Fraunhofer
UMSICHT

FRAUNHOFER INSTITUTE FOR ENVIRONMENTAL, SAFETY, AND ENERGY TECHNOLOGY UMSICHT

30 Years
FRAUNHOFER UMSICHT

ANNUAL REPORT
2019|20

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

SUSTAINABILITY AS A RECURRING THEME

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

TABLE OF CONTENTS

EVERYTHING AT A GLANCE.
On 60 pages, we report on our 2019 projects and the people behind the projects. Of course, possible future developments also play a role here.

PREFACE

Prof. Dr.-Ing. Eckhard Weidner | Director

Prof. Dr.-Ing. Görge Deerberg | Deputy Director

Dear readers,

In 2020, Fraunhofer UMSICHT celebrates its 30th anniversary, as a glance at the cover of our annual report has already revealed. The coronavirus, however, made quite a mess of the original plans for the celebrations. The pandemic was also responsible for the fact that other important topics, which were still the focus of attention at the turn of the year suddenly receded into the background.

Climate change and possible measures to reduce CO_2 emissions were topics that strongly impacted the economy, politics and society in 2019 and shaped the public discourse. Science is working intensively on solutions to these major challenges of our time. Fraunhofer UMSICHT is no exception. Our researchers are involved in numerous projects and initiatives. We have picked a few examples and present them to you in this annual report.

The joint project "Carbon2Chem®", for which we officially inaugurated a new laboratory building on the institute's premises in Oberhausen in March 2019, is concerned with closing carbon cycles. The "IN4climate.NRW" initiative has set itself the goal of shaping the path towards a climate-neutral industry. Together with five other scientific institutes, Fraunhofer UMSICHT forms the scientific competence center under the title "SCI4climate.NRW", which accompanies and drives the work of the initiative from a research perspective. The Fraunhofer Attract group "C1EKAT" of the institute is researching a possible CO_2 reduction by means of electrocatalysis. In the "DigitalFire" project, which is being worked on by employees in Oberhausen and Sulzbach-Rosenberg, digitization and process engineering are combined to optimize combustion in biomass combustion plants and thus keep CO_2 emissions as low as possible.

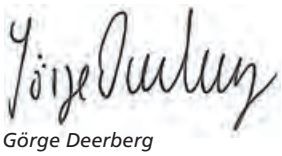
In numerous projects, we are pursuing our mission of being a pioneer of a sustainable change in policy in energy and raw materials, for example in the "HESKH" project (Hybrid Energy Storage Hospital) for the energy optimization of hospitals and in the "SusFireX" project with the development of sustainable and bio-based flame retardants for (bio-based) plastics and leather.

The circular economy and in particular the future of plastics against the background of climate change and resource and environmental protection are of great concern to us. For this reason, the Fraunhofer Cluster of Excellence "Circular Plastics Economy CCPE®" initiated by UMSICHT is researching plastics and their recycling. The joint project "TyreWear-Mapping" is also concerned with plastics, or more precisely tire abrasion, and is investigating its impact on the environment.

Have we made you curious? Then read on and learn more about these and other exciting projects and activities of our institute on the following pages. We hope you enjoy the read.

Cordial greetings

Eckhard Weidner



Görge Deerberg

INSTITUTE

THE BASIC DATA OF FRAUNHOFER UMSICHT.
Profile, Key Performance Indicators, Organizational Structure.

Photo: shutterstock

PIONEER FOR 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 inspire.

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 objective is to replace the so far largely linear economy with a circular economy.

The new "raw materials" of the circular economy are sustainably sourced carbon, renewable energy, and recycled products and materials. This is where Fraunhofer UMSICHT comes in with its strategic projects.

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

2019

Fraunhofer UMSICHT in Figures

39.26 MILLION €
OBERHAUSEN

10.19 MILLION €
SULZBACH-ROSENBERG

49.45 MILLION €
TOTAL BUDGET

29.8% INDUSTRY

60.4% PUBLICLY FUNDED RESEARCH PROJECTS INCL. EU

93 MASTER AND DIPLOMA THESES

10 DOCTORATES

440 OBERHAUSEN

89 SULZBACH-ROSENBERG

529 EMPLOYEES (AS OF 31/12/19)

377 PUBLIC

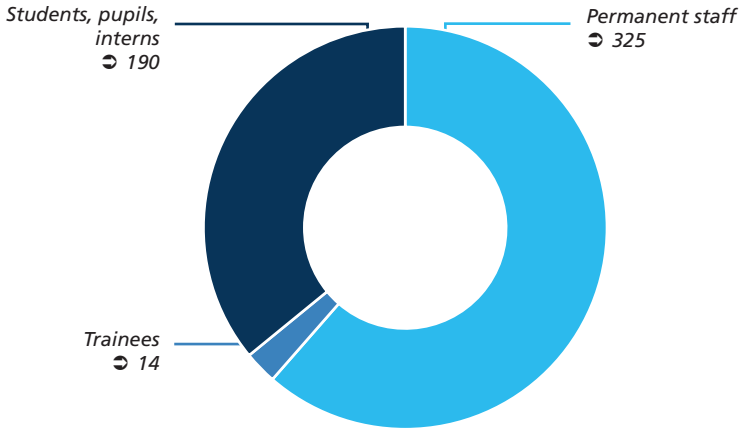
161 BUSINESS

538 PROJECTS

5 INTELLECTUAL PROPERTY RIGHTS FILINGS

STAFFING STATISTICS 2019

	OB	SURO
Permanent staff	263	62
Scientific	199	47
Administrative	64	15
Other staff	177	27
Trainees	12	2
Students, pupils, interns	165	25
Total staff	**440**	**89**



