



ANNUAL REPORT
2017 | 18

A report for you about us,
our products, our services and our res-
ponsibility for the future.



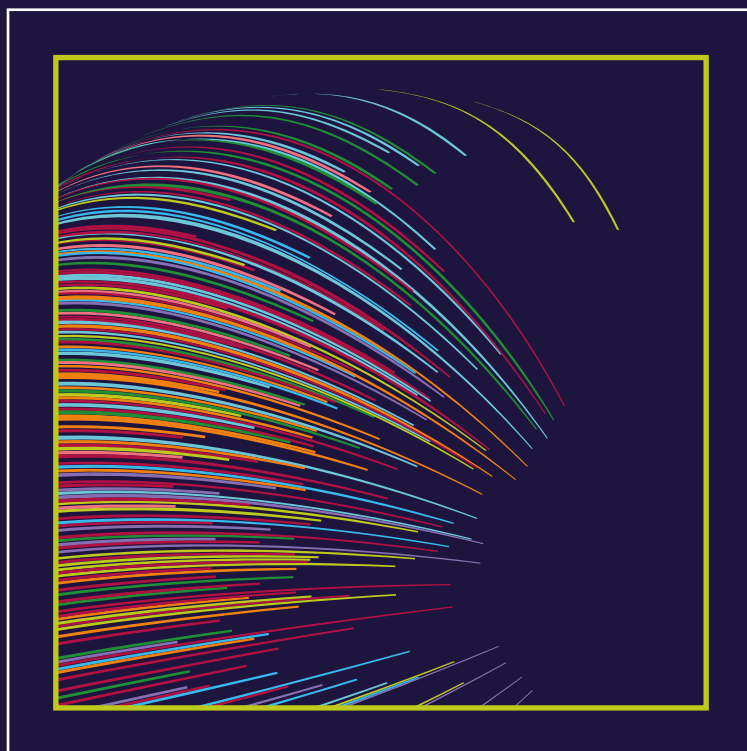
SUSTAINABILITY AS A RECURRING THEME

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!

TABLE OF CONTENTS



EVERYTHING AT A GLANCE.

On 60 pages, we report on our 2017 projects, the people behind the projects and the prospects.

4 PREFACE

6 INSTITUTE

- 7 Pioneers of a Sustainable Energy and Raw Materials Management
- 8 Facts and Figures
- 10 Organizational Structure

12 STRATEGIC PROJECTS

- 12 Fraunhofer Lighthouse Project: "Electricity as a Resource"
- 14 Carbon2Chem® – Carbon Dioxide: From Steel to Chemistry
- 16 Fraunhofer High Performance Center DYNAFLEX®
- 17 Roadmap for a Circular Economy

18 BUSINESS UNITS

- 19 Our Business Units | Overview
- 20 **Business Unit Polymer Materials**
 - 21 Service Portfolio
 - 22 Success Story
 - Bioplastic – Multi-wall Sheets
- 24 **Business Unit Chemistry**
 - 25 Service Portfolio
 - 26 Success Story
 - Catalytic Competence at the Institute
- 28 **Business Unit Environment**
 - 29 Service Portfolio
 - 30 Success Story
 - Recovery of High-tech Metals
- 32 **Business Unit Biomass**
 - 33 Service Portfolio
 - 34 Success Story
 - A Rooftop Greenhouse for Urban Food Production
- 36 **Business Unit Energy**
 - 37 Service Portfolio
 - 38 Success Story
 - Hybrid Compensation System to Provide System Services

40 INTERNATIONAL

- 40 International Collaboration with Kuwait, Canada, and Great Britain

42 PEOPLE/PRIZES AND AWARDS

- 43 Prizes and awards Awards in 2017
- 44 Starting up with Micro Steam Turbines
- 45 Goal: Optimizing the Energy Supply
- 46 Marketable Storage Technologies
- 47 Utilizing the Potential of Public Participation

48 NETWORK

- 49 The Fraunhofer-Gesellschaft
- 50 Board of Trustees
- 51 Spin-offs at a Glance
- 52 Research and Teaching/Institutions of Higher Learning
- 53 UMSICHT Research School
- 54 Interdisciplinary Distance Learning Environmental Sciences infernum
- 55 UMSICHT Science Award

56 BIBLIOGRAPHY

- 56 Fraunhofer Publications and Patents
- 56 Schedule 2017 and Services
- 57 Funding Information

58 CONTACT

- 58 How to Reach us
- 59 Fraunhofer UMSICHT in the Social Web

60 EDITORIAL NOTES

PREFACE



Prof. Dr.-Ing. Eckhard Weidner, Director



Prof. Dr.-Ing. Gorge Deerberg, Deputy Director

Dear readers,

What do Oberhausen (Germany), Kuwait, Birmingham (UK), Alberta (Canada), and Munich have in common? At first glance, very little. But a second glance is revealing: all of those places saw the launch of exciting new projects by Fraunhofer UMSICHT in 2017. And the issues that the projects address are just as diverse as their geographic locations: a rooftop garden as a place for urban food production, research, and encounters at the future job center in downtown Oberhausen; stocktaking and creation of a comprehensive waste management plan for the Emirate of Kuwait; research platforms for energy technologies in Birmingham and Alberta; and a study of the non-visual impact of a newly developed LED lighting system at an automotive plant in Munich. All this is just a small sampling of the many projects we worked on in 2017. There are also our long-term strategic projects, like "Strom als Rohstoff" (Electricity as a Resource), Carbon2Chem® and DYNAFLEX®, which focus on energy and material circulation. The projects do all have one thing in common: they support our goal of facilitating sustainable economic activity.

Another major topic for us in 2017 was the circular economy. In last year's preface, we wrote:

"We are also convinced that the circular economy, which will be an increasing focus for us, will become more and more important in the future, for instance in the area of plastics." Last year's wealth of initiatives, publications, and media articles on this topic shows that we were absolutely right – not least because of the EU strategy on plastic waste that was introduced in January 2018, which particularly aims to increase plastic recycling. We will stay on the ball here and continue to expand our activities in the area of the circular economy.


However, the current annual report begins with a look back at 2017. Read about detailed examples of our international activities, selected success stories from our five business units – Polymer Materials, Chemistry, Environment, Biomass, and Energy – and learn more about the people behind the individual projects.

We hope you enjoy your reading!

Cordial greetings



Eckhard Weidner



Görgo 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 being 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 (plastics 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 crucial contributions to a resource-saving society and industry. We strive 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. In doing so we focus on the balance of economically successful, socially just, and environmentally compatible developments.

Climate-neutral supply with energy and carbonic raw materials is possible if there is a fundamental change in the energy and raw materials system which takes into account societal and economic needs. The overarching goal is to replace the up to now mostly linear economy by a circular economy.

This is where Fraunhofer UMSICHT comes in, with its strategic projects based on two main principles: Circular Energy Economy and Circular Product Systems. *Read more about this on page 12.*

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

2017

Fraunhofer UMSICHT
in figures

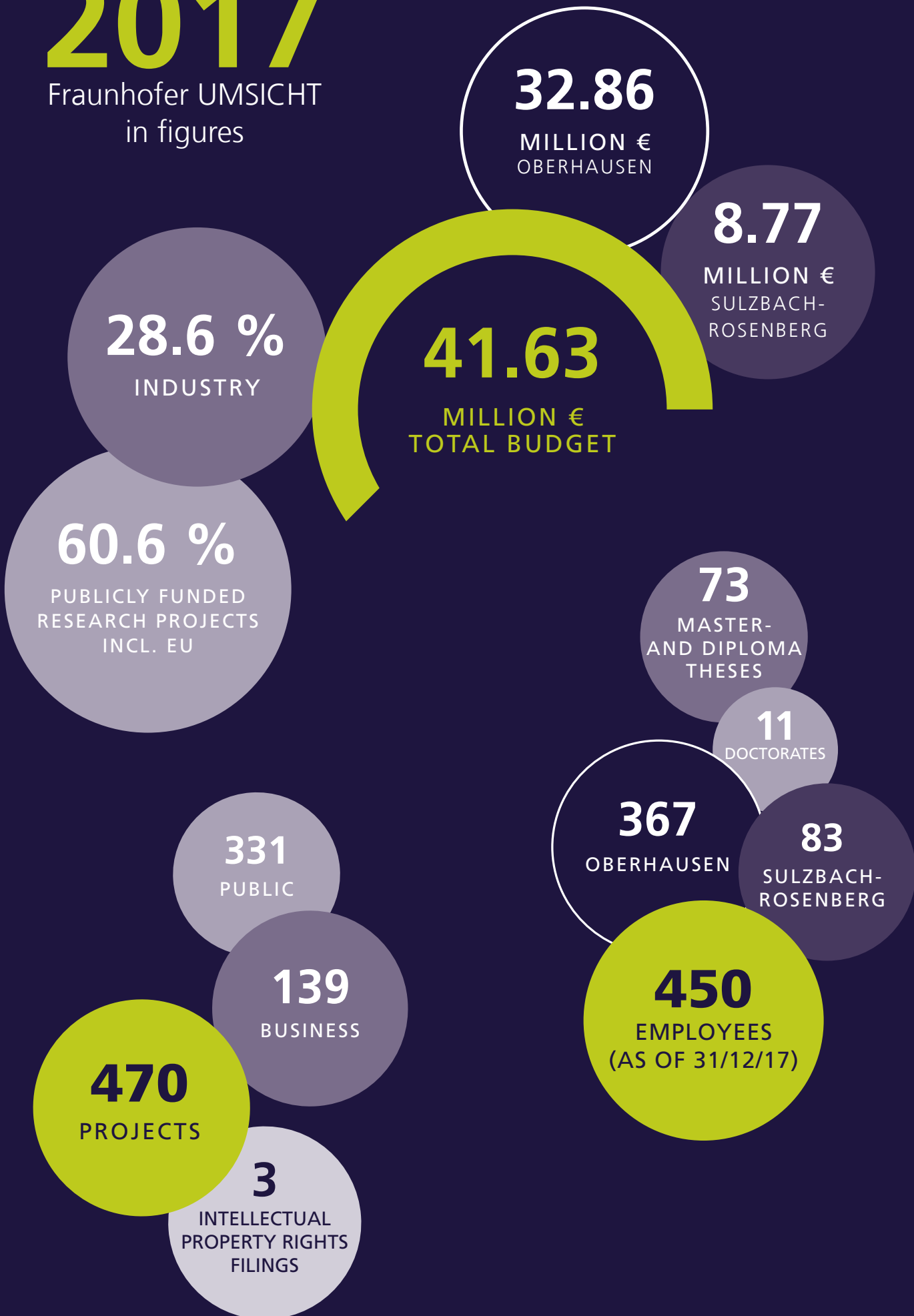
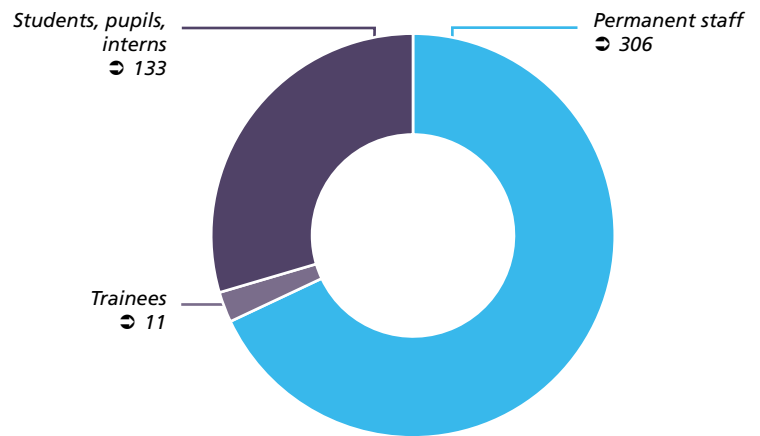




Foto: sushi100/photocase.com

STAFFING STATISTICS 2017

	OB	SURO *
Permanent staff	245	61
Scientific	189	49
Administrative	56	12
Other staff	122	22
Trainees	8	3
Students, pupils, interns	114	19
Total staff	367	83

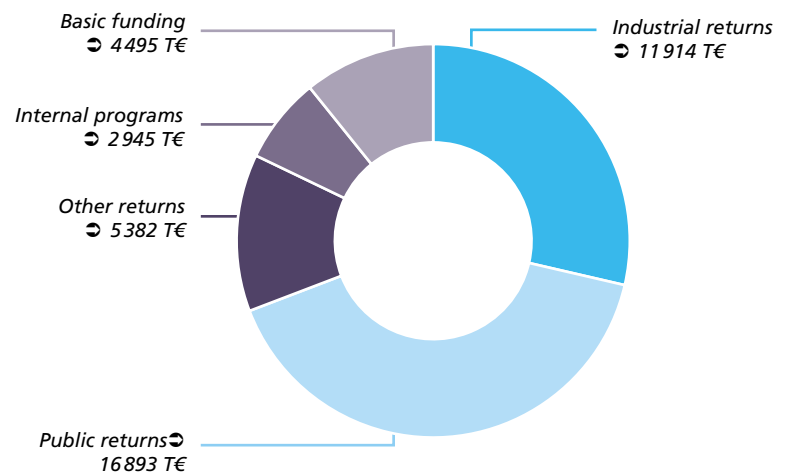


Staffing statistics
Fiscal year 2017; including all sites.

