that Fraunhofer will be known as a "full service provider of electrochemical research and development" in about ten years.

ETHENE AND ALCOHOLS AS BASE CHEMICALS

The focus in this case isn't on the production of methane as a fuel, known as "power-to-gas". While Fraunhofer Institutes are working in this direction as well, the lighthouse project is about synthesising chemicals with prices well above that of natural gas. This would also lead to faster relevance of the technology on the market. It should be possible to integrate the manufactured substances directly into the existing production structures of the chemical industry. Therefore the partner institutes plan to begin with the electrochemical manufacturing of ethene as well as various alcohols. Ethene is extremely important as a precursor material for polyethylene. Short-chain alcohols can be used to manufacture a large number of organic chemicals; higher alcohols are relatively high-priced raw materials which among other things are used to synthesise ester and acrylates.

TWO SYNTHESIS APPROACHES: CO₂ CONVERSION AND HYDROGEN PEROXIDE

CO₂ doesn't always have to be the precursor material: One study group is planning to apply the same principle for the decentralized manufacturing of hydrogen peroxide (H₂O₂) from oxygen and hydrogen. H₂O₂ is an environmentally friendly oxidant which is extensively used, for example to bleach pulp and paper.



IMPORTANCE AND OUTLOOK

Forecasts indicate that both the percentage of renewable energy in the German electrical grid as well as the amount of excess electricity will significantly increase in 15 years at the latest. It follows that generation of electricity will produce significantly less CO₂ and be more cost effective in the near term. This will allow future manufacturing to rely much more on "electricity as a resource" than it does today, in order to help achieve sustainability goals.

Professor Eckhard Weidner emphasizes the economic significance of this approach: "Expert analyses have shown that the energy transition also has to be harmonised with the requirements of energy-intensive industries, in order to allow for stable long-term growth. This means that it is also necessary to succeed in linking the energy system to chemical production systems. Electrochemical processes act as enabling technologies which form the underlying technology for this linking of systems."

The Fraunhofer alliance has already looked at the sustainable utilization of its results. The institutes plan to establish their own utilization platform for all innovation processes in the market, so that Fraunhofer will be known as a full service provider of electrochemical research and development in about ten years. They have already contacted companies in key sectors and are preparing for the public dialog. The light-house project »Electricity as a Resource« has a duration of three years.

PARTICIPATING FRAUNHOFER INSTITUTES

Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, Oberhausen (project coordination)
Fraunhofer Institute for Applied Polymer Research IAP, Potsdam/Golm
Fraunhofer Institute for Chemical Technology ICT, Pfinztal
Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB, Stuttgart
Fraunhofer Institute for Ceramic Technologies and Systems IKTS, Dresden
Fraunhofer Institute for Silicate Research ISC, Würzburg
Fraunhofer Institute for Surface Engineering and Thin Films IST, Braunschweig
Fraunhofer Institute for Industrial Mathematics ITWM, Kaiserslautern
Fraunhofer Institute for Process Engineering and Packaging IVV, Freising (consulting)
Fraunhofer Institute for Wood Research, Wilhelm Klauwitz Institute WKI, Braunschweig

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INTERNATIONAL

INTERNATIONAL PARTNERSHIPS

Fraunhofer has established strategic foreign partnerships in Europe and around the world, in order to promote the creation of scientific value and to achieve positive effects for Germany and the respective partner country. One goal of the internationalization strategy of Fraunhofer UMSICHT is the collaboration with high-tech universities in suitable countries. Synergies in technology development can be utilized in this manner, in order to advance the energy transition and the raw materials shift. The partnerships with Yachay Tech University in Ecuador, the University of Alberta in Canada and the University in Birmingham are three examples of the international activities.

The emerging nation of Ecuador is undergoing a sea change. Currently, still more of a raw material producer, it plans to become more of a raw material processor. Sustainable and nationwide social and economic development of the country should be possible over the long term. In order to improve its own international competitive position, it is investing in infrastructure but especially in research, teaching and education. The goal is to develop a structured research and economic landscape.

Examples include the introduction of a dual education system, closing of obsolete universities and construction of four new high-tech universities.

One of these is Yachay Tech, part of the 4500 hectare large research center Yachay – City of Knowledge. Yachay is around 4500 hectares in size and is located about 100 kilometres north-west of the capital city, Quito.

The Fraunhofer model of applied research is a perfect fit for the new policy in Ecuador, and the UMSICHT environment and energy subject areas and business units are among the top priorities for the university. Contact was initially established in 2010. The first class of students is now studying. Key areas of the cooperation include both research as well as education/teaching and joint industry projects.

Ecuador is highly agricultural, so that shared subject areas include water and water treatment technologies, material recycling and renewable energies .