Staffing statistics

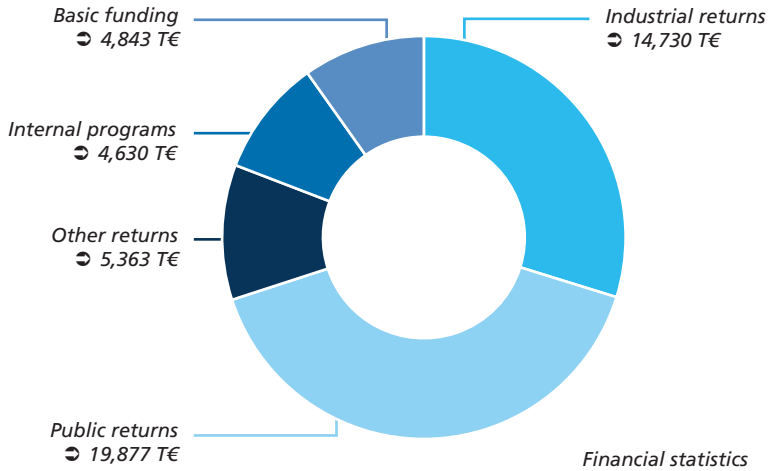
Fiscal year 2019; including all sites.

FINANCIAL STATISTICS 2019

[in thousand euros]

	OB	SURO
Operating budget	35,316	9,890
Other costs	16,764	5,930
Staff costs	18,551	3,960
Investments budget	3,941	295
External project investments	2,820	176
Internal investments	1,121	119
Total returns	**39,257**	**10,185**
Industrial returns	13,115	1,615
Public returns	17,568	2,309
Other returns	1,157	4,206
Internal programs	4,278	352
Basic funding	3,140	1,703

*OBERHAUSEN/SULZBACH-ROSENBERG



Financial statistics

Fiscal year 2019; including all sites.

ORGANIZATIONAL STRUCTURE

As of March 30, 2020

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.

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- Energy Systems Engineering
- Energy Systems
- Electrochemical Energy Storage
- Chemical Energy Storage
- Think Tank

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

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- Material Systems and High Pressure Technology
- Sustainability and Resources Management

INSTITUTE BRANCH SULZBACH-ROSENBERG

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- Energy Technology
- Recycling Management

BUSINESS UNITS

further information see pg. 18

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

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INNOVATION MANAGEMENT AND STRATEGIC PROJECTS

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DIVISION ORGANIZATION

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

STRATEGIC PROJECTS

CARBON2CHEM® – METALLURGICAL GASES AS A RAW MATERIAL FOR THE CHEMICAL INDUSTRY

German industry is constantly reducing its energy requirements and emissions of climate-damaging gases. However, thermodynamic and economic limits are close at hand. For some branches of industry, further reductions in energy demand and gas emissions can only be achieved by completely new production routes or production restrictions.

The joint project "Carbon2Chem®" aims to develop metallurgical gases produced during steel production as a valuable raw material source for the chemical industry. Using renewable energies, unavoidable carbon dioxide emissions from the steel industry are to replace fossil raw materials in the chemical industry. This process coupling is intended be transferable as a blueprint to other high-emission industries, thus further reducing the energy input of the manufacturing industry and significantly lowering the emission of climate-damaging gases.

The road to a climate-friendly industry can only be mastered through cooperation between partners from different sectors. One example of such cross-industry cooperation is the unique alliance between the steel industry, energy sector and chemical industry in the "Carbon2Chem®" project. Under the joint coordination of Fraunhofer UMSICHT, thyssenkrupp AG and the Max Planck Institute for Chemical Energy Conversion (MPI CEC), solutions are being developed in the project to convert the process gases from steel production into basic chemical substances. The focus is on carbon, which is still released in large quantities as carbon dioxide today.

Technological building blocks
Chemical synthesis technologies (e.g. catalysis) are needed to clean, condition and convert the gas into marketable chemical products or fuels. Providing such technologies and integrating them into the context of steel mills is therefore one of the main challenges. The search is not for the one big solution, but for an approach with flexibly linkable technology modules.

The consortium in the "Carbon2Chem®" project comprises 17 partners from science and industry. The interdisciplinary team combines the competencies from the respective fields of work in six subprojects – each has a clear content and technical focus on promising technologies that can be integrated into future integrated production with a steel mill.

Simulation of the overall system
A central element is the simulation of the planned overall system in order to plan and dimension essential aspects of product selection, the process logistics and process control. At the same time, the simulation allows essential conclusions to be drawn for the work in the subprojects. Based on the simulation results, both the economic efficiency and the sustainability of the overall system are evaluated.

Hydrogen production
One of the main questions of the project is how the necessary hydrogen can be provided for the chemical processes. The focus is on the production of hydrogen by water electrolysis using volatile renewable energies. In order to ensure the long-term performance of electrolysis under dynamic conditions, a larger plant is operated in the technical shop and several small test rigs are operated in the laboratory.

Technologies for gas treatment and synthesis
The processing of the metallurgical gases is of central impor-

JOINT PROJECT

Carbon2Chem®

KEEPING CARBON IN THE LOOP

tance for "Carbon2Chem®". A subproject is therefore working on process concepts that are tailored to the selected synthesis routes and that enable the provision of a synthesis gas of the quality required for chemical production under dynamic boundary conditions. Within this framework, Fraunhofer UMSICHT is developing and testing technologies and system solutions for gas purification and for the catalytic production of methanol and higher alcohols – each adapted to the use of processed metallurgical gases.