FINANCIAL STATISTICS 2017

[in thousand euros]

	OB	SURO *
Operating budget	31 038	8 292
Other costs	15 013	4 370
Staff costs	16 025	3 922
Investments budget	1 824	475
External project investments	1 174	188
Internal investments	650	287
Total returns	32 862	8 767
Industrial returns	11 006	908
Public returns	14 480	2 413
Other returns	538	4 844
Internal programs	2 939	6
Basic funding	3 899	596



Financial statistics
Fiscal year 2017; including all sites.

ORGANIZATIONAL STRUCTURE

As of January 2018

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 divisions 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

Director

Prof. Dr.-Ing. Eckhard Weidner (r.)

eckhard.weidner@umsicht.fraunhofer.de

Deputy Director

Prof. Dr.-Ing. Gorge Deerberg (l.)

goerge.deerberg@umsicht.fraunhofer.de

OFFICE

Manuela Rettweiler M.A.

Advisor to the Institute Management

Phone +49 208 8598-1109

Verena Buhle

Assistant to the Institute Management

Phone +49 208 8598-1152



DIVISION ENERGY

Prof. Dr.-Ing. Christian Doetsch

christian.doetsch@umsicht.fraunhofer.de

- Energy Systems Engineering
- Energy Systems
- Chemical Energy Storage
- Thermal Storage and Systems



DIVISION PROCESSES

Prof. Dr.-Ing. Gorge Deerberg

goerge.deerberg@umsicht.fraunhofer.de

- Biorefinery and Biofuels
- Photonics and Environment
- Information Technology
- Process Engineering
- Think Tank



DIVISION PRODUCTS

Dr.-Ing. Manfred Renner

manfred.renner@umsicht.fraunhofer.de

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



INSTITUTE BRANCH SULZBACH-ROSENBERG

Prof. Dr. rer. nat. Andreas Hornung

andreas.hornung@umsicht.fraunhofer.de

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

BUSINESS UNITS

further information see pg. 18

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.



Polymer Materials

Dr.-Ing. Manfred Renner

manfred.renner@umsicht.fraunhofer.de



Chemistry

Dr.-Ing. Axel Kraft (l.)

axel.kraft@umsicht.fraunhofer.de

Dr.-Ing. Hartmut Pflaum (r.)

hartmut.pflaum@umsicht.fraunhofer.de



Environment

Dipl.-Ing. Jürgen Bertling

juergen.bertling@umsicht.fraunhofer.de



Biomass

Dipl.-Phys. Thorsten Wack

thorsten.wack@umsicht.fraunhofer.de



Energy

Dr.-Ing. Wilhelm Althaus

wilhelm.althaus@umsicht.fraunhofer.de



INNOVATION MANAGEMENT AND STRATEGIC PROJECTS

Dr.-Ing. Hartmut Pflaum

hartmut.pflaum@umsicht.fraunhofer.de



DIVISION ORGANIZATION

Andreas Weber

andreas.weber@umsicht.fraunhofer.de

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

STRATEGIC PROJECTS

PIONEERING A SUSTAINABLE ENERGY AND RAW MATERIALS INDUSTRY

A climate-neutral supply of energy and carbon-containing raw materials can be achieved by fundamentally transforming the energy and raw materials system in a way that takes societal and economic needs into account. The overarching goal is to replace the previous, largely linear economic approach with a circular economy.

The new "raw materials" used in a circular economy are sustainably sourced carbon, renewable but often fluctuating energy, and products and materials maintained in a cycle.

This is where Fraunhofer UMSICHT comes in, with its strategic projects based on two main principles: Circular Energy Economy and Circular Product Systems.

FRAUNHOFER LIGHTHOUSE PROJECT:
"ELECTRICITY AS A RESOURCE"

The energy transition and its associated low-CO₂ electricity open up new paths for creating electricity-driven production. If this electricity is used in electrochemical reactions, base chemicals become available for industrial production processes that previously used crude oil. In the "Electricity as a Resource" lighthouse project, ten Fraunhofer institutes, coordinated by Fraunhofer UMSICHT, are developing and optimizing electrochemical processes that use electricity to produce important base chemicals. These electrochemical processes are traditional "enabling technologies" for system coupling between the energy system and chemical production. The lighthouse project is creating a permanent technological research and development platform for this, which will also be expanded for education and training.

Electrochemistry can supplement or replace catalytic thermochemical processes – if it also offers advantages in terms of efficiency or sustainability. There is a need for further research on the technical application of electrochemistry for new synthesis routes. It is essential to develop integrated catalysts and plant technology in order to create new process concepts for efficient, modular and decentralized production operations.

Two electrochemical synthesis routes

In the lighthouse project, new electrochemical processes are being developed and technically demonstrated, and prepared for integration into the German energy system. Two synthesis routes are being pursued:

Decentralized electrochemical production of hydrogen peroxide (H₂O₂)

Hydrogen peroxide (H₂O₂) is considered an environmentally friendly bleaching agent, e.g. for cellulose used in paper production. The industry currently produces H₂O₂ using the anthraquinone process, which requires large volumes of solvents, energy and capital in enormous plants. The decentralized production of a stable H₂O₂ solution has been shown in an electrochemical lab demonstrator.

Electrochemical conversion of carbon dioxide (CO₂) to ethene and alcohols

Carbon dioxide (CO₂) is created in industrial processes around the world. It is a useful carbon source for chemicals and fuels if it can be activated using renewable energy. In this case,



electricity, CO₂, and water become the raw materials for a CO₂ refinery. Alcohols are an important material group here because they are used as the starting material for many chemical products. As a result, the lighthouse project aims to produce alcohols (C₁-C₄ alcohols, C₄-C₂₀ alcohols¹) as its second electrochemical synthesis route. These alcohols have successfully been synthesized from CO₂ using three different processes.

¹ *The number in the index refers to the number of carbon atoms present in the alcohol (symbol: "C").*

Cross-sectional research

The development of synthesis routes is supported by cross-sectional research on system optimization:

Electrochemical component development and analytics

Membranes, electrodes, and sophisticated analytics are important elements of electrochemical cells and processes. The result is a completely new, cost-effective, and environmentally friendly membrane type for electrochemical cells.

Process modeling, simulation and optimization

Mathematical equations describe the mechanisms and relationships from the "molecule" level to the "process" level. The lighthouse project uses these equations to create a support tool for efficient electrochemical processes. This has allowed complex new lab experiments to be modeled and validated, and initial process models for H₂O₂ and CO₂ conversion to be developed.

System analysis and sustainability analysis

This sub-project creates energy scenarios, studies energy coupling processes, performs sustainability analyses, and integrates stakeholder interests. It derives scenarios for the future energy mix and pricing, and uses them along with scenarios for the German economic system as the basis for a comparative sustainability analysis. In addition, a reliable CO₂ market model (volume, quality, prices) has been created.

Exploitation and business models

"Electricity as a Resource" is designed for a long exploitation chain. To this end, it accesses innovation interfaces with industries such as chemicals, plant engineering, paper, textiles, recycling, and water, using a multi-industry approach. This will lead to the development of a Business and Innovation Center (BIC) that combines science, marketing and business development in order to design industry-relevant services. The platform gives users access to the Fraunhofer brand world, "eSource®."

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 Klauditz Institute WKI, Braunschweig

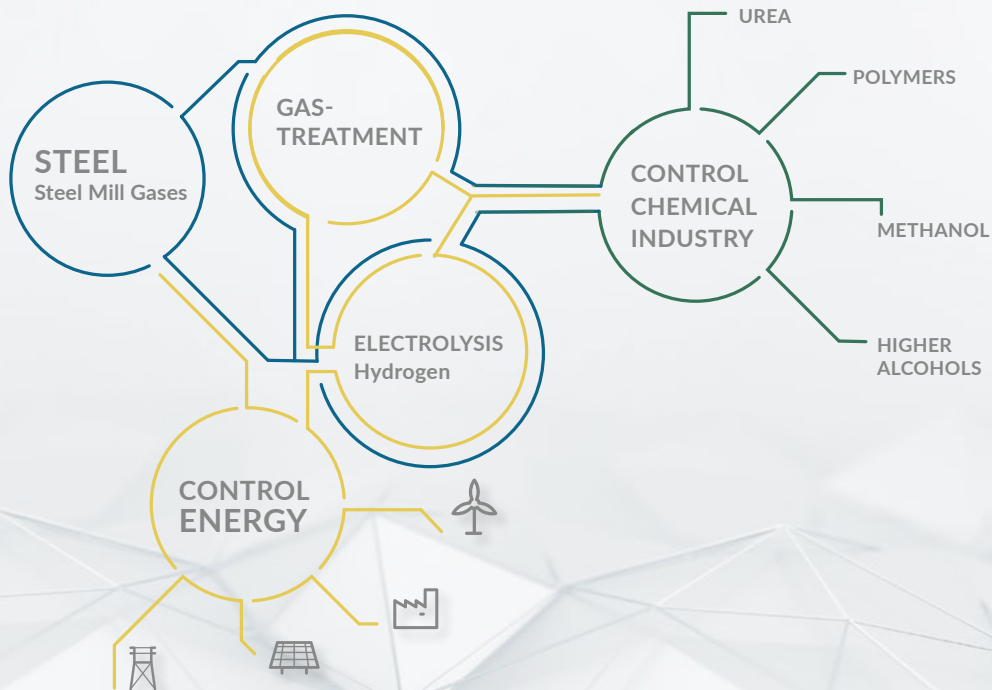
CONTACT

Dr.-Ing. Hartmut Pflaum | Business Developer Chemistry |

Phone +49 208 8598-1171 | hartmut.pflaum@umsicht.fraunhofer.de

Carbon2Chem®

Keeping carbon
in the loop



CARBON2CHEM® –
CARBON DIOXIDE: FROM STEEL TO CHEMISTRY

German industry is steadily cutting its energy demand and its output of polluting gases. However, the thermodynamic and economic limits are tight. Some industrial sectors would only be able to further reduce their energy demand by creating completely new production routes or with production restrictions. The Carbon2Chem® collaborative research project aims to exploit blast furnace gases from steel production as a valuable raw material source for the chemical industry. Using renewable energy, the inevitable carbon dioxide emissions from the steel industry can potentially replace fossil resources in the chemical industry. This process interface can then be used as a blueprint for other high-emission industrial sectors, which will further noticeably reduce energy use in the production industry and significantly lower emissions of polluting gases.

The road to climate-friendly industry can only be followed with the collaboration of partners from various sectors. One such cross-industrial partnership, the first of its kind, is the collaboration between the steel industry, the energy sector and the chemical industry on the Carbon2Chem® project. Coordinated jointly by Fraunhofer UMSICHT, thyssenkrupp AG and the Max Planck Institute for Chemical Energy Conversion (MPI CEC), the project develops solutions for converting the process gases from steel production into base chemicals – particularly the carbon they contain, which is currently still being released in large quantities as carbon dioxide.

Technological building blocks

Technologies are needed for chemical synthesis, for instance catalysis, that can clean, condition and convert the gas into marketable chemical products or fuels. Providing these technologies and integrating them into steel mills is thus one of the major challenges. The project is not looking for one major solution, but rather an approach with technology modules that can be combined flexibly.

The consortium for the Carbon2Chem® project includes a total of 18 partners from the fields of science and business. The interdisciplinary team combines the competences from each work area into seven sub-projects – each with a clear theme and a technically oriented focus on promising technologies that can be used in future integrated production with a steel mill.

Simulating the overall system

One central element is simulating the planned overall system in order to plan and dimension important aspects of product selection, process logistics and process control. At the same time, the simulation will allow significant conclusions to be drawn for work in the sub-projects. Based on the simulation results, the project will evaluate the cost-effectiveness and sustainability of the overall system.

Hydrogen production

Another Carbon2Chem® sub-project is studying how the hydrogen needed for chemical processes can be provided. The focus here is on producing hydrogen through water electrolysis, using volatile renewable energy sources. To this end, a large plant is operated in the technology center along with several small test stands in the lab in order to ensure the long-term efficiency of electrolysis despite changes in load.

Technologies for gas processing and synthesis

A major issue for Carbon2Chem® is processing the blast furnace gases. One sub-project is working on process concepts, designed for the selected synthesis routes, that allow a synthetic gas to be provided with the quality level needed for chemical production under dynamic boundary conditions.

In this context, Fraunhofer UMSICHT is developing and testing technologies and system solutions for gas purification as well as for the catalytic production of methanol, higher alcohols and oxymethylene ether – each designed to use processed blast furnace gases.