NEW TECHNOLOGIES THROUGH COLLABORATIVE PARTNERSHIPS

Several MoUs (Memorandum of Understanding) which secure collaborations have already been signed. "We are currently in detailed talks about the specific implementation. The range of approaches is very large: Student or doctoral candidate exchanges, joint workgroups, teaching activities or further education opportunities through UMSICHT are possible", explains Anna Grevé, head of the Chemical Energy Storage department. The team with Axel Kraft, Business Developer Chemistry, and Gabriela Ortmann, external consultant, is also looking into potential funding possibilities for industrial projects. The goal of the activities in Ecuador is to adapt new technologies to the local conditions or further develop them through a collaborative partnership. Fraunhofer UMSICHT will also play a role in gaining access for German industry.

Goal: Fraunhofer-Alberta Innovation and Business Platform

The changing energy sources of the 21st century demand sustainable energy production and supply concepts. Identifying suitable partner countries is important in order to advance new technologies around the world. With Canada as a high-tech partner country, strengths can complement one another perfectly. A research partnership with the Canadian University of Alberta is in place. Around 400 research laboratories are



located on the campus. This makes it one of the country's leading research university with around 38 000 students. The goal of the collaboration is to bundle competencies in the shared subject areas of bio-industry (bio-refining and bio-batteries), electrochemical energy systems as well as food and products. Contact was initially established in 2012, with the two cooperation partners signing the first memorandum of action this past year. The Federal Ministry of Education and Research and the Canadian Embassy support the partnership.

The first joint project starts in June

The goal is to generate research findings through joint projects which hold significant potential for technology transfer to industry. The first joint research project "MiDeCO₂ – an innovative CO₂ decontamination technology to ensure food safety of low water activity food products" with both public and industry funding is expected to start in mid 2016. Another project "Biobattery – Decentralized production of fuel from biomass" is in the application stage. -more, the partners are active jointly in networks such as the Biorefining Conversions Network (BCN). Fraunhofer UMSICHT will contribute its expertise in the field of TCR® (thermo catalytic reforming) to this project. Fraunhofer UMSICHT is also working on a research project for a Canadian company on the subject of "Bio-Hipe-Composite-Development of a bio-based high performance composite for the use in automotive applications".

Another strategic goal is to intensify the partnership through a local Fraunhofer presence. The long-term goal is to develop the "Fraunhofer – Alberta Innovation and Business Platform". The higher-level goal of the platform is to strengthen the collaboration between Fraunhofer and the University of Alberta. This is based on four pillars: Research (basic research), students (student exchange), programs (approaching business), membership (gaining industry partners and conducting pre-competitive research).

BIRMINGHAM: FRAUNHOFER UMSICHT PROJECT CENTER IN PLANNING STAGE

The framework conditions for establishing a joint research platform between Fraunhofer UMSICHT and the University of Birmingham have been clarified as of early 2016. The long-term goal is to establish a Fraunhofer UMSICHT Project Center, the detailed implementation of which is currently in planning. The planned focus will be on the "biobattery" and the "TCR® technology". The collaboration is intended to expand upon the technology expertise in the field and to initiate joint international projects.

1 Campus of the Yachay Tech University, part of the 4500 hectare large research center Yachay – City of Knowledge.

2 Representatives of the University of Alberta and Fraunhofer UMSICHT signing the memorandum of action.

CONTACT

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Cooperation Canada/University of Alberta:

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PEOPLE

PRIZES AND AWARDS

RESEARCH INVOLVES LOTS OF PEOPLE.

Behind our work there are people; we would like to introduce some of them to you, since without them we would be nothing.



AWARDS

Whether for particularly innovative projects or the professional achievement of an individual person: Fraunhofer UMSICHT and its employees received a variety of honours and awards in 2015. The awards clearly show: It's worth advocating for the integration of sustainable methods and environmentally friendly technologies in society and for improving people's quality of life in this manner.

ACHEMA START-UP AWARD FOR COMPACT ELECTRIC ENERGY STORAGE SYSTEMS

Four years ago, the two UMSICHT researchers Thorsten Seipp and Sascha Berthold had the idea of a compact redox flow battery for residential use, which would allow for economical and reliable buffering of photovoltaic power produced on site. The spin-off Volterion GmbH which resulted and is now producing and selling small-format redox flow batteries for decentralized storage, has won the ACHEMA Start-up Award in the energy category for its technological and economic potential.

More info: www.volterion.com

TWO AWARDS FOR THESIS ON THE USE OF BIOGENIC RESIDUES

Pravakar Mohanty even won two awards for his thesis, which was supervised by Andreas Hornung at the Institute Branch Sulzbach-Rosenberg: he received the "Hari Om Ashram Preit Research Award on Renewable Energy" and the "Dr A V Rama Rao Foundation's Award". For his thesis, Pravakar Mohanty

performed research on the use of biogenic residues to manufacture fuels for use in the mobility sector and for the generation of power. Mohanty works in the Department of Science and Technology of the Indian government in New Delhi.