Technical infrastructure

A central infrastructure exists to support joint research and development. In the project laboratory, which is operated by Fraunhofer UMSICHT in cooperation with MPI CEC in Oberhausen, catalyst behavior is investigated using synthetic metallurgical gases. To validate the laboratory results with real steel mill gases, thyssenkrupp AG has built a pilot plant for "Carbon2Chem®" near the steel mill in Duisburg. Here it is demonstrated how the chemical processes react to real gas compositions under industrial conditions in a cross-industry network.

Methanol pilot plant

Methanol can be used in many ways as a basic chemical or synthetic fuel and is produced based on carbon monoxide, carbon dioxide and hydrogen. At present, the carbon required comes mainly from fossil sources such as natural gas. In the case of the "Carbon2Chem®" project however, the basis is metallurgical gas. What has already been achieved on a laboratory scale is now being prepared for large-scale implementation: A pilot plant for methanol production has been in operation in Oberhausen since July 2019. The design features correspond to those of a large-scale plant, and the production capacity alone is lower at up to 75 liters of raw methanol (mixture of methanol and water) per day. At the end of the technical conversions and the test series with pure gases, the plant will be moved from Oberhausen to the "Carbon2Chem®" pilot plant in Duisburg. Here the plant will have direct access to real metallurgical gases, so that tests can be carried out under industrial conditions.

The results of the first two years of "Carbon2Chem®"
Published by Wiley-VCH, Chem. Ing. Tech. 2018, 90, No. 10: Carbon2Chem®
Order free of charge: *s.fhg.de/X2A*

More info: *www.umsicht.fraunhofer.de/carbon-cycle*

1 ***The 500 square meter Carbon2Chem® laboratory at Fraunhofer UMSICHT in Oberhausen.***

SPONSORED BY THE
Federal Ministry of Education and Research

Carbon2Chem®

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Photo: shutterstock/Composing: Fraunhofer UMSICHT

Fraunhofer Clusters of Excellence combine the competencies of institutes to investigate relevant topics with scientific excellence. The aim is to establish virtual institutes with international visibility.

FRAUNHOFER CLUSTER OF EXCELLENCE "CIRCULAR PLASTICS ECONOMY CCPE®"

Shaping the change from a linear to a circular plastics economy together – with this goal five Fraunhofer Institutes have been working together in the "Circular Plastics Economy CCPE®" cluster since the end of 2018. Under the leadership of Fraunhofer UMSICHT, they are researching technical and social innovations for the sustainable transformation of the entire plastics value chain. The first scientific results were achieved in 2019 – starting with self-reinforced polymers, e.g. from polylactic acid (PLA) and bio-based additives, a test rig for environmental degradation tests and solutions for material and chemical recycling on a demonstration scale.

Strong visibility in industry and politics

"CCPE® has achieved considerable success in its first year," Dr.-Ing. Hartmut Pflaum, head of the cluster's office, is pleased to report. "In addition to the scientific results, we have also achieved a high visibility in the outside world." One of the highlights, for example, was the participation in the K plastics trade fair, where almost 200 new contacts were made and bound to the cluster. Furthermore, Prof. Eckhard Weidner, head of the cluster and director of Fraunhofer UMSICHT, presented the work on the circular plastics industry at the climate congress of the CDU in Berlin.

Guarantee of success: The team behind CCPE®

An important guarantee of these successes: The team behind CCPE®. "The cluster pursues a common strategic research agenda with a matching virtual structure that is supported by all the people in the cluster," explains Hartmut Pflaum. "The team of about 60 employees has grown together very well and works together across the boundaries of the participating Fraunhofer Institutes – IAP, ICT, IML, LBF and UMSICHT – in an interdisciplinary way." The framework for this cooperation is formed by three areas or divisions: In the "Materials" division, plastics are created from a sustainable mix of resources. The "Systems" division develops processes – including digitally mapped processes – that lead to optimal value-added cycles. The "Business" division offers integrated system services for plastics in the recycling industry – for example, a circular child car seat, an assessment using Circular Readiness Level® and an innovation radar for new business models.

Orders from the industry

An ecosystem which currently consists of around 50 companies, associations and public institutions, provides the link to practice. The first industrial orders were received in 2019: Together with a leading manufacturer of tailor-made high-performance additives for engineering plastics, L. Brüggemann GmbH & Co KG, Fraunhofer LBF is developing new stabilizer systems for recycled plastics. They are intended to improve the properties of polyolefin recyclates, especially those made of polypropylene and polyethylene, and are groundbreaking in using the potential of these plastics longer and more efficiently.

Hartmut Pflaum expects further industrial cooperations in 2020. Then, Fraunhofer IVV will additionally support the cluster – in the areas of packaging, approval procedures, and recycling.

More info: s.fhg.de/A8i, www.ccpe.fraunhofer.de

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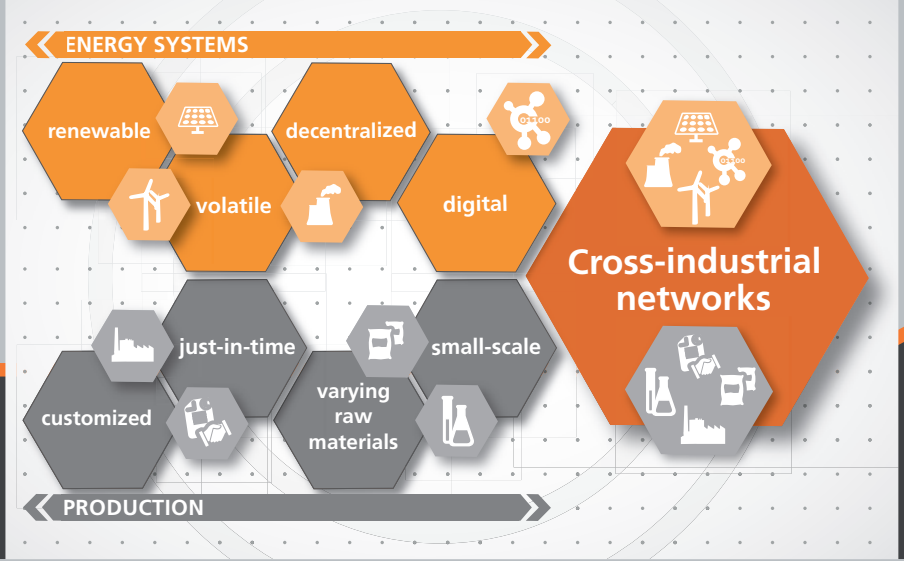