Technical infrastructure

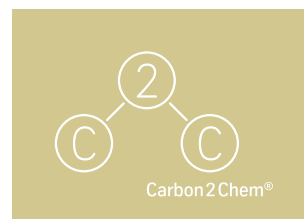
There is a central infrastructure in place to support the joint research and development. In the project lab that Fraunhofer UMSICHT operates jointly with the MPI CEC in Oberhausen, researchers are using synthetic blast furnace gases to study catalyst behavior. One focus is on the processes' potential for flexibility, so that production can be made as dynamic as possible later on.

In order to validate the lab results with real blast furnace gases, thyssenkrupp AG constructed a technical center for Carbon2Chem® near the steel mill in Duisburg. This center is used to demonstrate how chemical processes respond to real-life gas compositions under industrial conditions, in the cross-industrial collaborative research project. The direct link to the steel mill means that the necessary process control studies can be performed under dynamic boundary conditions.

Closing the cycles

Cost-effectiveness, climate protection and sustainability are the main tasks of the Carbon2Chem® project. The consortium's goal is thus to transfer the research findings to steel mills and comparable industrial sites on a large scale as quickly as possible.

The project was launched in June 2016 with a kickoff event at the power station in Duisburg's Landscape Park. The collaborative research project will continue until 2020 and is funded by the Federal Ministry of Education and Research (BMBF). The overall project is designed for a period of 10 years.



KONTAKT

Prof. Dr.-Ing. Görgе Deerberg | Project coordination Carbon2Chem® |
Phone +49 208 8598-1107 | goerge.deerberg@umsicht.fraunhofer.de
Dr.-Ing. Torsten Müller | Office of Carbon2Chem® |
Phone +49 208 8598-1284 | torsten.mueller@umsicht.fraunhofer.de



**FRAUNHOFER HIGH PERFORMANCE CENTER DYNAFLEX®
DYNAMIC AND FLEXIBLE TECHNOLOGIES FOR
ENERGY AND RAW MATERIALS**

In the future, manufacturing companies and energy operators will increasingly use low-carbon and renewable power. The benefit of "green" power has one disadvantage, though: it occurs in fluctuating volumes, because resources like the sun and wind come and go. Large plants with continuous operations may then be at a disadvantage. The goal of the High Performance Center DYNAFLEX® is to help energy supply and production cope with these and plan compatible, adaptable, flexible, and modular production systems.

What does dynamic, adaptive, and flexible mean?

Dynamic: The boundary conditions for the production will become more volatile: examples for this are "green" electricity and stock exchange fluctuations for energy and raw materials. Production processes must be able to respond swiftly, i. e. dynamically.

Adaptive: Processes, machines, and equipment must be designed to adapt to changing boundary conditions so they can be used in the long term and operated under various conditions, for instance changed supply situations (energy, raw materials).

Flexible: In the future, production systems must be able to react on short-term changes of the requirements, e.g. changes in energy supply or batch sizes. Smaller, modular systems are flexible in terms of their capacity, the raw materials they can process, and the variety of products they can produce.

Leading platform for process dynamics and adaptivity

Fraunhofer UMSICHT, the coordinator of the High Performance Center DYNAFLEX®, is working with the three universities in the Ruhr region – Bochum, Duisburg-Essen and Dortmund – as well as industrial partners to study the dynamics of technical systems, which will help them optimize the overall system of the future and predict the impact of fluctuations on production and the energy supply.

The goal is to create the leading platform in the Ruhr metropolitan region for process dynamics and adaptivity during the energy transition and raw materials shift together with a network from science and industry. Together with industrial partners, within DYNAFLEX® these methods will be tested and applied in implementation projects in the long term. Potential partners include energy, production, chemistry, biotechnology, and plant engineering companies. In addition, the research findings will be shared directly with young scientists through the partner universities and the Fraunhofer Academy (the Fraunhofer Gesellschaft's further education institution), and used for further training of specialists and employees.

First milestones

A toolbox was developed as a repository for excellent scientific methods in the area of process dynamics – for instance for dynamic balancing, analytics, and modeling. In addition, the researchers created the networking platform "s.fhg.de/dynaflex-en" to provide structure, to educate regional science clusters, and as a basis for open, interdisciplinary collaboration on simulations. The researchers are currently developing new business models and operating concepts for the energy sector and production. Using simulation models, solutions are being developed to help energy-related machines and processes keep their functionality for years despite highly volatile boundary conditions.

KONTAKT

*Dr.-Ing. Georg Janicki | Project Management Fraunhofer DYNAFLEX®
High Performance Center | Phone +49 208 8598-1420 | georg.janicki@umsicht.fraunhofer.de*



ROADMAP FOR A CIRCULAR ECONOMY

In absolute terms, our lifestyle has led to rising resource consumption and emissions. Fundamental changes in our current economic system as well as our consumption behavior are necessary in order to achieve sustainable development. This is where the concept of a circular economy comes in; Fraunhofer UMSICHT is working toward implementing this through its projects.

The goal of the circular economy is to use intelligent product design to manage goods and resources in cycles, through reuse and further use as well as recycling. This will generate more jobs and add value, especially on site, and ideally prevent waste from being created.

Circular Economy

Excerpt from the definition provided by Fraunhofer UMSICHT:

In a circular economy, the materials utilized remain in a material cycle beyond the life cycle of the goods. Waste, emissions, dissipative losses, and the extraction of raw materials from the environment are therefore to be reduced as far as possible. The reuse and continued use of goods along with the recycling of materials and substances are essential, as well as a design of the goods that allows for recirculation without quality losses and without accumulation of pollutants. The period of utilization for materials is as long as possible, and they are returned to the cycle at the end of their period of utilization as quickly as possible. Materials for which dissipative losses are unavoidable are degradable. The optimized energy consumption for maintaining the cycle is ideally provided from renewable resources. Substances that cannot be recirculated are utilized as energy.



Key competence: Circular Plastics

Plastics are essential for our well-being, health, resource conservation, and energy efficiency. But too much plastic waste ends up in our ecosystem and food chains. The institute's mission: finding solutions for a plastic transition from the scratch – and changing the perception, management and handling of plastics. A microplastics consortium study creates factual knowledge to provide a reliable data basis for this topic.

Improving circularity for industrial branches

Fraunhofer UMSICHT also investigates the opportunities that the circular economy offers for individual industrial branches, and sketches out possible steps on the roadmap toward improving circularity. On behalf of VCI NRW (the German Chemical Industry Association in North Rhine-Westphalia), the institute conducted a study that showed the opportunities and potentials for circular use based on three different material flows for the German chemical industry.

Improving exchanges between the actors

In order to establish a functional circular economy, it is essential to improve exchanges between the actors. Fraunhofer UMSICHT acts as a driver to initiate and moderate communication for instance between primary and secondary producers, raw materials manufacturers, producers, industrial designers, and waste disposal companies. Any trade-offs at the interfaces for the value chain are discussed transparently and openly at an early stage, which smoothens the path for common solutions and business models aiming at a circular economy.

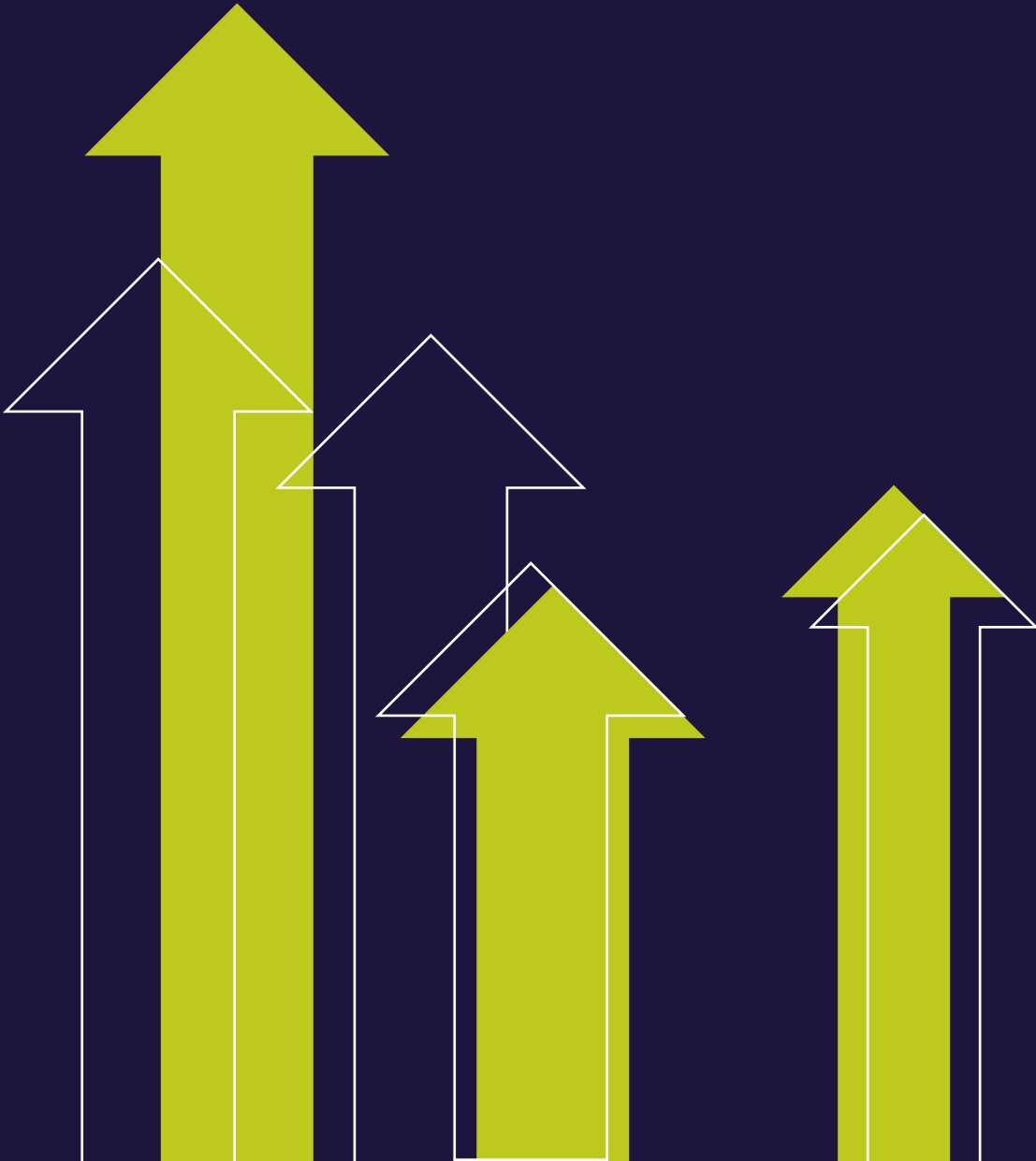
KONTAKT

Dr.-Ing. Markus Hiebel | Group Manager Sustainability and Resources Management |
Phone +49 208 8598-1118 | markus.hiebel@umsicht.fraunhofer.de

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

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

BUSINESS UNIT

POLYMER MATERIALS



Photo: shutterstock

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

CONTACT

Dr.-Ing. Manfred Renner | Business Developer Polymer Materials |

Phone +49 208 8598-1411 | manfred.renner@umsicht.fraunhofer.de



BIOPLASTIC MULTI-WALL SHEETS

1 *Multi-wall sheet made from bioplastics.*

2 *Folded box made from multi-wall sheet (bioplastic).*

Like corrugated cardboard, plastic multi-wall sheets can be folded to make e. g. transport boxes. They are lightweight but very sturdy. Unlike boxes made from corrugated cardboard, the plastic boxes are watertight, waterproof and easy to clean. They are suitable as transport packaging for fresh foods like fruit and fish, as well as for reusable packaging systems. Currently, such multi-wall sheets are only made from fossil-based plastics, usually polypropylene (PP). Fraunhofer UMSICHT now offers a bioplastics-based alternative.

The objective: bioplastics as a sustainable alternative

A German-Colombian team of researchers led by Fraunhofer UMSICHT carried out a joint 'Bioeconomy International' project to develop multi-wall sheets made from bioplastics. The switch from fossil-based plastics to bioplastics saves non-renewable resources and helps lay the foundation for a structural change toward a bio-based industry. A particular challenge that Fraunhofer UMSICHT faced in developing the material was the high complexity of the industrial profile extrusion. In addition, the cost-effectiveness of the new material was a concern. As a result, the researchers used commercially available bioplastics and additives.

The result: a new material

Fraunhofer UMSICHT developed a tailored blend system made from bioplastics having similar properties to the PP blend that is to be replaced. The initial processing tests on a hollow profile extrusion system were very promising. The project was successfully concluded with an industrial pilot test to manufacture multi-wall sheets by the Colombian industrial partner. The bioplastic product, for example, can be used for manufacturing transport boxes to export flowers, perishable fruits, vegetables or fish. In addition, further applications of the developed material in the floriculture and horticulture sector will be tested.

Environment, methods: systematic further development

Up to now market-available PLA blends, however, are not suitable for the challenging multi-wall sheet extrusion process. The processing behavior of the material first needed to be improved before a breakthrough was achieved.