GERMAN RENEWABLES AWARD FOR "SMARTREGION PELLWORM"

A consortium of science and industry has developed an intelligent power grid on the North Sea island of Pellworm, allowing for the redistribution and storage of excess energy. The "SmartRegion Pellworm" project is not only considered a showcase project of a successful energy transition, it was also distinguished by the "Cluster Renewable Energy Hamburg (EEHH) with the "German Renewables Award" in the "Project of the Year" category. Fraunhofer UMSICHT was involved in the scientific aspects of the project.

More info: www.smartregion-pellworm.de/home.html

JULIAN MESSER DISTINGUISHED FOR OUTSTANDING MASTER'S THESIS

The Friends and Patrons Group of the Fraunhofer Institute in Sulzbach-Rosenberg has distinguished Julian Messer for his master's thesis on the subject of thermal energy storage. In the course of his work, he studied methods of transferring the thermal energy of hot gases to solid materials.

- 1 ACHEMA award presentation.
- 2 Distinguished with two awards: Pravakar Mohanty.
- 3 Hybrid plant on Pellworm.
- 4 Julian Messer with his thesis.



1

Photo: Fraunhofer UMSICHT/Daniel Sadrowski

ENERGY TRANSITION – AND NOW?

Prof. Dr.-Ing. Christian Doetsch is director of the Energy Department at Fraunhofer UMSICHT and has been working at the institute for 20 years. His goal is to find sustainable solutions which allow for the efficient conversion of the energy industry to renewable sources of energy. The core competencies of the team: developing innovative technologies for energy supply systems or storing of electricity and heat, implementing these in pilot and demonstration plants and completing system analysis studies.

What tangible benefits and what challenges does the energy transition bring with it?

The energy transition has created new opportunities. Without it, the power plant market would have continued to operate as before. I see one important challenge in the fact that we currently solely have an electricity transition in Germany. However, a large percentage of the energy market consists of the heat and transport sectors.

How can an energy transition which goes beyond the electricity transition succeed?

We have to avoid isolating the electrical system. We have to try to transfer electrical energy, for example to the heat sector. That would have two advantages: A much larger market for renewable energy would open up. Then green electricity could replace crude oil or natural gas. The problem of balancing energy supply and demand over time – caused by the fluctuations of renewable energy such as wind and sun – would be reduced somewhat. The electricity grid has to be balanced within the millisecond range, or it collapses. Heat however is slow, welcome buffering effects arise in the heat sector. The increased use of heat pumps would be one possibility.

How important are energy storage systems?

They are important for the energy transition, but not the only requirement. With a penetration level of 40 to 60 percent green electricity, we will require additional regional energy storage systems. We will need electricity and thermal energy

storage, primarily in the mid-power range for specific nodes, in order to reduce the load on the electrical grid locally or regionally. Fraunhofer UMSICHT is working on such technologies, e. g. on redox flow batteries or different types of thermal energy storage systems.

In your opinion, what will the energy system of the future look like?

In the end, we will be using over 80 percent renewable energy in the mobility, heat and electricity sectors. Renewable energies are used in all three sectors. We can access the heat sector with electricity, the two areas are very linked. Then the biggest challenge is in the mobility sector. This is because electromobility, so for example purely battery-powered cars, are only suitable for low-power applications. They cannot be used in the aviation, trucking or shipping sectors. Chemical storage systems such as synthetic fuels are one possibility in these areas. We are also performing research in this area.

1 Prof. Dr.-Ing. Christian

Doetsch believes that the biggest challenge of the energy transition is in the mobility sector.

MORE INFO

battery-lab.umsicht.fraunhofer.de



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THE KEY TO A SUSTAINABLE RAW MATERIALS MANAGEMENT

Dr.-Ing. Markus Hiebel has worked at Fraunhofer UMSICHT since 2001 and is head of the Sustainability and Resources Management Department. The department includes the Sustainability Assessment Group and the Spatial Analysis and Raw Material Systems Group. Its objective is to channel resources so that they contribute to sustainable development. Together with his team, he conducts sustainability assessments, performs strategic studies on raw materials and products and derives corresponding action strategies.

How will the flows of raw materials change in the future?

In its new Circular Economy Package at the end of 2015, the EU puts greater emphasis on life-cycle thinking and into product design and information about the materials contained in products. This is intended to lead to greater recycling efforts. At the same time, the concept of sustainable development defines requirements: Product manufacturers, for example, have to create transparency in the supply chains (social standards, environmental standards).

What is currently the biggest challenge for the raw materials management?