DYNAFLEX®

PERFORMANCE CENTER DYNAFLEX®
STRENGHTENING MUNICIPAL INDUSTRIAL REGIONS

Energy system transformation is a mainstay of structural change and requires rethinking in many areas. Current business activities and corporate strategies are therefore increasingly focusing on technologies to increase efficiency and avoid CO_2 emissions. However, the limits of what is technically feasible have already been reached in the optimization of many processes in companies. In order for successful economic ecosystems to continue to grow in an increasingly dynamic and volatile environment, coordinated, adaptable solutions at the interface of energy and materials management are necessary.

Cross-industrial networks

Sustainable and environmentally friendly value creation primarily means a change for those involved, but also serves as a clear competitive advantage. In order to position affected companies well in competition and to reduce their challenges, experts see the future in the joint action of the players in regional cross-industry networks. "In future, value chains will have to go beyond previous sector and industry boundaries. Why not jointly utilize local material and energy flows in the best possible way on site? This can create decisive advantages through regional synergies," explains Dr.-Ing. Georg Janicki, head of the office of the Performance Center DYNAFLEX®. DYNAFLEX® particularly supports medium-sized companies and start-ups by bundling expertise in the Wissensmetropole Ruhr (Knowledge Metropolis) and implementing it in application and demonstration projects. The Performance Center is coordinated by Fraunhofer UMSICHT and plans sustainable interface projects for the energy and basic materials industries in close cooperation with scientific partners from the universities of the University Alliance Ruhr and companies.

Such a project is being implemented, for example, in an industrial estate in Bad Langensalza, where a network with numerous players is being implemented based on renewable energies and sustainable raw materials. With the support of Fraunhofer UMSICHT, the partners want to build a ground-mounted photovoltaic plant in a joint project. The electricity produced will be fed into the power grid or used with innovative Power-to-X concepts – via the production of hydrogen – to manufacture basic products for the chemical, plastics, fertilizer or fuel industry. The concepts contribute to grid stability and enable the establishment of a new sustainable technology cluster and new value chains of neighboring companies. In addition, they favor the settlement of companies in the region. The project plays a pioneering role in the implementation of climate-friendly and cross-sectoral technologies.

Creating long-term structures

Following the positive evaluation in 2019 and the successful completion of the pilot phase of DYNAFLEX®, the second phase will be launched in 2020 with application and research projects on energy system transformation and cross-industry networks. In addition to intensive cooperation with industry, the transfer of knowledge in teaching and training is an important aspect in order to introduce specialist personnel to innovative technologies as early as possible. The aim from 2021 is to transform the Performance Center into a permanent structure.

More information: *www.dynaflex.de, s.fhg.de/fLw*

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Photo: IN4climate.NRW

IN4CLIMATE.NRW/SCI4CLIMATE.NRW TOGETHER FOR A CLIMATE-NEUTRAL INDUSTRY IN NORTH RHINE-WESTPHALIA

The Paris Climate Change Convention of 2015 sets out clear goals to counteract climate change and provides a guideline for the future development of industry and business. In order to achieve the climate protection goals, immense efforts are required, which must be tackled as quickly as possible. The structure for a sustainable world must be created in which it is possible to operate both climate-neutrally and competitively. IN4climate.NRW, a platform unique in Germany where industry, science, and politics work together, makes an important contribution to this. The initiative is supported by the scientific competence center SCI4climate.NRW, which is made up of six leading scientific institutes (including Fraunhofer UMSICHT). The overriding goal is to show ways towards a climate-neutral basic materials industry in 2050 – while maintaining economic efficiency and competitiveness.

Ensuring competitiveness

North Rhine-Westphalia is the industrial core region of Germany. In 2018, over 10,000 industrial companies generated annual sales of 358 billion euros. However, these companies are also responsible for a good 19 percent of the state's greenhouse gas emissions. In order to ensure competitiveness and at the same time operate in a climate-neutral manner, fundamentally new production processes and production methods are required.

IN4climate.NRW designs cross-sector solutions and creates synergies between individual sectors. For this purpose, different technologies which contribute to achieving the set goals are identified, evaluated and linked. Necessary infrastructure requirements are considered: Among other things, the focus is on gas networks (initially for hydrogen) and on the associated components such as storage technologies or renewable energy systems. Parallel to these system challenges, IN4climate.NRW addresses necessary adjustments to the political and legal framework conditions as well as social aspects.

Scientific Competence Center: SCI4climate.NRW

The concrete topics relevant for the basic-material-producing industry are discussed in a dialogue between IN4climate.NRW and the scientific competence center SCI4climate.NRW. The work is carried out within the framework of SCI4climate.NRW, which brings together the following research institutions:

Wuppertal Institute | Fraunhofer UMSICHT | RWTH Aachen | German Economic Institute | Verein Deutscher Zementwerke | VDEh-Betriebsforschungsinstitut

SCI4climate.NRW currently deals with the topics hydrogen, carbon dioxide economy, circular economy with a focus on polymers, political framework conditions as well as narratives and communication. In the future, heat (low-temperature and high-temperature heat, process heat, waste heat utilization, system concepts such as power-to-heat (-to-power) etc.) will also be considered.