The material was scientifically developed through systematic studies of the interdependencies between composition, melt behavior, processing properties, and the characteristics of the final product.

2



Customer benefit: tailor-made materials

Several product manufacturers now recognize the opportunities in developing sustainable products based on bioplastics.

On the one hand, it promotes ecological business; on the other hand, it creates a development lead that secures and improves companies' market opportunities in the future.

Available bioplastics usually have to be adapted to the existing manufacturing processes. Fraunhofer UMSICHT is an experienced partner in this area. Interdisciplinary teams work closely with plastics manufacturers and plastics processing companies to develop tailor-made bioplastics – from the initial idea to small-scale production.

Successful transnational collaboration

Four partners from Germany and Colombia shared their knowledge and experience in the course of the project:

- Fraunhofer-Institute for Environmental, Safety, and Energy Technology UMSICHT, Oberhausen, Germany
- Institute for Plastic and Rubber Research and Training (ICIPC), Medellín, Colombia
- FKUR Kunststoff GmbH, Willich, Germany
- Compañía de Empaques S.A., Itagüí, Colombia.

The combined competence of the two research institutes, Fraunhofer UMSICHT and ICIPC, was extremely valuable for developing the innovative bioplastic compound used in the challenging industrial extrusion process for multi-wall sheets.

Close collaboration with the industrial partners made fast practical implementation possible. Market launch of the material is expected soon after the end of the project.

Sustainability:

Bio-based plastics are not made from fossil resources like crude oil or natural gas but from renewable raw materials.

They make an important contribution toward our independence from fossil fuels and toward reducing CO₂ emissions. The material use of renewable raw materials significantly offers more value and employment impact than bioenergy.



CONTACT

Dr.-Ing. Stephan Kabasci | Head of Department Bio-based Plastics |
Phone +49 208 8598-1164 | stephan.kabasci@umsicht.fraunhofer.de

BUSINESS UNIT **CHEMISTRY**



SERVICE PORTFOLIO

We offer process engineering research and development services as well as products and processes including industrial property rights. We provide solutions for the increasing demands for affordable sustainability and innovation in chemistry, petro-chemistry and refinery. We have our own know-how in 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 fuels (diesel, kerosene). Biomass, synthesis gas, and selected residues constitute the portfolio of raw materials from which we suggest process-specific solutions. Upstream and downstream processing as well as product formulations round out our expertise. We are points of contact for the whole value added and logistics chains, develop specific sustainability assessments and strategies and 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 (thermo-/electro-)chemical-catalytic process steps
- Development and optimization of scalable processes including 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

CONTACT

Dr.-Ing. Axel Kraft | Business Developer Chemistry |

Phone +49 208 8598-1167 | axel.kraft@umsicht.fraunhofer.de

Dr.-Ing. Hartmut Pflaum | Business Developer Chemistry |

Phone +49 208 8598-1171 | hartmut.pflaum@umsicht.fraunhofer.de



CATALYTIC COMPETENCE AT THE INSTITUTE

1 *The institute's technical infrastructure allows for catalyst synthesis and characterization, upscaling and testing.*

2 *A look at the X-ray diffractometer used to characterize heterogeneous catalysts.*

Over the last five years, Fraunhofer UMSICHT has dramatically expanded its competences in the area of heterogeneous catalysis. Today, its mature technical infrastructure supports not only the preparation of innovative catalysts, but also order testing under industry-relevant conditions. The institute is thus setting new standards for producing energy sources and basic chemicals from renewable synthetic gas.

The goal: developing catalysts on a commercial scale

More than 80 percent of all chemicals produced worldwide come in contact with catalysts during at least one of their manufacturing steps. The catalyst functions as an additive that, without being consumed, accelerates the speed of a chemical reaction and reduces the amount of energy required, usually as part of the energy in the form of temperature and pressure. Catalysis is not only essential for many processes in the manufacturing industry – it also offers the potential for redesigning the existing processes as part of the energy transition and raw material shift. In order to move the catalytic concepts from basic research to large commercial-scale systems, Fraunhofer UMSICHT has expanded its scientific excellence in the area of catalysis. The long-term goal is to use this expertise in large projects and contract work for industrial clients.

The result: processes that are tailored to the new energy and raw material base

Within just five years, the Catalytic Processes group has become successfully established at the institute and has developed a strong infrastructure. The team of researchers mainly focuses on the area of heterogeneous catalysis, with an emphasis on catalysts for producing energy sources and basic chemicals from conventional as well as renewable synthetic gas. In cooperation with partners from the sectors of basic research, plant engineering, and the chemical industry, catalysts are prepared, tested, and further developed for large-scale commercial use.

Environment and methods: the catalysis infrastructure at Fraunhofer UMSICHT

The institute has a technical infrastructure of mature pilot-plant-scale systems and processes that can be transferred to industrial clients' pilot plants. The institute's own catalysis lab provides realistic conditions where analyses can be performed; the results are then used for optimized catalyst and process development. The important criteria for catalysts here are conversion, yield, selectivity, and long-term stability. In addition, the "BigBatch" preparation unit, with a reactor volume of 20 liters, can synthesize catalysts weighing up to one kilogram. This system is an important part of catalyst development in the institute, and has already been successfully implemented for the production of larger volumes of catalysts. Among other things, the institute's catalysis



expertise is used in the collaborative Carbon2Chem® project. Based on catalytic processes, technologies are developed for chemical synthesis that can clean and condition smelting gases and turn them into marketable chemical products or fuels. In Fraunhofer's Lighthouse project "Electricity as a Resource," the research group is also working on developing integrated electrocatalysts and plant technology.

The customer benefit: industrial catalysis

Fraunhofer UMSICHT also offers its expertise in heterogeneous catalysis to industrial clients. One of its service offerings involves developing catalysts for existing and new production processes. At the same time, the institute also uses catalytic processes to help companies switch to an innovative raw material base.

Our customers primarily come from the chemical industry and the plant engineering sector. However, our established infrastructure, which includes catalyst synthesis and characterization, upscaling and testing, is also interesting for companies in the energy sector that develop power-to-X technologies.

Catalysis: contributing to the energy transition and raw material shift

Now that the energy transition has been decided, moving away from fossil-based, carbon-containing energy sources and toward renewable energy is unavoidable. In addition to the energy sector, the chemical industry is also highly dependent on crude oil, natural gas and coal. Countless everyday products are manufactured using base chemicals that are produced from fossil resources. In order to eliminate this dependency in the long term, existing product lines will need to be adapted to use renewable raw materials and new recycling systems will have to be developed.

Catalytic processes based on synthesis gas chemistry play a key role here, since they allow renewable raw materials as well as CO₂ to be used as carbon sources. The catalytic processes developed by Fraunhofer UMSICHT can thus contribute to a sustainable carbon economy.

Sustainability:

Catalysts accelerate chemical reactions and reduce the amount of activation energy required, which makes production processes more energy-efficient and cost-effective. Fraunhofer UMSICHT also uses the greenhouse gas CO₂ directly as a raw material in many catalytic processes, in an attempt to realize a cascading use of carbon. One example is production of the base chemical methanol, which can be synthesized from the waste product CO₂ and renewable hydrogen (H₂).



CONTACT

Dipl.-Chem. Heiko Lohmann | Group Manager Catalytic Processes |
Phone +49 208 8598-1197 | heiko.lohmann@umsicht.fraunhofer.de

BUSINESS UNIT **ENVIRONMENT**



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

CONTACT

Dipl.-Ing. Jürgen Bertling | Business Developer Environment |

Phone +49 208 8598-1168 | juergen.bertling@umsicht.fraunhofer.de



RECOVERY OF HIGH-TECH METALS

1 Pilot reactor for thermochemical treatment of 70 kg/h electronic waste.

2 gagedta+ process chain for recovery of high-tech metals from electronic waste

High-tech metals are used to manufacture servers, smartphones, fiber optic cables, and increasingly also in the automotive industry, although they are found less frequently there. The gagedta+ process improves the recycling rates for critical metals by treating waste electrical and electronic equipment – something that was previously only possible to a limited extent because of the plastics they contain. The process creates marketable intermediate and finished products.

The objective: keeping metals in circulation

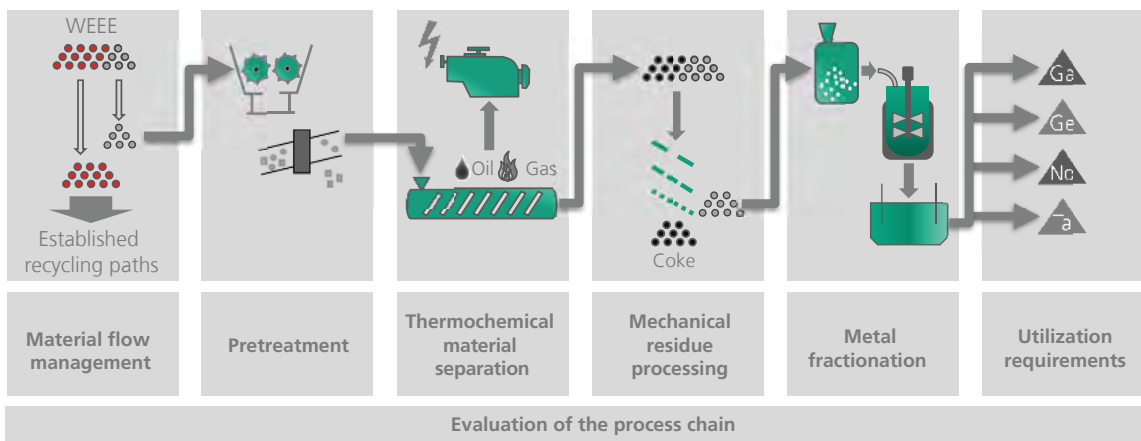
Only a very small portion of the high-tech metals in circulation worldwide is currently recycled from waste electrical and electronic equipment (WEEE). In some cases, it is less than 1 percent. Recovering and returning the metals to the economic cycle can help protect natural resources and provide cost-effective raw materials. The objective is to use the recycled metals to manufacture new items and metal products. Intermediate products can be used as substitutes for primary raw materials in metal manufacturing.

The result: reducing our dependency on imports

In particular, the high share of plastics in WEEE is problematic when it comes to metal recycling. The gagedta+ process removes these plastics from (waste) material flows and gives metal producers a completely new, wide range of materials for their process: electrical and electronic equipment. The individual process modules can be used to separate out impurities and contaminants, and to enrich high-tech or other metals. Using the secondary raw materials from the gagedta+ process – metal concentrates, pure metals, and metal alloys – can reduce our dependency on raw-material imports.

Environment, methods: separating materials effectively and without losses

The extraction of precious and high-tech metals are by no means in conflict. It is fundamentally possible to extract all of the metals and separate them from one another. The usual path for recycling metal-containing waste often leads to the copper smelting process, which is very efficient for recovering gold and copper, for instance, but high-tech metals are then lost in the slag. With the gagedta+ approach, they are removed from the waste flows right at the start of the recycling chain, so they never end up in the normal disposal path. The desirable metals – gallium (Ga), germanium (Ge), neodymium (Nd) and tantalum (Ta) – are enriched along a modular process chain; in the final step, they are recovered and become a marketable product.



Customer benefits: increasing the value of the fractions

For waste disposal and recycling companies, gagentda+ provides the opportunity to use residual fractions to produce valuable intermediate or final products rather than disposing of them, which is subject to costs. Selling these products generates additional income. In addition, gagentda+ can be used to further increase the value of fractions from WEEE preparation, since the process enriches not just high-tech metals, but also precious and bulk metals in the metal concentrates.

A successful collaboration: from test centers to pilot plants

The project is made possible by a support program initiated by the Federal Ministry of Education and Research (BMBF), "r4 – Innovative Technologies for Resource Efficiency – Research on Providing Raw Materials with Strategic Economic Importance." Fraunhofer UMSICHT in Sulzbach-Rosenberg is working with seven partners from the fields of science and industry to develop a modular process chain for the decentralized recovery of selected technology metals.

The consortium consists of:

- Fraunhofer UMSICHT – Sulzbach-Rosenberg Branch
- Fraunhofer IGB
- Fraunhofer IPA
- Fraunhofer ISC – IWKS Project Group
- Georg Simon Ohm University of Applied Sciences Nuremberg
- ALBA Electronics Recycling GmbH
- Kautz Technologies GmbH
- Hubert Tippkötter GmbH

The project first studied various WEEE fractions to identify material flows that are especially relevant for recycling high-tech metals. Sample materials were provided by ALBA Electronics Recycling GmbH. Next, Fraunhofer ISC performed a pretreatment step to separate electronic components with high-tech metals from the carrier material, using an electrohydraulic crushing technique. The team at Fraunhofer UMSICHT then carried out the thermochemical treatment, including various shredder residues, printed circuit boards, tantalum capacitors, fiber optic cables and LCD displays. A pilot plant constructed by Kautz Technologies GmbH has been set up and put into operation for larger-scale tests at the Fraunhofer UMSICHT location in Sulzbach-Rosenberg, with a throughput of 70 kg/h. Further mechanical processing of the metal concentrate will take place at TH Nuremberg and at Fraunhofer UMSICHT. At the end of the process chain, biological and electrochemical tests will be performed by the Fraunhofer Institutes IGB and IPA to turn the extracted metals into new materials for industrial use.