Falling raw materials prices (e. g. for metals and crude oil) are putting a lot of pressure on recycling companies. This situation will change again in the next few years. However, companies have to make it through the lean times, which they will hopefully do, because recycling almost always makes sense from an ecological perspective.

How is Fraunhofer UMSICHT contributing to this?

Our department is already helping companies - through communication with stakeholders - to identify and make allowances for potential hot-spots (critical areas such as emissions, occupational health and safety and recycling) during product development. We prepare ecological impact and life cycle assessments in order to perform product optimizations with our customers and to develop strategies. To do so, we use modern life cycle assessment software, geoinformation systems and

an extensive network of industry and scientific community contacts. Our neutral and interdisciplinary perspective is often helpful for customers in this area and supports exciting technical development projects such as recycling of construction and demolition waste or bioplastics.

What changes can we make in our everyday lives to support a sustainable resource economy?

On a social level, trends such as repair cafés, free access to blueprints or 3D printing for the production of spare parts indicate that there is a growing number of groups which has a critical view of our throwaway society and works against it. Everyone can also ensure that they give preference to more environmentally friendly and ethical products when they shop. Other areas of life involve the energy supply (e.g. electricity from renewable energy), the selected means of transportation or social involvement in corresponding groups and initiatives.

1 *Strategies for the raw materials management:*
Dr.-Ing. Markus Hiebel.

CONTACT

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Phone +49 208 8598-1181 | markus.hiebel@umsicht.fraunhofer.de



FOCUS ON CITIES: FROM RESOURCES MANAGEMENT TO CITIZEN PARTICIPATION

Simone Krause holds a geography degree and has headed the Spatial Analysis and Raw Materials Systems group at Fraunhofer UMSICHT since January 2016. While directing the analyses of space and material flow processes in municipalities and industry, she directly worked with the urban community to develop a concept for the city of the future Oberhausen in the project "Vision 2030+ Present – Vision – Future".

What is the project "Vision 2030+ Present – Vision – Future" about?

The project asks the question of what the city of Oberhausen should ideally look like in the year 2030+. Fraunhofer UMSICHT is involved as the scientific partner in the project funded by the Federal Ministry of Education and Research and is responsible for implementing and supporting the process.

Within this framework, we collect ideas and visions which the Oberhausen citizens and the entire urban community have for their place of residence.

What added value does citizen participation provide?

The residents of a city should be perceived as responsible citizens and should also take on this responsibility. But this only works when all development steps are transparent. Therefore, we inform the citizens, perform impromptu surveys on the street and offer workshops and regulars' tables. This approach has already produced many ideas and suggestions – such as the desire for multi-cultural and intergenerational venues – which can be used to forge an integrated vision for the city of Oberhausen.

The "Altmarktgarten" project will change Oberhausen as well. What is it about?

Construction of an integrated rooftop greenhouse on the new Jobcenter in Oberhausen is expected to start in 2017. It will follow the Fraunhofer inFARMING® concept, which uses resources such as waste water and waste heat from the building below and strengthens the regional value creation

chain by marketing the products locally. For this urban farm, it is also important to make all information public so that the Oberhausen citizens can get a complete picture and anticipate the project.

A look ahead to 2030: What do you envision?

I think it would be great if Oberhausen was a colourful city laboratory: A city where citizens, both creatives and scientists, find a place where they can play a role and can work together. A place where old crafts are valued just as much as new things and where local and regional value creation chains develop.

1 *Dipl.-Geogr. Simone Krause: "Dipl.-Ing. Jürgen Bertling, Head of Department Systemic Product Design at Fraunhofer UMSICHT, is also engaged in public communication. For example, he coordinates the Innovative Citizen, a festival for new urban skills, as well as DEZENTRALE Dortmund, a community think tank for challenges of the future."*

MORE INFO

www.vision-2030-oberhausen.de



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1

RESEARCH DOMAIN: REGAINING OF PHOSPHOROUS

Sonja Wiesgickl studied environmental engineering (specialty: process technology) at the "Ostbayerischen Technischen Hochschule OTH Amberg-Weiden". She came to Fraunhofer UMSICHT, Institute Branch Sulzbach-Rosenberg, in 2012. She is performing research on phosphorus reclamation in the Biological Process Technology Department.

What projects are you currently researching?

My work focuses on the regaining of phosphor from sewage sludge and biogenic residues. I am currently performing research work for the national projects Klärschlammverwertung (sewage sludge reclamation) for the Nuremberg region (KRN-Mephrec, funded by the BMBF) and pharmaceutical residues in P-recyclates (commissioned by the German Environment Agency).

I am also coordinating the Project Ashes international research project. Together with our Brazilian project partners, we are studying the sustainable use of waste from the production of sugar and ethanol.

What do you enjoy the most about your work?