More Info: *www.in4climate.nrw, s.fhg.de/6iB*

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1

C1EKAT – CO_2 REDUCTION BY ELECTROCATALYSIS

Whether cement plant, technology group or chemical factory – many companies in large-scale industry are faced with the question of how to reduce their CO_2 emissions. One answer is electrocatalysis. With its help, the supposed waste product can be converted into a valuable chemical.

The crux of the matter: Many catalysts consist of cost-intensive precious metals or materials that are sensitive to catalyst poisons such as sulfur. This is where the Attract group "C1EKAT – CO_2 reduction by electrocatalysis" comes in. Scientists from the Ruhr-University Bochum and Fraunhofer UMSICHT, under the direction of Prof. Dr. Ulf-Peter Apfel, have been working on a more efficient conversion of CO_2 since March 2018.

The focus is on new materials that are both inexpensive and robust. Currently, the team is working with catalysts containing iron and nickel sulfide, for example. "We have started to produce gas diffusion electrodes from these materials," explains Ulf-Peter Apfel. "They allow us to suppress the generation of hydrogen and thereby simultaneously favor the reduction of CO_2." In concrete terms, this means that, depending on the electrode design, there is a better reaction with the carbon dioxide, while water is kept away from the electrode. This simplifies the process and saves energy.

However, whether higher alcohols, fats, ethane or other chemicals are then present at the end of the conversion depends not only on the catalyst. How are the reactor and the electrode constructed? What are the flow conditions like? And how are supply and discharge of the gases handled? All these factors play an important role in the reduction process. The Attract group develops the right answers to these questions both based on basic research and with the help of trial and error.

"Both go hand in hand in our work," says Ulf-Peter Apfel. "Often it's the little things that lead to different results, and we have to puzzle together what it was and what we can learn from it."

The Attract group is ideally positioned for this type of approach: It can simultaneously draw on the work and results of the university and on the expertise and equipment of Fraunhofer UMSICHT. This division is an integral part of Attract: Fraunhofer's internal funding program offers outstanding external scientists the opportunity to advance their ideas towards application within an optimally equipped Fraunhofer Institute close to the market.

The duration of "C1EKAT – CO_2 reduction by electrocatalysis" is five years. The intention is to have a laboratory demonstrator ready at the end of the project. However, the team has already set itself this goal for the coming year. "It's sporty, but possible," says Ulf-Peter Apfel. "In the final stage, we are aiming for the industrialization of our development. It remains to be seen whether this will really happen."

1 *Kai junge Puring, Dr. Stefan Piontek and Mathias Smialkowski (from left) from the team of Prof. Dr. Ulf-Peter Apfel with electrolysis cell in which the experiments were carried out.*

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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

E – ENVIRONMENT

- Circular economy, ecodesign, and recycling
- Life cycle analyses
- Water, wastewater
- Urban farming
- Citizen science, co-creation

B – BIOMASS

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

E – ENERGY

- Decentralized energy production and energy use
- Sustainable neighborhoods
- Energy storage/conversion
- Cross-sectoral energy systems
- Sustainable energy materials

BUSINESS UNIT
POLYMER MATERIALS

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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 recyclate-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

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

MARKETS AND INDUSTRIES

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

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Photo: Fraunhofer LBF

BIO-BASED FLAME RETARDANTS FOR (BIO-BASED) PLASTICS AND LEATHER

1 *Starting point for the development of environmentally friendly flame retardants were bio-based platform chemicals that were brought to react with different phosphorus compounds according to the modular principle.*

The flame retardants available on the market in plastic or leather products are highly effective and prevent or slow down the ignition of flammable materials. However, their environmental and health balance is rather critical. In the "SusFireX" project, Fraunhofer UMSICHT and the Fraunhofer Institute for Structural Durability and System Reliability LBF have developed new bio-based phosphorus-based flame retardants with high technical performance and an improved environmental balance.

Flame retardants (FRs) are used to delay the ignition of flammable materials and to slow down or completely prevent the spread of flames. Especially due to the increasing use of highly flammable plastics in buildings, vehicles or electrical appliances, they are often lifesavers. Modern flame retardants are characterized by their outstanding effectiveness. In addition to their chemical-technical properties for fire prevention, however, innovative flame retardants should also be produced in a sustainable manner. This is however not yet the case with many flame retardants available on the market, some of which also have a high toxicity and persistence. There is a technology gap here, which Fraunhofer UMSICHT and Fraunhofer LBF have closed in the WISA project "SusFireX" (WISA = Fraunhofer internal business-oriented strategic alliance).

Result: Halogen-free phosphorus-based bio flame retardant

Flame retardant additives are intended to inhibit or in the best case even prevent the combustion process in the solid, liquid or gas phase. To develop their flame-retardant effect, flame retardants intervene at various points in the combustion process, for example during decomposition, ignition or flame propagation. The flame-retardant effect is based on different mechanisms depending on the substance. Two major challenges in the development of more environmentally friendly flame retardants were the transferability of classical FR synthesis routes to bio-based starting materials and the production of bio-FRs at competitive prices.

The Fraunhofer researchers jointly developed an innovative halogen-free bioflame retardant with a high phosphorus content based on renewable platform chemicals. It has the same technical performance as conventional flame retardants available on the market, but has an improved environmental balance and can be produced in an efficient multistage one-pot synthesis. In initial application tests, it has been shown that bio-FRs can be used in various engineering plastics, bio-based plastics, and leather.