Sustainability:

Substituting primary metals avoids the particularly high environmental burdens that result from primary extraction. Oil and gas products can be used as needed to create power and heat in a combined heat and power unit, and made available to other applications. In order to ensure compliance with ecological, economic, and social standards, Fraunhofer UMSICHT balances all of the processes in the value chain. Using the data for product requirements from industrial and business partners, the process chain is supplemented and optimized.



CONTACT

Dr.-Ing. Peter Hense | Group Manager Recycling Technologies |
Phone +49 9661 908-435 | peter.hense@umsicht.fraunhofer.de

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, including trace gas analytics
- Development of methods for reduction of emissions, flue gas purification
- Catalyst and bioprocess development
- Digitization technologies for the agricultural sector
- 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

Dipl.-Phys. Thorsten Wack | Business Developer Biomass |

Phone +49 208 8598-1278 | thorsten.wack@umsicht.fraunhofer.de



A ROOFTOP GREENHOUSE FOR URBAN FOOD PRODUCTION

1 The "Altmarktgarten" is the first inFARMING® project in Germany.

2 The photonics lab at UMSICHT studies the influence of light on plant growth.

More than half of the people in the world live in cities. The number of densely populated urban centers is growing, and undeveloped areas and green spaces are rare. A concept developed by Fraunhofer UMSICHT makes it possible to integrate agriculture into buildings: inFARMING®. The first building-integrated vegetable production using this concept is currently being constructed on the roof of the future job center building in Oberhausen.

The objective: creating new usable agricultural areas in cities

Because of global trends like the growing world population and increasing urbanization, as well as climate change and land sealing, the local food supply is playing an increasingly important role. Expert studies currently assume that the challenge for developed countries will not be further maximizing the yield, but instead keeping yields the same while reducing the environmental impact. The inFARMING® concept of Fraunhofer UMSICHT aims to produce food and make it available in a regional, resource-conserving, and integrated context.

The result: a link between production systems and building infrastructures

Under the inFARMING® umbrella brand, Fraunhofer UMSICHT is advancing the integration of horticulture in cities and metropolitan areas. To this end, its researchers develop materials, new cultivation systems, specific lighting strategies, and recycling processes for nutrients, water and energy, and perform feasibility and implementation studies as well as acceptance and participation studies. The produce goes straight from the roof to the consumer, and plants receive their nutrients from black water. The building or the urban district provides the necessary energy, water, and nutrients.

Facility and methods: the photonics lab

In the photonics lab, researchers use special grow rooms and plant growth chambers to study how light influences plant growth. Various lighting scenarios are created using LED modules to determine which conditions produce higher or lower levels of various components in the plants. In the UV chamber, for instance, Fraunhofer UMSICHT studies ways to sterilize water, along with options for photocatalysis.



How customers benefit: the agriculture of the future

inFARMING® can be used in sustainable and resource-conserving concepts for the urban agriculture of the future. Ensuring a supply of fresh, high-quality food while also reducing the environmental burden puts pressure on the food production system.

Traditional, conventional agriculture is very resource-intensive – worldwide, in addition to the space requirements, it uses about 70 percent of the available drinking water. In addition, agricultural energy consumption contributes to about 14 percent of the world's CO₂ emissions. In Germany, there are about 1,200 million square meters of flat roofs on non-residential buildings. Of those, about 360 million square meters could theoretically be used to cultivate plants in building-integrated production facilities using the inFARMING® concept, which would trap about 28 million tonnes of CO₂ per year.

Implementation

One of the first showcase projects for the inFARMING® concept is the "Altmarktgarten" in Oberhausen. On behalf of OGM Oberhausener Gebäudemanagement GmbH and in collaboration with the City of Oberhausen, a new job center building is erected here with a 1000-square-meter integrated rooftop greenhouse based on the inFARMING® concept. It will be the first research and demonstration center for building-integrated agriculture. With tours, events, and workshops, it will become a place for urban production, research, and gatherings.

A flagship project for the city

One important aspect of this project is involving people at the site. There are regular informational events on the topic of building-integrated agriculture, and the finished building will house a seminar room for education and information offerings. The building will also have a café that serves produce grown on the roof. Research is currently being done to determine whether the freshly harvested fruit and vegetables can be offered to consumers directly at the farmer's market next to the new job center.

The "Altmarktgarten" is the first inFARMING® project in Germany, and a flagship project for the city of Oberhausen. It will also help enhance the neighborhood.

Sustainability:

inFARMING® offers ideas and methods to prevent greenhouse gas emissions, to minimize space usage and land sealing through agriculture, and to reduce transport costs. In addition, consumers receive regional products that are produced right in their neighborhood.



CONTACT

Dipl.-Ing. Volkmar Keuter | Head of Department Photonics and Environment |
Phone +49 208 8598-1113 | volkmar.keuter@umsicht.fraunhofer.de

BUSINESS UNIT **ENERGY**

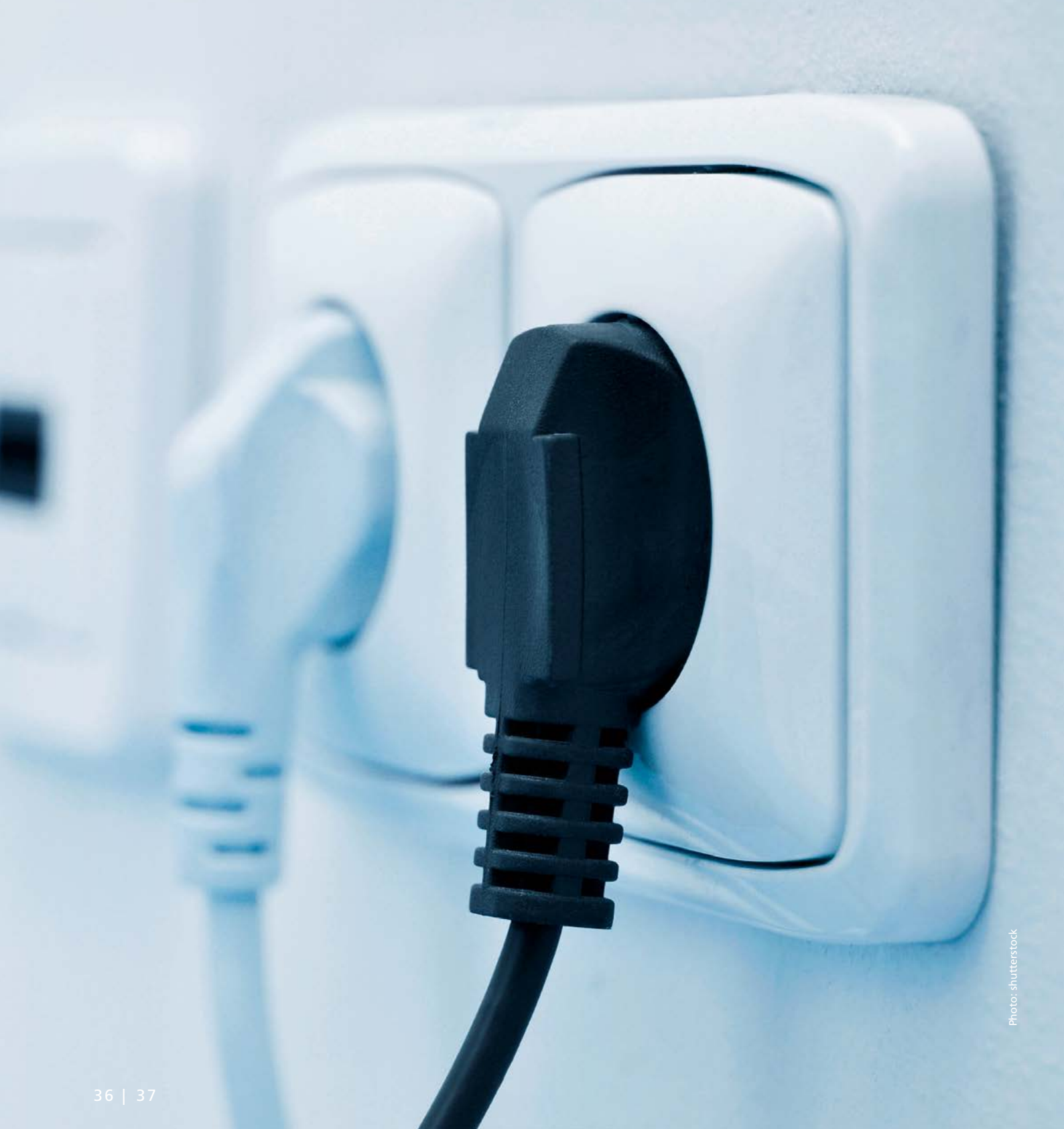


Photo: shutterstock

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_{el}
- 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, decentralized bio energy (conversion) processes
- Improving the flexibility of CHP systems, heat demand forecasts
- Management of decentralized 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

Dr.-Ing. Wilhelm Althaus | Business Developer Energy |

Phone +49 208 8598-1186 | wilhelm.althaus@umsicht.fraunhofer.de



HYBRID COMPENSATION SYSTEM TO PROVIDE SYSTEM SERVICES

- 1 Bipolar plate made by Fraunhofer UMSICHT.
- 2 Fully welded redox stack.

Energy storage systems and innovative system services are important elements of a future-oriented energy network. Until now, they have always been set up as different assembly units. A team made up of experts from the fields of research, business, and energy supply is developing a hybrid compensation system that combines the two elements – which improves both system quality and system costs.

The goal: ensuring a stable power supply and consistent voltage quality

The German government's energy policy requires the proportion of renewable energy in the power supply to be at least 35 percent by 2020 and 80 percent by 2050. This goal can only be achieved if the individual elements of the energy transition work together seamlessly. Electrical energy storage devices are an important system element in order to help stabilize the fluctuating electricity flow from wind and solar power plants according to demand. Another important element are power converters, which feed the required voltage type into the network. However, power converters have a negative impact on the voltage signal. In order to ensure consistent voltage quality, network operators use something called system services.

The result: a hybrid compensating system has been designed and is being built

At the technical level, storage solutions and system services are still being realized as separate elements/assembly units. The problem is that many different systems are needed for the various requirements. As part of the collaborative HYBKomp project funded by the Federal Ministry for Economic Affairs and Energy (BMWi), researchers at the Institute of Energy Systems, Energy Efficiency and Energy Economics at TU Dortmund University hope to demonstrate a new technical solution that combines the assembly units into one system. A hybrid compensation system consisting of two storage elements – a redox-flow battery and a flywheel storage device – is equipped with a freely configurable power converter and the corresponding measurement, control, and communication equipment. The system can respond flexibly to changing demands for effective power storage and provision as well as for reactive power supply. The demonstrator will be installed and tested in Stadtwerk Haßfurt GmbH's medium-voltage distribution network.

Environment and methods: redox-flow battery development with innovative bipolar plates

Fraunhofer UMSICHT contributes its expertise in the area of redox-flow batteries, especially when it comes to developing and manufacturing bipolar plates, and is delivering a 40kW_{el} prototype for the project. Bipolar plates are a key component of redox-flow batteries. They are used to merge individual cells into stacks, which are then configured into a battery. The innovative bipolar plate material is already being successfully used in small redox-flow stacks at Volterion, a Fraunhofer spinoff, and is undergoing field tests. Especially for large outputs in the megawatt range and large capacities (megawatt hours), the technology offers clear economic advantages over lithium-ion batteries.

The modular flywheel storage device is used to provide large outputs quickly. The redox-flow battery stores energy for longer periods of time. Storage in external tanks means that battery capacity can be scaled independently from battery output and also enlarged subsequently.

The customer benefit: flexible and cost-effective

The new hybrid compensator can be technically optimized for the required supply stabilization and the necessary system services at low investment costs. This is supported by the largely modular redox battery output, the independently scalable redox capacity and the modular flywheel storage as well as scalable power converters.

Successful networking of project partners

HYBKomp was launched on September 1, 2017, and project duration is over a period of three and a half years. In addition to the Institute of Energy Systems, Energy Efficiency and Energy Economics at TU Dortmund University and Fraunhofer UMSICHT, the partners include SWW Wunsiedel GmbH and Stadtwerk Haßfurt GmbH. STORNETIC GmbH is responsible for the flywheel storage devices, and KAUTZ Starkstrom-Anlagen GmbH will connect the electronic power components to the system. Finally, the Institute for Factory Automation and Production Systems at Friedrich-Alexander University Erlangen-Nuremberg is contributing a control system to help the individual network compensation components work together.

Sustainability:

Fraunhofer UMSICHT develops and manufactures thermally welded bipolar plates for the battery storage devices, which allow for an innovative redox stack structure. A battery stack consisting of many individual cells can thus be welded together and constructed without sealing gaskets, which makes it much more reliable compared to the previous technologies. For the first time, cost-effective electrical storage systems can be manufactured that are also relevant for the market segment of industrial applications. This also contributes to the energy transition.