I really like the fact that I am performing research on innovative solutions and processes in the field of regaining of phosphor! I get a lot of enjoyment from developing ideas independently and implementing them in the form of technical concepts. I also value the pleasant atmosphere in the team, and the fact that I have the opportunity to collaborate internationally.

What current challenges do you see in the field of regaining of phosphor?

Phosphor reclamation from sewage sludge must be economically feasible. The prices for secondary phosphate are currently well above the market price for primary phosphate. In addition to the often higher cost of the recycled products, a lack of

markets is also preventing the spread and implementation of phosphor regaining plants. The phosphor regaining technologies as a whole have to be assessed in order to optimize the processes and to improve integration of the processes in the operating procedures of wastewater treatment plants. This means that there is a need for complete concepts for the implementation of suitable phosphor reclamation technologies.

We also work with the industry to develop recommendations for increasing the acceptance of secondary phosphate in agriculture.

What do you do to relax?

I relax on wellness holidays, but also by going swimming and jogging. I also want to take part in the New York Marathon and am currently training for that.

1 Sonja Wiesgickl is performing research on the regaining of phosphor in the Biological Process Technology Department.

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NETWORK

LUCKILY, WE ARE NOT ALONE ON THIS EARTH.

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



Photo: Fraunhofer

THE FRAUNHOFER-GESELLSCHAFT

With its focus on applied research and key technologies of the future, the Fraunhofer-Gesellschaft plays a prominent role in the European innovation process. Customers are not the only ones to profit from the effect of applied research: with research and development work, the Fraunhofer Institutes contribute to the competitiveness of the region, of Germany, and of Europe. They promote innovations, strengthen the technological performance capability, and ensure the training and continued education of the urgently needed future generation of scientists and engineers.

FACTS AND FIGURES AT A GLANCE*

Research of practical utility is the central task of the Fraunhofer-Gesellschaft which was founded in 1949. Fraunhofer ...

- conducts application-oriented research for the benefit of the economy and to the advantage of society,
- currently maintains 67 institutes and research institutions in Germany,
- has approx. 24 000 employees, primarily with degrees in natural sciences or engineering,
- has an annual research budget of 2.1 billion euros, of which 1.8 billion euros are generated in contract research. More than 70 percent of these are derived from contracts with industry and from publicly financed research projects. Almost 30 percent are contributed by the German Federal and Länder Governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society for another five or ten years.
- Our contractual partners and clients are: industry companies, service providers as well as the public sector.

*As of February 2, 2016

FRAUNHOFER INTERNATIONAL

International cooperations with excellent research partners and innovative companies worldwide ensure direct access to the most important current and future areas of science and economy.

FRAUNHOFER AS EMPLOYER

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society.

Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career at companies due to the practical training and experience they have acquired.

1 The building of the Fraunhofer-Gesellschaft (FhG) in Munich.

MORE INFO

www.fraunhofer.de/en/about-fraunhofer.html





SPIN-OFFS AT A GLANCE

The goal of the Fraunhofer Gesellschaft is to develop innovative technologies which lead to market-ready products. One way to put a development into application and to market the technologies developed at the institute is to establish a spin-off. In addition to a good business concept, areas including financing, investment and business management have to be implemented successfully as well.

A-TEC Anlagentechnik GmbH

Worldwide expert in the utilization of mine gas and gas extraction.

Foundation: 1998 | ba@atec.de | www.atec.de

Catfish Solutions UG (limited liability)

Multivendor and sector-independent IT consulting company.

Foundation: 2011 | info@catfishsolutions.com | www.catfishsolutions.com

Datapool Engineering GmbH

Partner for process and safety technology software solutions.

Foundation: 2001 | webmaster@datapool-engineering.com | www.dp-e.de

FKuR Kunststoff GmbH

Development and distribution of a wide range of bioplastics.

Foundation: 2003 | info@fkur.com | www.fkur.com

Greasoline GmbH

Transformation of waste grease into mixtures of hydrocarbons which can be used as fuels, fuel components and as chemical raw materials.

Foundation: 2011 | contact@greasoline.com | www.greasoline.com

Ruhr Compounds GmbH

Processing of rubber waste materials to produce high quality plastics.

Foundation: 2011 | info@ruhr-compounds.de | www.ruhr-compounds.de

Susteen Technologies GmbH

Transformation of waste biomass through thermo catalytic reforming to produce high quality fuels such as biooil, biochar and syngas.

Foundation: 2014 | info@susteen.de | www.susteen.de

viteso UG (limited liability)

IT service provider with a focus on developing high quality apps for mobile end user devices.

Foundation: 2012 | info@viteso.de | www.viteso.de

VSM Solar Private Limited

Design, production and installation of solar-powered air conditioning systems, fridges and cold rooms in India, Sri Lanka and Bangladesh.