Environment, methods: Variation of synthesis routes by means of modular design

The starting point were bio-based platform chemicals that were reacted with different phosphorus compounds according to the modular principle. The aim was to develop syntheses that were as energy and atomically efficient as possible and effective synergistic formulations. By varying the synthesis routes as well as the functional groups, gas- and solid-phase active flame retardants can be combined in one molecule in adjustable proportions.

At Fraunhofer LBF, the syntheses were developed in laboratory flasks and then transferred to the kilogram scale. The properties of the flame retardants could be specifically adapted to the respective application by varying the building blocks.

SUSTAINABLE

Flame retardants are found in almost every technical product, e.g. in computers, vehicles and building materials. As additives, FRs are systemically relevant to many industries and market segments, both technologically and economically. However, conventional flame retardants are often characterized by low environmental compatibility and considerable human toxicity. Both the inhalation of the smoke gases produced by the FRs during a fire and their accumulation, e.g. in house dust, blood serum or breast milk, are hazardous to health. Environmentally friendly alternatives are therefore urgently needed. The halogen-free phosphorus-based flame retardant developed in the "SusFireX" project is an environmentally friendly solution for various applications in the plastics and leather sector.

Fraunhofer UMSICHT tested the flame retardants produced at Fraunhofer LBF in bio-based plastics such as PLA, PHBH (poly(3-hydroxybutyrate-co-3-hydroxyvalerate)) and cellulose acetate. In terms of processability, the new flame retardants in PLA do not differ from commercially available non-bio-based flame retardant additives. In synergistic formulation, even small amounts of the innovative FR combinations are sufficient to achieve an efficient flame retardant effect.

The greenhouse gas balance of the flame retardant formulations in PLA could be improved, as only a very low total concentration of flame retardant is required due to the synergistic mixing. In addition, the reduced flame retardant content has less effect on the material-typical properties of PLA.

Customer benefit: More environmentally friendly FRs for electronics, construction and transport sector

The market segment for halogen-free flame retardants is growing steadily due to stricter environmental and health regulations. In addition to the effectiveness of flame retardants, their environmental compatibility is increasingly being demanded. Thanks to the expertise of the two institutes in the fields of plastics processing, synthesis development, scale-up and sustainability management, the company is able to offer a wide range of products and services. In the course of the evaluation, a joint solution for sustainable FRs was found, the application of which was successfully demonstrated for some engineering plastics as well as (bio-based) plastics and leather. The flame retardant systems can be used in the electronics, construction, and transport sectors, among others.

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BUSINESS UNIT
CHEMISTRY

Photo: shutterstock

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 including 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

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1

RECYCLING INDUSTRIAL COFFEE GROUNDS

1 *Within the framework of the project "InKa – Intermediate from industrial coffee grounds", a high-quality recycling concept is being developed in which waste is turned into a valuable material.*

In the household, things are simple: Coffee grounds end up in compost or are used as a facial scrub. In industry and gastronomy, things are different: When coffee beans are processed into extract coffee, a moist residue is produced. Up to now, this has been used as fuel for energy generation or disposed of. Fraunhofer UMSICHT is on the trail of new ways of utilizing this coffee residue – for example in the plastics and paper industries.

Objective: To replace raw materials that are scarce

In the project "InKa – Intermediates from industrial coffee grounds", scientists are working on an industry-oriented approach to produce high-quality intermediates from commercially produced coffee grounds. They are intended to replace other, less available raw materials and contribute to improving the properties of the respective end products.

Result: Coffee grounds become products for the plastics and paper industry

Coffee grounds can be separated into coffee oil and deoiled coffee grounds. The **oil** is not suitable for consumption, but can be converted into chemical intermediates. The researchers are investigating whether the intermediates are suitable for optimizing polymers. These polymer additives can be used as plasticizers or modifiers of the impact strength of bio-based plastics.

The **deoiled coffee grounds** are considered an alternative raw material for the paper and cardboard industry. After sufficient comminution, it can be incorporated into fibrous materials, for example. Coffee grounds can also be used to produce other secondary valuable substances – including glycerin, polysaccharides, flavorings, and various minerals such as potassium. Short-chain fatty acids – especially alkyl palmitate – are a by-product with known industrial applications. It is used for example as biofuel, raw material for surfactants or in the chemical industry.

Environment, methods: Primary refining via two routes

The core topic of the project is **primary refining** – in other words, the question of what an efficient process for separating valuable fractions from the coffee grounds could look like. The scientists are investigating two routes. In "Route A", extraction produces deoiled coffee grounds as the first intermediate product. The coffee oil is transesterified with an alcohol and then separated. The result is a fraction of largely saturated fatty acid alkyl esters and a fraction with a high C18:2-alkyl ester content. The latter is catalytically modified to an intermediate that is further processed as a monomer.

"Route B" provides for a process-intensified process step. This means that the triglyceride components are directly derivatized to alkyl esters already in the coffee grounds. Subsequently, the intermediates and secondary materials already mentioned under "Route A" are obtained in a multistage separation process.

The **secondary refining** process that follows the primary refining process is to be reproduced in the project framework by means of laboratory tests. The objective is to prepare the technical application of the produced intermediates for the optimization of polymers and to validate the feasibility. With regard to the deoiled coffee grounds, the secondary refining process will investigate and validate the processing of deoiled coffee grounds as an alternative raw material for the paper and cardboard industry. Deoiling already prepares the coffee grounds for paper production in aqueous media.

Customer benefit: From waste product to recyclable material

The use of industrially produced coffee grounds in Germany is currently limited to recycling in energy processes. Composting is associated with specific technical requirements and the release of residual components. Composting can hardly be regarded as an adequate use of a large volume of recyclable residual material. Even approaches for high-quality recycling concepts such as the extraction of bioactive substances for food, cosmetics and pharmaceuticals have not yet been implemented on an industrial scale.