SUSTAINABLE

CONTACT

Dr.-Ing. Anna Grevé | Head of Department Chemical Energy Storage |
Phone +49 208 8598-1271 | anna.greve@umsicht.fraunhofer.de

INTERNATIONAL

INTERNATIONAL COLLABORATION WITH KUWAIT, CANADA, AND GREAT BRITAIN

Fraunhofer UMSICHT works with partners around the world in order to take advantage of synergies in technology development and to create additional scientific value. Its strategic partnerships with industrial and project partners in Kuwait, with the University of Alberta in Edmonton, Canada, and with the University of Birmingham, UK, are three current examples of these international activities.

WASTE MANAGEMENT PLAN FOR KUWAIT

Since January 2017, Fraunhofer UMSICHT has been working in Sulzbach-Rosenberg to develop a waste management plan for the Emirate of Kuwait. The project's overarching goal is to create an information system that can be used to supervise and monitor waste producers, transports, treatment plants and disposal sites. The monitoring system will show any limit values that are exceeded and make it possible to visually track the waste – conveniently, via smartphone. In addition, the project will develop the country's waste management guidelines for the next 20 years. In addition to these conceptual and planning-related aspects, UMSICHT will provide solutions for problems that are identified in the field of waste management and implement them in practice.

On behalf of the local cement plant KCC (Kuwait Cement Company) and with support from the Kuwaiti environmental agency, UMSICHT performed tests involving thermal utilization of waste tires at the local cement plant in Kuwait. These will be used to reduce large waste-tire disposal sites in the country and to prevent frequent fires at these sites. In addition, the waste tires will replace the black coal currently used in the production process. The tests included an extensive measurement program under various conditions, using different volumes of waste tires. The goal of the testing was to evaluate whether utilizing waste tires had any negative impact on the production process, product quality or the environment.

RESEARCH PARTNERSHIP WITH CANADA

Technology platform for bioenergy

Since 2013, Fraunhofer UMSICHT has been working with the University of Alberta in Edmonton, Canada, in a strategic research partnership. In 2017, they officially launched the establishment of a joint technology platform. Representatives from Fraunhofer UMSICHT and the University of Alberta signed the contract in Munich on October 24. Both institutions perform research in the topic areas of bioindustry (biorefineries and biobatteries), electro-chemical energy systems, food, and products, and they hope that combining their competencies in the partnership will generate research findings with strong technology transfer potential.

Biobatteries

The technology platform's goal is to launch joint projects to develop new energy technologies and to test them using starting materials from Alberta. Biofuels, battery storage units, and alternative CO₂ uses are the first areas to be addressed. "We are very pleased to have found such an excellent partner in the University of Alberta to help expand our research activities at the international level," says Prof. Andreas Hornung, director of the Fraunhofer UMSICHT branch in Sulzbach-Rosenberg.

One of the first specific projects involves a biobattery that uses TCR® (thermo-catalytic reforming) technology developed by Fraunhofer UMSICHT and will now go to Edmonton. TCR® can be used to transform biogenic residual materials and industrial



Photo: University Birmingham / John James

biomass waste into oil, gas or biochar. The biobattery project will test a range of possible materials from Alberta, such as residential, agricultural, and forestry waste. The technology is already being tested in Birmingham, UK; in Alberta, it will allow remote communities in particular to transform their local waste into energy. The TCR® system will be delivered to Alberta in late 2018.

A RESEARCH PLATFORM FOR A GREEN BIRMINGHAM

Globalization means that more energy is being consumed than ever before, and the demand for energy is constantly growing. Climate change and the high consumption of fossil fuels represent an increasing problem. The new joint research platform launched on May 17, 2017, by the Birmingham Energy Institute and Fraunhofer UMSICHT hopes to develop solutions for this problem. Specialized academic knowledge combined with industrial expertise, can provide new approaches for energy and waste management in order to offer effective results for cities and communities.

"The joint research platform is an important step, and it is ushering in a new era. Guests from all over the world came to Birmingham to celebrate the occasion, including investors from Brazil, Italy and Germany. We used the large research portfolio and financial resources of the University of Birmingham, along with the kind support of the city of Birmingham, to create solutions for a green Birmingham," says Professor Andreas Hornung, the director of the Fraunhofer UMSICHT branch in Sulzbach-Rosenberg, who also holds a chair in Bioenergy at the University of Birmingham.

Focusing on TCR® technology

The collaboration between the Birmingham Energy Institute and Fraunhofer UMSICHT is initially concentrating on a new technology developed by Professor Hornung – thermo-catalytic reforming (TCR®). A TCR® demonstrator has already been installed in Tyseley Energy Park in the city of Birmingham. The TCR® technology is a central and important element of the energy capital vision for the West Midlands region. In the future, additional commercial TCR® units will be developed for the city of Birmingham as part of the collaboration. The concept is described as a "thermal belt," and it is a solution to the globally growing demand for clean energy and fuels.

- 1** *A view of the calciner tower and rotary kiln on the production line*
- 2** *Launching a joint research platform by the Birmingham Energy Institute and Fraunhofer UMSICHT at the University of Birmingham*

CONTACT

Kuwait: Dr.-Ing. Matthias Franke | Head of Recycling Management |
 Phone +49 9661 908-438 | matthias.franke@umsicht.fraunhofer.de

Cooperation Canada/University of Alberta:

Prof. Dr.-Ing. Christian Doetsch | Division Director Energy |

Phone +49 208 8598-1195 | christian.doetsch@umsicht.fraunhofer.de

Dipl.-Ing. Samir Binder | Deputy Director Institute Branch Sulzbach-Rosenberg |

Phone + 49 9661 908-402 | samir.binder@umsicht.fraunhofer.de

Birmingham: Prof. Dr. rer. nat. Andreas Hornung | Director of Institute Branch Sulzbach-Rosenberg | Phone +49 9661 908-403 | andreas.hornung@umsicht.fraunhofer.de

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.





PRIZES AND AWARDS IN 2017

In the last year, Fraunhofer UMSICHT and its employees received numerous honors and awards for their innovative and technical achievements.

EARTO 2017, European Innovation Award for Leather Tanning

With CLEANATAN®, Fraunhofer UMSICHT has developed an innovative leather tanning process that reduces emissions and lowers production costs. Dr. Manfred Renner was granted one of two innovation awards from EARTO, the European Association for Research and Technology Organisations, at a ceremony in Brussels. With this award, the nonprofit association honors products and services that offer great social or economic benefits for the EU.

Alfred Kärcher Prize 2017

The growing rate of plastic consumption and losses from waste are increasingly associated with pollution from microplastics. In her Master's thesis, Leandra Hamann developed solutions to help reduce wastewater pollution from plastic particles, using biometric filters. The UMSICHT employee was awarded the Alfred Kärcher Prize for her practical solution.

Volterion GmbH is a finalist for the Red Herring Top 100 Europa Award

Volterion GmbH produces and sells small-format redox-flow batteries for decentralized storage. The spin-off from Fraunhofer UMSICHT was chosen as a finalist for the Red Herring Top 100 Europe Award. The media company's prestigious list honors the year's most promising private technology ventures from the European economic region.

Award-winning final theses and projects

Alexander Haase (Bachelor) and Lisa Wunderlich (Master) were recognized by UMSICHT-Förderverein (UMSICHT Friends and Patrons Group) for their final thesis projects. Two young researchers also impressed the group: Victor Katayama and Lukas Kopietz were chosen by the jury to receive awards for their project sketches "LightSavers– Biofeedback-Steuerung für LED-Pflanzenbelichtungssysteme" (LightSavers – Biofeedback Controllers for LED Plant Illumination Systems") and "Selektives Lasersintern von Eisen-Elektroden für Batterieanwendungen" ("Selective Laser Sintering of Iron Electrodes for Battery Applications").

Pioneers at KlimaExpo.NRW:

Award for Commitment to Climate Protection

For years now, Fraunhofer UMSICHT has dedicated its research activities to ensure sustainable energy and raw materials management. As a result, the institute and its spin-off, Volterion, were featured in the statewide KlimaExpo.NRW exhibition as climate protection pioneers.

IHK-Bestenehrung (Top Performance Award) 2017

Benedikt van Kampen, a Fraunhofer UMSICHT employee, is one of the best trainees who completed training as a Technical Product Designer in 2017. He was given an award by the Chamber of Industry and Commerce for Essen, Mülheim an der Ruhr and Oberhausen.

1 Dr. Manfred Renner (r.) at the EARTO Innovation Awards ceremony.

2 Volterion founders Thorsten Seipp, Sascha Berthold, and Thomas Gebauer (l. to r.).



STARTING UP WITH MICRO STEAM TURBINES

Producing electrical power by using steam as a resource in any industrial process – this is the vision of the founders of TURBONIK GmbH – a spin-off of Fraunhofer UMSICHT. A highly efficient micro steam turbine allows economical and ecological power generation especially within the low capacity range. One of the four founders, Managing Director Dr. Björn Bülten explains technical details and how the vision was turned into a company.

What is the advantage of the micro steam turbine in comparison to conventional turbines?

It is up to 40 percent more efficient than conventional steam turbines in its range – with lower maintenance and investment costs. The environmentally friendly water lubrication of the bearings stands out exceptionally. Along with the elimination of a gear drive, the turbine runs completely oil-free. The micro steam turbine is used in steam supply systems and can produce up to 300 kW of electrical power even at small steam flows, which significantly helps companies lower their electricity costs.

When did the idea emerge to start your own company?

I wrote my PhD thesis at UMSICHT on optimizing high-speed steam turbines for organic working fluids. Thanks to various special features of these turbines and my optimization, it was able to achieve very high efficiency levels. Then the idea was to develop a similar turbine for water steam. The market potential was promising, which led to the decision to start our own company. When it came to the next steps, like developing the prototype and the business plan, it was beneficial to have such a good entrepreneurial culture at UMSICHT and a funding by EXIST. My colleagues' experience were also very important.

How have the responsibilities changed since founding TURBONIK on June 9, 2017?

Since November, I have been employed 50 percent at UMSICHT and 50 percent at TURBONIK. After our initial enthusiasm, we also realized that starting a company means a lot of administrative work. Of course, I spend more time now being in contact with customers and working on business development.

What is the status in the establishment of your company?

The prototype is running in test mode at Energieversorgung Oberhausen AG (evo), and is expected to go into regular operation this year. We are currently in exchange with several other potential customers, and the market potential is promising – there are around 10,000 steam boilers in Germany alone. We hope to sell three to five additional turbines in 2018. At UMSICHT, we will be working to develop further applications for these kinds of turbines.

¹ Dr. Björn Bülten and Dr. Johannes Grob are the managing directors of TURBONIK GmbH since June 9, 2017.

CONTACT

Dr.-Ing. Björn Bülten | Group Manager Waste Heat to Power |
Phone +49 208 8598-1375 | bjoern.buelten@umsicht.fraunhofer.de



GOAL: OPTIMIZING THE ENERGY SUPPLY

Annedore Kanngießer studied Environmental Technology & Resource Management at Ruhr University Bochum and started her career at Fraunhofer UMSICHT early on, as a student assistant. After receiving her *Diplom (diploma)*, she completed her doctoral thesis in 2013. For the last five years, she has been the manager of the Energy System Optimization group.

What kind of research does the Energy System Optimization group do?

We look at which energy supply technologies are used in which situations, and how they need to be dimensioned and operated. The desired benefit could be financial, for instance in the sense of maximizing profit for the plant operator. Alternatively, we can also pursue systemic goals, like minimizing CO₂ emissions. We can develop mathematical optimization models and apply them to scenario calculations. In recent years, a particular focus has been on energy storage units and technologies that can flexibly schedule power consumption and/or generation, for instance a combined heat and power plant or a heat pump equipped with thermal storage.

What are some of your current projects?

We are working on a large number of projects, often jointly with our neighboring "Energy Supply Systems" group or in cooperation with other departments in the institute, as well as external partners from the fields of science and practice. One typical project is "FlexKWK," which looks at adding flexibility to a combined heat and power plant with thermal storage and continuous-flow heater in a local heat network. The innovative dimensioning and operation method that we have developed make it possible to provide flexibility for the power system. As the energy transition progresses, this concept will also be economically attractive in the near future.

In another project ("KompEx"), we are supporting the development of an innovative compressed-air storage technology by defining requirements from the application perspective, with consideration for technical, economic, and regulatory aspects. A third example is the "City-as-Storage" ("Die Stadt als Speicher") project. In this project, we completed a one-year field test in the fall of 2017, where various flexible plants in the model region of Herten were combined into a virtual storage system and controlled by our proprietary optimization algorithm.

What goals do you and your team have for 2018?

We want to strengthen our customer focus so we can continue to put our findings from the last few years into practice. In addition, the many models we have developed make us well equipped to address new questions from customers. In addition to energy supply companies and public utilities as our primary customer group, our expertise is useful for any company that is considering using power storage systems and that wants to optimize its benefit in this area.