Foundation: 2011 | info@vsm solar.com | www.vsm solar.com

Wagro Systemdichtungen GmbH

Development and production of innovative sealing systems on the basis of swellable materials for structural engineering and pipeline construction.

Foundation: 1999 | info@wagro-systemdichtungen.de |

www.wagro-systemdichtungen.de



REDOX FLOW BATTERY FOR RESIDENTIAL USE STORES SOLAR ENERGY

The use of renewable energy such as solar power is essential in order to achieve national and international climate goals. Energy storage systems are required in order to use energy from photovoltaic systems at night and in low-light conditions. Volterion GmbH will produce and market the "Redox Home Battery", based on cells and an innovative stack design developed at Fraunhofer UMSICHT. The on-site consumption of power for a single-family house can be increased from around 30 percent to up to 80 percent by using the battery.

CONTINUOUS SUPPLY OF SOLAR ENERGY

The demand for photovoltaic systems to cover the on-site energy demands is growing continuously. Energy storage systems are essential in order to supply the solar power on a continuous basis. This market is currently dominated by lead or lithium based batteries. However, these are either very expensive, have a low cycle stability or tend to pose an elevated risk of fire. This is why Thorsten Seipp and Sascha Berthold from the Chemical Energy Storage Department developed a redox flow battery for residential use, which stores the electricity produced on site economically, safely and reliably.

The battery consists of a power unit in a stack configuration and two tanks filled with electrolyte, the storage component. During charging, the electrical energy is converted to chemical energy and stored in the electrolyte. The opposite reaction takes place during the discharging process to delivery electrical energy.

PROCESS AND ELECTRO TECHNICALLY COMPLETE UNIT

With the goal of producing and marketing the Redox Home Battery under license, the three directors Seipp, Berthold and Gebauer together with Prof. Dr.-Ing. Doetsch and Dr. Burfeind founded Volterion GmbH with head offices at the Zentrum für

Produktionstechnik (center for production technology) (ZfP) in Dortmund. Complete redox modules with a continuous power rating of to 2 to – in the near future – 10 kW are being produced here and at Fraunhofer UMSICHT. New production techniques allow for automated, cost-effective production and have made the redox flow battery ready for the mass market. The stacks are welded and not pressed together as they are in previously available solutions. This technology eliminates complex seals.

Potential customers include utility companies, heating system manufacturers or solar installers. The tanks, electrolyte and installation can be configured on a per-unit basis for the respective requirements during process and electro technical production. The first modules are already being used successfully.

1 *The three Volterion directors Thorsten Seipp, Sascha Berthold and Thomas Gebauer (from left to right).*

2 *The redox module allows for a significant increase in the percentage of power used on-site for a single-family house.*

MORE INFO

www.volterion.com



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Photo: simonh/photocase.com

RESEARCH AND TEACHING/ INSTITUTIONS OF HIGHER LEARNING

1 Applied research requires close ties with science. During the 2014/15 winter semester, Fraunhofer UMSICHT sent 24 lecturers to 6 universities and 3 colleges, and during the 2015 summer semester it sent 17 lecturers to 3 universities and 2 colleges.

The research and development market is fast-paced. As an institute that, with its application and market-oriented services and products, is acting at the intersection of research at the university and industrial practices and products, we particularly rely on strategic partnerships with institutions of higher learning in Germany and Europe. There is an active exchange between institutions of higher learning, students, and Fraunhofer UMSICHT. In addition to joint projects, many employees teach at colleges or universities in the region.

RESEARCH AND TEACHING

Prof. Dr.-Ing. Eckhard Weidner

Manages both Fraunhofer UMSICHT and the Chair of Process Engineering Transport Processes at the Ruhr University Bochum, where he also teaches. This provides the institute with a direct connection to the university and strengthens the scientific network of both research facilities.

Prof. Dr.-Ing. Görgo Deering

Deputy Director of the institute of Fraunhofer UMSICHT, has been holding the adjunct professorship "Environmental and Process Technology" at the Faculty of Mechanical Engineering of the Ruhr University of Bochum since January 2011. He is also the scientific director for the infernum distance learning course, jointly offered by the the FernUniversität in Hagen (distance learning University of Hagen) and Fraunhofer UMSICHT under the umbrella of the Fraunhofer Academy.

Prof. Dr. rer. nat. Andreas Hornung

Director of the Institute Branch in Sulzbach-Rosenberg, founded the European Bioenergy Research Institute EBRI at Aston University in Birmingham. He holds a position as Professor of High Temperature Process Technology at the Friedrich Alexander University Erlangen-Nuremberg, holds an adjunct professorship at the University of Bologna and a chair in bioenergy at the University of Birmingham.