The development of an industry-oriented, technologically high-quality approach to the use of commercially produced coffee grounds – as aimed for in the "InKa" project – on the other hand offers industry and the catering trade the opportunity to define a common waste product as a valuable material for the plastics and paper industry.

SUSTAINABLE

After oil, coffee is the second most important commodity in the world. However, as its commercial importance grows, so does the waste generated by industry and the catering trade. Worldwide, six million tonnes of coffee grounds are produced each year, with one million in the EU. The "InKa – Intermediate from industrial coffee grounds" project is developing a high-quality recycling concept that turns waste into a valuable material.

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BUSINESS UNIT
ENVIRONMENT

Photo: shutterstock

SERVICE PORTFOLIO

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

RESEARCH AND DEVELOPMENT SERVICES

- Sustainability and resource strategies for business and politics
- 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
- 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
- Economic feasibility studies for processes, methods, and products
- Preparation of eco-assessments and sustainability assessments in accordance with DIN EN ISO 14040/14044 for products, processes and services
- Customer-tailored safety and hazardous material management software
- Analytics services with problem-oriented assessment and action recommendations
- Stakeholder and dialog processes

MARKETS AND INDUSTRIES

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

CONTACT

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1

HOW DOES THE TIRE WEAR AFFECT THE ENVIRONMENT?

1 *The "TyreWearMapping" project runs from November 2017 to April 2020.*

2 *Tire abrasion has been shown to be a contributory cause of fine dust pollution in cities and a source of microplastics.*

3 *The researchers are developing measures to minimize the impact of tire abrasion on the environment in future.*

Over time, car tires lose substance and release abrasion in the form of tiny particles and fine dust. Concrete data on release, distribution and dispersion in air, soil and water are not yet available. In order to be able to use this knowledge to close gaps, Fraunhofer UMSICHT and industrial partners are investigating the influence of tire abrasion throughout Germany in the "TyreWearMapping" project.

At the end of its average service life of 50,000 km or four years, a common passenger car tire weighs a good 1 to 1.5 kg less than at the beginning. With almost 46 million registered passenger cars in Germany, tire wear adds up to around 113,000 tonnes per year, based on an average annual mileage of around 13,000 km. In addition, there is tire wear caused by other road users such as trucks, trailers, buses, tractors, construction vehicles, motorcycles and bicycles – another 50,000 tonnes. From the road the particles get into the air, soil and water. In the "TyreWearMapping" project, extensive data on the emission and spread of tire abrasion are being collected and evaluated.

Objective: To reduce the environmental impact of tire wear

The joint project initially aims to close the gaps in our knowledge of the environmental effects of tire abrasion and to produce maps of the distribution of tire abrasion in Germany. For this purpose, the researchers are using mobility, geo and weather data from the Federal Ministry of Transport and Digital Infrastructure (BMVI). In addition to the atmospheric dispersion of tire wear, the catchment areas of two rivers are examined as examples: the Wupper in North Rhine-Westphalia and the Panke, a tributary of the Spree, in Berlin. Finally, calculation models and tools will be developed with which measures to reduce the environmental impact of tire abrasion can be planned in a targeted manner.

Result: Digital planning and decision tool

First, the factual data on traffic, origin of tire wear etc. is combined with GIS data. To quantify and analyze the distribution and dispersion of the particles, the researchers develop GIS-based maps using novel calculation models. The project results will finally be implemented in a digital planning and decision tool, which will allow actors to plan transport infrastructures and required treatment capacities for road runoff, for example.

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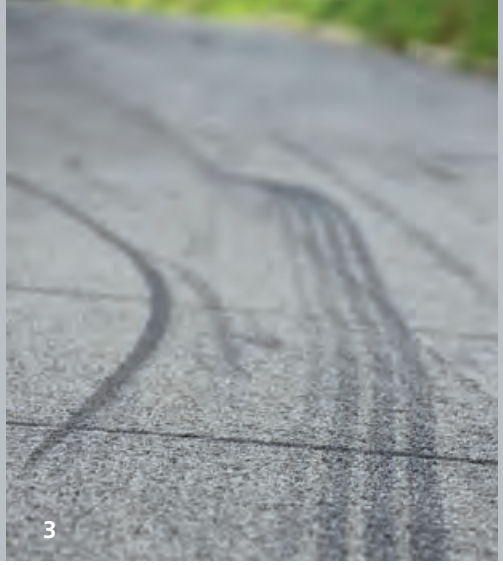

3

Environment, methods: All influencing factors in the matrix

Various methods are used to model the release, distribution and propagation of tire abrasion: In addition to probabilistic modelling, a new approach based on neural networks for atmospheric dispersion is used. The data allow conclusions to be drawn, for example, as to where (highway vs. city center) and under what conditions (weather) tire abrasion occurs particularly frequently. The modelling assumes a certain amount of tire wear for Germany, which is distributed along the traffic routes according to a distribution function. Different traffic situations are considered; within these, there are further influencing factors such as the radius of curvature of the road, gradients and vehicle speed.

Vehicle resistance, acceleration and deceleration, cornering and gradients are major factors influencing the formation and release of tire abrasion. The aim of the model is to consider as many influencing factors as possible in order to obtain a high-resolution image of the distribution of tire abrasion in Germany and to improve local predictions.

SUSTAINABLE

Tire abrasion has been shown to be a contributory cause of fine dust pollution in cities and is currently the largest known source of microplastics in the environment. In the project "TyreWear-Mapping" an initial data basis has been created that allows the influence of tire abrasion on water, soil and air to be precisely quantified. With the help of the developed planning tool, the researchers provide decision-makers in transport infrastructure planning with a means of minimizing the environmental impact of tire wear.