1 Dr. Annedore Kanngießer, Group Manager
Energy System Optimization

CONTACT

Dr.-Ing. Annedore Kanngießer | Group Manager Energy System Optimization |
Phone +49 208 8598-1373 | annedore.kanngiesser@umsicht.fraunhofer.de



MARKETABLE STORAGE TECHNOLOGIES

Developing innovative storage technologies and concepts is extremely important for a sustainable energy system. The Center for Energy Storage systematically develops the necessary storage technologies and creates technical applications. Samir Binder, deputy director of the Sulzbach-Rosenberg division, coordinates the individual projects.

What role will storage technologies play in the future energy system?

Energy storage systems enable the decoupling of energy supply and use. Electrical energy that cannot be used is stored. It is converted back into electrical power and fed into the grid at times of high demand. Thermal storages are often an important building block for making processes energy-efficient. Chemical storages have the potential to meaningfully link the sectors of power, heat, and mobility.

What is the Center for Energy Storage (CES)?

The Center for Energy Storage, which has been funded by the state of Bavaria since 2012, has locations in Sulzbach-Rosenberg (Fraunhofer UMSICHT) and Straubing (Fraunhofer IGB). It works in the areas of system analysis, chemical energy storage and thermal storage. For the thermal storage, we concentrate on storing waste heat and supplying it again in the temperature range from 60 to 1100 °C. The development of thermochemical storage systems for long-term storage of excess power, in the form of carbon-based oils and solids, is another important focus. Thermo-catalytic reforming (TCR®) was developed in this context and is currently being tested in initial industrial applications.

How close to the market are these developments?

The Center cooperates closely with municipalities and industrial partners so it can explore the economic framework conditions for the storage solutions at an early stage, and can adapt the devel-

opments to create marketable, subsidy-independent solutions. Its partners range from local start-ups to global players like Volkswagen and Siemens. The goal of the R&D activities is to build and operate high-performance pilot plants on a commercial scale. This allows application-relevant investigations and optimization measures as well as an assessment of the economic efficiency of the examined processes – essential requirements for a fast scale-up to the initial decentralized demonstration plants.

What will the CES be working on in the next few years?

Starting in August 2018, a new technical center will be built. Here, the storage concepts are used on an industrial scale and tested under real-life conditions. That includes accounting for increased networking and digitization. The result will be an intelligent overall system where the interactions between energy production, energy storage, and energy consumption can be studied and demonstrated.

1 Samir Binder: graduated aeronautical engineer and the deputy director of Fraunhofer UMSICHT's branch in Sulzbach-Rosenberg.

CONTACT

Dipl.-Ing. Samir Binder | Deputy Director Institute Branch Sulzbach-Rosenberg |
Phone +49 9661 908-402 | samir.binder@umsicht.fraunhofer.de



Foto: Fraunhofer UMSICHT/PR-Fotografie Köhring

1

UTILIZING THE POTENTIAL OF PUBLIC PARTICIPATION

The number of technophiles and people working with technology is growing. For an application-oriented scientific organization like Fraunhofer, this represents significant potential. Jürgen Bertling, the Deputy Head of the Sustainability and Resource Management department and a business developer in the Environment division, involves the public, their opinions and their knowledge in his projects – including e:Lab and +SeniorDesignLab.

Why is it so important to involve the public in research projects?

There are two good reasons to involve the public in scientific projects and strategy processes. First of all, the people who use a technology are the ones who have extensive knowledge about useful and useless functions, desirable and undesirable effects. Thanks to the Internet, they also have extensive opportunities to find information and share their thoughts in social networks. Often they are also stakeholders who may place social and ecological demands on the technology.

Public participation is thus a tool for integrated optimization and for critically reflecting on technology, and an important element in responsible research, development, and innovation. The second reason is strategic. There are many technophile movements (makers, fab labs, biohacking, urban farming, etc.) whose participants spend their free time thinking about 3D printing, drone building, fermentation, new biomaterials, etc. After a playful starting phase, they almost always develop a concrete interest in exploiting the results. That is where Fraunhofer can be a valuable partner, thanks to its competence in making ideas field-ready, developing smart business models, and turning them into start-ups.

Where did the idea of the public e:Lab laboratory come from?

In the e:Lab project, we apply our concept of public participation to the energy transition. If energy production is going to be less centralized in the future, if supply-side management will be replaced by demand-side management, then it makes sense to involve the public to a greater extent.

Our funding sponsor, the innogy foundation, obviously agrees. We are putting it to the test in the areas of living, mobility, and developing a communal citizens' energy council.

The +SeniorDesignLab, on the other hand, focuses specifically on the needs of older people. Please tell us a little more about the objectives of that project.

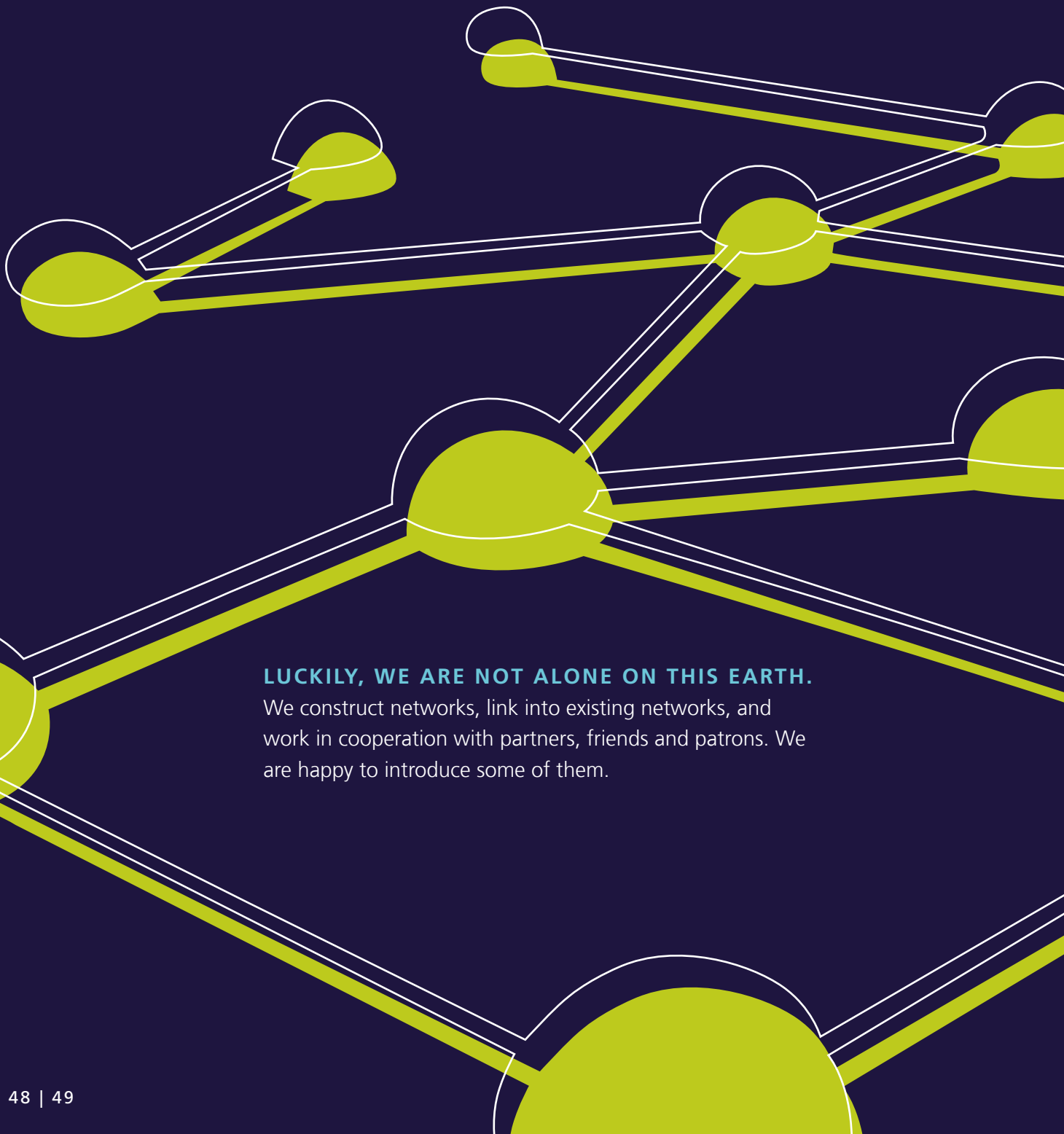
The goal of the +SeniorDesignLab is to develop everyday helpers for self-determined living in old age. And what better way to meet that goal than with solutions developed by seniors themselves and produced using digital manufacturing techniques? In addition to technical solutions, we also want to work with our partners in the areas of trades, design, and science on ways to integrate older people into fab labs in a targeted and fair manner that is also compatible with the local economy.

1 Jürgen Bertling believes it is worth exploring whether collaborative forms of manufacturing, energy production, and agriculture can contribute to sustainable development in the form of vital neighborhoods and livable cities.

CONTACT

Dipl.-Ing. Jürgen Bertling | Business Developer Environment, Deputy Head of Sustainability and Resources Management | Phone +49 208 8598-1168 | juergen.bertling@umsicht.fraunhofer.de

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.



Foto: 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, improve the acceptance of modern technologies, 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 72 institutes and research institutions in Germany,
- has approx. 25,000 employees, primarily with degrees in natural sciences or engineering,
- generates an annual research budget of 3 billion euros, of which nearly 2 billion euros are generated in contract research. About 70 percent of these are derived from contracts with industry and from publicly financed research projects. Around 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 January 2018

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.

MEHR INFOS

<https://www.fraunhofer.de/en/about-fraunhofer.html>

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



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.

CHAIR

Hubert Loick

Chairman of the Board of Trustees

Loick AG, Managing Director

Prof. Dr. Ada Pellert

Deputy Chairwoman of the Board of Trustees

FernUniversität in Hagen, Rector

MEMBERS

Hon. Adv. Prof. (Tsinghua) Dr.-Ing. Reinhold Achatz

thyssenkrupp AG

*Corporate Function Technology, Innovation/Corporate Function
Technology, Innovation & Sustainability*

Burkhard Drescher

Innovation City Management GmbH

Managing Director

Dr.-Ing. habil. Christiane Glasmacher-Remberg

BASF Personal Care and Nutrition GmbH

Head of Research Düsseldorf RCPIOD

Prof. Dr.-Ing. Sabine Grüner-Lempart

Hochschule Weihenstephan-Triesdorf

Senator

Dipl.-Wirt.-Ing. Bernd Homberg

Energieversorgung Oberhausen

Technical Member of the Board

Prof. Dr. Andrea Klug

Ostbayerische Technische Hochschule Amberg-Weiden

President

Dr.-Ing. Lars Kulik

RWE Power AG

Member of the Board, Department Lignite (CTO)

Eckart Lilienthal

Federal Ministry of Education and Research

Department 721 - Policy Issues Sustainability, Climate, Energy

Dipl.-Ing. Carmen Michels

FKuR Kunststoff GmbH

Chief Operating Officer

Daniel Schranz

Stadt Oberhausen

Mayor

Prof. Dr.-Ing. Roland Span

Ruhr-Universität Bochum

Chair of Thermodynamics

Our thanks go to the retired members of the board of trustees, Dr. Thomas Mathenia and Mr. Ernst Gerlach, for their excellent cooperation and support.

¹ *Competent consulting and*

multiplier: UMSICHT Board of Trustees (As of: November 23, 2017).



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

Expert in mine gas utilization and the suctioning off of gas.

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

Catfish Solutions GmbH

Manufacturer-neutral and industry-independent IT consulting company.

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

Datapool Engineering GmbH

Software solutions for process engineering and safety technology.

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

FKuR Kunststoff GmbH

Development and sales & distribution of a broad range of bio-based plastics.

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

Greasoline GmbH

Transformation of old fats into blends of hydrocarbons that 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 residues into high quality plastics.

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

Susteen Technologies GmbH

Conversion of biomass residues through thermo-catalytic reforming into high quality energy sources.

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

Thermallium SPRL, Mons, Belgium

Coating for heat insulation and safety applications.

Foundation: 2016 | info@thermallium.com | www.thermallium.com

Turbonik GmbH

High-efficient and oil-free micro steam turbines for power generation from process steam.

Foundation: 2017 | info@turbonik.de | www.turbonik.de

viteso UG (limited liability)

Service provider for IT solutions with a focus on the development of high quality apps for mobile end devices.

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

Volterion GmbH

Energy storage for private homes.

Foundation: 2015 | info@volterion.com | www.volterion.com

VSM Solar Private Limited

Development, production, installation of solar-powered air conditioners, refrigerators, and walk-in coolers in India, Sri Lanka, Bangladesh.

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

Wagro Systemdichtungen GmbH

Development and production of sealing systems based on substances capable of swelling for civil engineering and pipeline construction.