Prof. Dr.-Ing. Christian Doetsch

Director of the Energy Division and honorary professor at the Faculty of Mechanical Engineering at the Ruhr University of Bochum for the topics of energy storage and refrigeration engineering.



INTERDISCIPLINARY DISTANCE LEARNING ENVIRONMENTAL SCIENCES INFERNUM

The successful and scientifically-substantiated solution of complex challenges in the fields of environment and sustainability presupposes interdisciplinary thinking and approaches. The interdisciplinary distance learning program in environmental sciences "infernium" transmits the knowledge necessary for this purpose and builds fluency in the "languages" of various disciplines. infernium is distinguished by its interdisciplinary curriculum, professional breadth, and organizational flexibility; it is unique in the landscape of German university further education programs.

infernium combines the aspects of economic performance, social responsibility and ecological compatibility and this way provides the students – even those without a prior degree from an institution of higher learning – with a qualified further education in the spirit of an education about sustainable development.

Since 2000, infernium – as a distance learning program – allows students to work independently and in a structured way, to obtain scientific further education in parallel to job and family, and to improve their chances in the job market. Individual teaching programs can be compiled from (inter)disciplinary modules and the course of studies can be started at any time.

THE FOLLOWING DEGREES CAN BE OBTAINED:

- Master of Science (M.Sc.)
- University Certificate of Environmental Sciences
- Certificates for individual modules
- University Certificate Environment Manager

infernium is a joint offer of the FernUniversität in Hagen (distance learning university) and Fraunhofer UMSICHT under the auspices of the Fraunhofer Academy.

Extensive further development of the blended learning concept and the course curriculum will take place within the framework of the joint project "mint.online", which is funded by the BMBF from 2011 to 2017. The goal shared by Fraunhofer UMSICHT and the the FernUniversität in Hagen (distance learning University of Hagen) is to further align infernium with the specific needs of the students from the working world.

KONTAKT

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1 *The distance learning program pursues the right path with its novel orientation and this is not the least of the reasons why it is allowed to call itself "Place of Progress 2014". The title is an award by the Ministry for Innovation, Science, Research and Technology of the German State of North Rhine-Westphalia (NRW) for guiding intellectual forces from NRW that combine economy, ecology and social issues. In addition, infernium received rewards from the German UNESCO commission as "Official Project" of the "UN Decade of Education for Sustainable Development" three times.*

MORE INFO

www.umweltwissenschaften.de





Photo: Fraunhofer UMSICHT/Ilika Drnovsek

FRAUNHOFER TALENT SCHOOL

- 1 Pupils of the Fraunhofer Talent School 2015.
- 2 In addition to fascinating workshops, students are offered an increasingly varied framework program. A special highlight of 2015 at the Fraunhofer UMSICHT Talent School was the visit to the Duisburg-Nord landscape garden with a guided night-time headlamp tour.

Within the framework of the Fraunhofer Talent School, 18 students interested in the natural sciences and technology visited Fraunhofer UMSICHT on October 14 to 16, 2015. They were able to gain an in-depth look at the theory and practice of two current research topics in two workshops on the topics of computer science and microplastics. The Fraunhofer Talent School is an annual workshop program for youths in grades 9 to 13.

DERIVING TECHNICALLY INTERESTING PROPERTIES FROM NATURE

The goal of the "Computer science – bionically inspired solutions in robotics" workshop was to acquire basic bionics knowledge and general skills of scientific work. To this end, models from nature such as kangaroos or elephant trunks were analysed and technically interesting properties were derived. Suitable transfer and implementation approaches were highlighted as well. The theoretical knowledge was subsequently put into practice with Lego® Mindstorms® robots.

EFFECTS OF MICROPLASTIC ON THE ENVIRONMENT

The pollution of waters and the environment with microplastic is increasingly gaining public attention. After acquiring basic knowledge on this highly relevant subject, participants of the "Microplastics – small particles with big consequences?" workshop discussed potential solution approaches. The students discussed the effects of microplastic on the environment and performed experiments.

The workshop took place for the first time in 2015 with convincing results: "Due to the good feedback, we hope to offer the workshop again next year", says Jana Rolshoven from the UMSICHT Academy. This year the participants particularly enjoyed the excursion to the Emscher-Genossenschaft / Lippeverband sewage treatment plant in Dülmen. Here it was possible to establish a direct link between theory and practice.



2

CONTACT

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BOARD OF TRUSTEES

Since December 2002, a Board of Trustees with members from science, industry, politics and administration has been providing advice to the institute.

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Dr.-Ing. Andreas Schütte

FNR Fachagentur Nachwachsende Rohstoffe e. V., Managing Director



Join now!

UMSICHT Friends and Patrons Group
"UMSICHT-Förderverein"

Photo: shutterstock

25 YEARS OF UMSICHT FRIENDS AND PATRONS



The goal of the "Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik e.V. (UMSICHT Friends and Patrons)" is to provide ideas and material support to innovative research and development projects already in the very early phases. The 25 year anniversary was celebrated together with the institute in 2015.

The current 47 members (as of November 2015) of the UMSICHT Friends and Patrons helps North-Rhine Westphalia – especially the Ruhr region – to gain access to future-capable and sustainable technological developments.

The funding focuses on project ideas in the subject areas of sustainable energy, processes and products. Among other things, assistance is provided for technical groundwork (e.g. proof of principle) and forecast studies on current topics. The Friends and Patrons help to inform public opinion by sponsoring events.

SUPPORTING YOUNG TALENT

Great value is placed on supporting young talent in the field of science. Outstanding theses were once again presented at the last members meeting which took place on 3 September 2015, almost exactly 25 years after the founding meeting on September 4, 1990.

In addition to a certificate, the distinguished students receive Euro 500 for a bachelor thesis and Euro 1000 for a master's thesis, donated by the UMSICHT Friends and Patrons.

FOUNDATION FOR SUCCESSFUL PROJECTS

In addition, two projects by young scientists are provided with Euro 10 000 each in start-up funding. The funding provides support particularly in the initial phase.

Building on this foundation, over the past few years several funded projects were already initiated, patents registered and products developed to market maturity.

The UMSICHT Friends and Patrons has supported various fields at Fraunhofer UMSICHT with over Euro 1 million in funding since it was formed 25 years ago. The money comes from membership fees and donations and was among other things used for the following purposes:

- Funding for laboratory and shop equipment
- Start-up funding of projects
- Support for holding workshops, conferences and events such as BIO-raffiniert and UMSICHT: Zur Sache!
- Supporting young talent: Prizes for the best bachelor and master thesis of the year, Girls' Day
- UMSICHT Science Award

Over half of the total funding was used for start-up financing of projects.



1

Photo: Fraunhofer UMSICHT/Ilka Drnovsek

UMSICHT SCIENCE AWARD

In June 2015, the Fraunhofer UMSICHT Friends and Patrons awarded the UMSICHT Science Award endowed with a total of Euro 15 000 for the seventh time. Dr. Lars Heepe received the award in the science category. Cornelia Borrmann and Anja Krieger are the award winners in the journalism category. They were distinguished for their easy to understand communication of socially relevant topics in the environment, safety in process technology and energy fields.

AWARD WINNER

Dr. rer. nat. Lars Heepe *Science category*
was distinguished for his dissertation "Kontaktmechanik biologisch inspirierter Haftsysteme" (contact mechanics of biologically inspired adhesion systems). In this work, he examines the mechanisms which allow insects, spiders and geckos to stick to vertical and smooth surfaces. He transferred the principle to an adhesive film and to a bionic gripper, which has potential energy savings of approx. 95 percent in comparison to conventional vacuum grippers, and discovered potential anti-fouling applications. *(Pictured in the center)*

Cornelia Borrmann *Journalism category*
was distinguished for the cross-media online article "Body language of trees". The article presented the Claus Matthecks analysis method for trees. It helps to detect tree damage on the basis of a tree's warning signals and to determine the potential for damage. This can save the trees from being felled. The method is easy and universally applicable. *(Pictured on the left)*

Anja Krieger *Journalism category*
questioned how microplastic can be removed from the ocean ecosystem in the half-hour radio feature "Die Entmüllung der Meere. Strategien gegen Plastik im Ozean" (Cleaning up the oceans. Strategies against plastic in the sea.) for the Deutschlandfunk (German World Service radio) program Science in Focus. *(Pictured on the right)*

UMSICHT FRIENDS AND PATRONS MEMBERSHIP

The "Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik e. V. (UMSICHT Friends and Patrons)" is a major element of the vibrant and productive surroundings of Fraunhofer UMSICHT.

The members of this group support the institute in realizing ideas for research and development.

They work to smooth the way for the development of sustainable technologies and are involved in shaping public opinion in the fields of environmental, safety and energy technology. In addition, the UMSICHT Friends and Patrons also award the annual UMSICHT Science Award endowed with Euro 15 000 in prize money. Become a member now!

1 *Speakers, award winners, jury and supporters of the 2015 UMSICHT Science Award.*

MORE INFO

www.umsicht-foerderverein.de



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BIBLIOGRAPHY / SERVICE

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We look forward to hearing from you!
If you have any questions, suggestions or project ideas,
please contact us. You can reach us in several different
ways.

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

How to reach us (PDF)

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FRAUNHOFER SPECIALIZED PUBLICATIONS AND PATENTS

The publications and patents that result from the research activity of the Fraunhofer Institutes are documented in the "Fraunhofer-Publica" database.

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