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

www.wagro-systemdichtungen.de



Foto: shutterbank

RESEARCH AND TEACHING/ INSTITUTIONS OF HIGHER LEARNING

1 Applied research requires close ties with science. During the 2016/17 winter semester, Fraunhofer UMSICHT sent 23 lecturers to 4 universities and 4 universities of applied sciences, and during the 2017 summer semester it sent 16 lecturers to 6 universities and 1 university of applied sciences.

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 universities or universities of applied sciences in the region.

RESEARCH AND TEACHING

Prof. Dr.-Ing. Eckhard Weidner

Manages both Fraunhofer UMSICHT and the Chair of Process Technology 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 Deenberg

Deputy Director of the institute of Fraunhofer UMSICHT, holds the adjunct professorship "Environmental and Process Technology" at the Faculty of Mechanical Engineering of the Ruhr University of Bochum. 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, as Associate Professor 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. In addition, he is Member of the Board of the Research Department »Closed Carbon Cycle Economy« at the Ruhr University of Bochum.



Foto: shutterstock

PAVING THE WAY TO THE DOCTORATE: UMSICHT RESEARCH SCHOOL

The UMSICHT Research School is a supporting offer for doctoral candidates of the institute and was launched in November 2016. The objective is to make doctorates possible within 3 to 4 years and to create uniform framework conditions. Through training plans with individually coordinated continuing education offers, the necessary and helpful competencies for the doctorate and for a career with Fraunhofer UMSICHT are to be acquired.

1 *The UMSICHT Research School helps doctoral candidates to work targetedly on the doctorate.*

SUPERVISION

The supervising professors as well as the supervisors/mentors at the institute agree, in the context of a supervision/mentoring agreement, to regular meetings with the doctoral candidates regarding the progress of the work and adherence to the time and work schedule.

QUALIFICATION

Through doctorate coaching and special continuing education offers tailored to the needs of the doctoral candidates, their competencies are developed further commensurate with requirements. These offers constitute a qualified foundation for the time after the dissertation – at or outside of Fraunhofer UMSICHT. Furthermore, the doctoral candidates are offered colloquia and regular information meetings.

NETWORKING

With an internal website specifically created for the doctoral candidates, Fraunhofer UMSICHT promotes the exchange among them. The networking with the other scientists and employees of the institute as well as with other Fraunhofer Institutes and a variety of external research institutions furthermore supports a broad integration of the doctoral candidates into the national and international science community.

CONTACT

Dipl.-Biol. Volker Knappertsbusch | Coordination UMSICHT Research School | Phone +49 208 8598-1232 | volker.knappertsbusch@umsicht.fraunhofer.de



MORE INFO

www.umsicht.fraunhofer.de/en/jobs-career/promotion.html





infernum
 Interdisziplinäres Fernstudium
 Umweltwissenschaften



1

INTERDISCIPLINARY DISTANCE LEARNING ENVIRONMENTAL SCIENCES

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 2016, infernum additionally received an award from the German UNESCO Commission and from the German Federal Ministry of Education and Research as "Network of the UNESCO World Program of Action for Sustainable Development".

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 "infernum" transmits the knowledge necessary for this purpose and builds fluency in the "languages" of various disciplines. infernum is distinguished by its interdisciplinary curriculum, professional breadth, and organizational flexibility; it is unique in the landscape of German university further education programs.

infernum combines the aspects of economic performance, social responsibility, and ecological compatibility and this way provides the students with a qualified further education in the spirit of an education about sustainable development.

Since 2000, infernum – 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

infernum 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 has taken place within the framework of the joint project "mint.online", which was funded by the BMBF (Federal Ministry of Education and Research) 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 infernum with the specific needs of the students from the working world.

CONTACT

Dipl.-Ing. Anja Gerstenmeier | Head of Department UMSICHT Academy | Phone +49 208 8598-1111 | anja.gerstenmeier@umsicht.fraunhofer.de



Photo: Fraunhofer UMSICHT/Ilika Dimovsek

UMSICHT SCIENCE AWARD



In July, the UMSICHT Friends and Patrons Group endowed the UMSICHT Science Award for 2017. Dr. Michael Saliba received the award in the Science category for his work on perovskite, a solar-cell material. Dr. Till Krause and Klaus Uhrig made a documentary about phytomining, for which they won an award in the category of Journalism. Since 2010, the award has been endowed to people for a comprehensible communication of topics relevant to society in the fields of environment, safety in processing technology and energy.

AWARD WINNER

Science category:

Dr. Michael Saliba

In his project "A Perovskite/Silicon Tandem for a Sustainable Energy Future," Dr. Saliba further developed the cost-effective solar-cell material perovskite by combining it with established silicon solar cells. Inorganic-organic perovskites are a new class of semiconductor that was discovered five years ago for use in solar-cell research. The disadvantage of the previously used perovskites is that they become unstable when exposed to heat and moisture, which quickly reduces their effectiveness. The solar-cell tandem made of silicon and perovskite optimizes the effectiveness. In addition, Dr. Saliba was able to operate a perovskite solar cell at 85 °C for 500 hours, with full illumination and under full load, at 95 percent of its initial performance.

Journalism category:

Dr. Till Krause and Klaus Uhrig

The duo of journalists was recognized for their film "Superplants – Die blühende Revolution" (Superplants – The Blossoming Revolution"). Their documentary, which aired on ARTE, focused on plants that extract heavy metals from the soil as well as their possible applications. One of these is phytomining, which can decontaminate the soil while also providing valuable raw materials. The team's research took them to New Caledonia, Australia, England, France, and Germany, among other places.

UMSICHT FRIENDS AND PATRONS MEMBERSHIP

The "Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik e. V. (UMSICHT Friends and Patrons)" is an essential element of a lively and powerful environment of Fraunhofer UMSICHT.

The members of this group support the institute in the realization of research and development ideas regarding environmental, safety, and energy technology. Furthermore, the group participates in the organization of congresses and seminars, funds promising young scientists and guest scientists, and each year awards the UMSICHT Science Award. **Become a member or a sponsor of the prize yourself, too. Talk to us.**

1 *The award winners in the circle of the supporters of the UMSICHT Science Award 2017.*

CONTACT

Verena Buhle | Administrative Office of the UMSICHT Friends and Patrons Group | Phone +49 208 8598-1152 | verena.buhle@umsicht.fraunhofer.de

BIBLIOGRAPHY

FUNDING INFORMATION

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.

At s.fhg.de/publica-fraunhofer-en, you can find pointers to papers, conference presentations and proceedings as well as research reports, studies, publications of institutes of higher learning, and patents and/or registered designs. Documents available electronically can be retrieved directly from the database in full text.

Information regarding specialized publications is available from our specialized information service:
fachinformation@umsicht.fraunhofer.de

Information regarding industrial property rights is available from our industrial property rights officers:
srb@umsicht.fraunhofer.de

SCHEDULE 2017 AND SERVICES

To find current information regarding our events and trade fairs, please visit our homepage on the Internet at:
www.umsicht.fraunhofer.de/de/messen-veranstaltungen.html
(in German only)

Keep up-to-date and subscribe to our newsletter or register for our press mailing list.
We will be pleased to supply you with the latest news about our work and send you information on our workshops, conferences, and participations in trade fairs. You may unsubscribe at any time. The newsletter is issued not more than four times a year. If you are interested in receiving the most up-to-date news please register for our press mailing list.
www.umsicht.fraunhofer.de/newsletter
www.umsicht.fraunhofer.de/de/presse-medien.html



Foto: shutterstock

FUNDING INFORMATION

Page 12/13

The project "Electricity as a Resource" is financed out of funds from the lighthouse project initiative of the Fraunhofer-Gesellschaft. With this initiative the Fraunhofer-Gesellschaft intends to strengthen the business location Germany by swiftly turning scientifically original ideas into marketable products.

Project duration: 08/2015 – 07/2018

Page 14/15

The project Carbon2Chem® with the funding numbers 03EK3037 to 03EK3043 is funded by the Federal Ministry of Education and Research (BMBF) from 2016 – 2020.

Page 16

The pilot phase of the Fraunhofer High Performance Center DYNAFLEX® as a joint project is financed until 12/2019 out of funds of the Fraunhofer-Gesellschaft and the Federal State of North Rhine-Westfalia with the participation of industrial partners.

Page 34/35

Rooftop greenhouse as a place of urban food production. The project "Altmarktgarten" is funded out of the national program "National Projects of Urban Development" of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

"Altmarktgarten" – System Solutions for Green in the City.

The project "Design and Construction of a Roof-integrated Greenhouse for Sustainable Plant Production and as a Nucleus for Cultural and Innovation Processes in Urban Development" is funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) out of the national program "National Projects of Urban Development".

Project duration: 2016 – 2019

Page 38/39

The project HYBKomp is funded by the Federal Ministry of Economic Affairs and Energy (BMWi) within the framework of the 6th Energy Research Program of the Federal Republic. The project management is supervised by Project Management Jülich (ptj).

Project duration: 09/2017 – 02/2021

Page 40/41

The project "Bioeconomy international 2015: MiDeCO₂ - An Innovative CO₂-Decontamination Technology to Ensure Food Safety of Low Water Activity Food Products" is funded by the Federal Ministry of Education and Research (BMBF) within the framework of the funding initiative "International Co-operations" of the Federal Republic.

Project duration: 01/2017 – 12/2019

BMBF-Project FKZ 031B0107

Page 46

The "Centrum für Energiespeicherung CES" (Center for Energy Storage) is funded by the Bavarian Ministry of Economic Affairs, Energy and Technology (StMWi). The new building of the Center is financed out of funds of the European Fund for Regional Development, the Federal Ministry of Education and Research (BMBF) as well as the Bavarian Ministry of Economic Affairs, Energy and Technology (StMWi).

CONTACT SERVICE

We are looking forward to getting into contact with you! If you have any questions, suggestions, and ideas for projects do not hesitate to contact us. You can reach us in many ways.

HOW TO REACH US

Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT

Osterfelder Strasse 3
46047 Oberhausen
Germany

Phone +49 208 8598-0

Fax +49 208 8598-1290

E-mail info@umsicht.fraunhofer.de

Internet www.umsicht.fraunhofer.de

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



How to reach us (PDF)

Fraunhofer UMSICHT

Institute Branch Sulzbach-Rosenberg

An der Maxhütte 1
92237 Sulzbach-Rosenberg
Germany

Phone +49 9661 908-400

E-mail info-suro@umsicht.fraunhofer.de

Internet www.umsicht-suro.fraunhofer.de

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



How to reach us (PDF)

Fraunhofer UMSICHT

Willich Branch

Siemensring 79
47877 Willich
Germany

Phone +49 2154 9251-0

Fax +49 2154 9251-61



FRAUNHOFER UMSICHT IN THE SOCIAL WEB



Facebook



Google+



LinkedIn

URL INFORMATION

At the time of printing the web presence of the Institute was being revised. As a result it may happen that links mentioned in the report are no longer available.

In this case please use the search function of our homepage.

www.umsicht.fraunhofer.de/en.html

EDITORIAL NOTES

SELF-PUBLISHER AND PUBLISHER

Fraunhofer Institute for Environmental,
Safety, and Energy Technology
UMSICHT
Osterfelder Strasse 3
46047 Oberhausen, Germany

Phone +49 208 8598-0

Fax +49 208 8598-1290

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

E-mail info@umsicht.fraunhofer.de

Fraunhofer UMSICHT is a constituent entity of the Fraunhofer-Gesellschaft, and as such has no separate legal status.

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

Hansastraße 27 c

80686 Munich, Germany

EXECUTIVE BOARD

*Prof. Dr.-Ing. Reimund Neugebauer, President,
Corporate Policy and Research Management*

*Prof. Dr. Georg Rosenfeld, Technology Marketing and
Business Models*

*Prof. Dr. Alexander Kurz, Human Resources,
Legal Affairs and IP Management*

Dipl.-Kfm. Andreas Meuer, Controlling and Digital Business Processes

Register court: Amtsgericht (District Court) Munich

Register No. VR 4461

VAT ID No. DE 129515865

EDITORIAL TEAM

Iris Kumpmann (responsible)

Sebastian Hagedorn M. A.

Stephanie Wehr-Zenz M. A.

presse@umsicht.fraunhofer.de

REPORTING PERIOD

January 1, 2017 – January 1, 2018

EDITORIAL DEADLINE

February 28, 2018

LAYOUT, TYPESETTING, GRAPHICS

Anja Drnovsek

LEGAL NOTICE

Unless otherwise stated, all rights to text, images and depictions remain property of the publisher. Designations used in this report may be trademarks, the use of which by third parties for their own purposes may infringe on the rights of their owners.

TRANSLATION

*LUND Languages Translation Agency (GmbH),
Cologne, Germany*

FRAUNHOFER UMSICHT IN THE SOCIAL WEB

www.facebook.com/UMSICHT

www.linkedin.com/company/fraunhofer-umsicht

www.youtube.com/fraunhoferumsicht

plus.google.com/+fraunhoferumsicht

www.twitter.com/umsicht