Customer benefit: Environmentally friendly planning of transport networks

The digital planning and decision tool is designed to be user-friendly. Using the integrated models, the dispersion of tire abrasion particles in water and in the air can be calculated. The knowledge of tire abrasion hotspots can be used, for example, to take targeted regulatory measures such as filter systems at road runoffs and construction measures or to control traffic in a targeted manner. Every user is also involved in the development – the tool is to be continuously developed with the participation of external stakeholders.

Project partners

- iMA Richter & Röckle GmbH & Co. KG
- Engineering company Prof. Dr. Sieker mbH

Associated partner

- Wupperverband

CONTACT

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BUSINESS UNIT **BIOMASS**

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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

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DIGITIZATION OF BIOMASS FURNACES

1 *The possibilities of digization can also be used for older combustion systems such as the Mawera FSR440.*
2 *Low fuel qualities can also be operated efficiently.*

Up to now, the operating and plant parameters for controlling biomass combustion systems have mostly been manually adapted to the fuel. This is costly and requires long experience. With digital process monitoring and control, operation can be made much more efficient and economical. Fraunhofer UMSICHT considers the entire process chain of biomass furnaces, optimizes it, and tests newly developed modules in real operation.

Objective: Use of low fuel qualities at a constant output

In Germany, there are about 900,000 biomass boiler plants and about 700 biomass cogeneration plants. For a more economical operation, these plants can also be enabled to process fuels of lower quality including biogenic residues. Most systems are basically capable of this, but manual adjustment of the parameters is complex and requires a lot of experience. Errors in setting the firing system lead to higher emissions and in the worst case to higher wear and tear, with maintenance consequences and downtimes. This is where digital technology comes into play: If it is possible to run a greater variety of different fuel qualities with optimum combustion by using advanced components in the control and regulation technology, economic benefits are quickly realized.

Result: Automated setting of optimum firing parameters

In a test furnace, researchers from Fraunhofer UMSICHT first install various sensors, cameras and data acquisition systems. The data obtained – e.g. on calorific value, fuel composition and quality, grate temperature and plant condition – are collected and evaluated. Machine learning methods or artificial neural networks are used here. They create the basis for the automated adjustment of the optimum firing parameters. In addition, the sensor data can be used to display the actual state of the plant at any time; the operator can be warned in case of critical plant states. A user-friendly frontend will make all information on the plant available at any time and from any location – for example via mobile devices.

Environment, methods: Promptly into the profit zone

Continuous digital process monitoring and control of the firing system has so far only been used in large biomass cogeneration plants or waste incineration plants. One of the reasons are the high technology costs. However, the prices for electro-technical components, sensor technology and software solutions are falling. Within the framework of the "DigitalFire" project, researchers at Fraunhofer UMSICHT are evaluating hardware available on the market (sensors, measuring components, camera systems) on the one hand, and open source software solutions

2

and AI libraries on the other. These are used, for example, in optical image recognition. In the next step, the application in biomass furnaces as well as possible modifications are examined. The goal: Operators should be able to achieve economic profitability as soon as possible after investing in new plant components.

Customer benefits: Digital process monitoring also for smaller output classes

The "DigitalFire" project makes continuous digital process monitoring available for the first time for firing systems in smaller output classes (boiler plants or smaller biomass power plants from 100 kW to 20 MW thermal output). On the one hand, a higher range of fuels is available due to digitized control. On the other hand, environmental pollution is reduced to a minimum due to optimized clean combustion.

SUSTAINABLE

Through innovative modules for data acquisition and a machine-learning approach, greater fuel flexibility is achieved, which specifically promotes the use of biogenic residues. This contributes to an efficient and environmentally friendly use of resources, including the avoidance of greenhouse gases and consequently the conservation of natural resources. The development and integration of new technologies along the process chain and the associated strengthening of the bioenergy sector will improve the availability and efficiency of biomass combustion plants and reduce emissions. In addition, the competitiveness of the domestic economy is strengthened and jobs are secured and created, especially in rural areas. The systems' ability to learn and the better adaptability of the plants contribute to the low-emission use of biomass in the heating sector.

Cross-location collaboration

BFAutomation GmbH & Co KG is accompanying the project as a partner. It supports the researchers in the development and integration of new modules. The IT specialists of the Fraunhofer UMSICHT locations in Oberhausen and Sulzbach-Rosenberg work hand in hand to set up and link the server infrastructure, data evaluation, and application development.

More Info: s.fhg.de/98J

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BUSINESS UNIT
ENERGY

Photo: shutterstock

SERVICE PORTFOLIO

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

RESEARCH AND DEVELOPMENT SERVICES

Energy system analysis and design

- In municipal, regional, and industrial structures: energy concepts, optimization, implementation of energy storage systems, 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: redox flow-batteries, compressed air energy storage systems, phase change materials and slurries
- Cross-energy technologies: power-to-gas, power-to-chemicals
- Catalytic-processes, low temperature plasma processes
- Customer-specific, innovative, large-scale, flexible, weldable bipolar plates
- Pilot plant construction, electricity generation from waste heat, combined energy generation, innovative chillers, use of geothermal energy
- New turbomachinery, small steam turbines, turbomachinery test bench

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
- New resources in steam and compressed air networks

MARKETS AND SECTORS

- Energy services providers 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

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1

THE HOSPITAL AS A HYBRID ENERGY STORAGE

1 *Key visual of the "Hybrid energy storage hospital" (HESKH) project.*

The problem is well known: The growing share of renewable energies in the electricity mix increases the risk that the demand cannot be covered continuously. At the same time, there is an oversupply in many sunny and windy hours. The solution approach that Stadtwerke Bochum GmbH and Fraunhofer UMSICHT are investigating is new, however: In the "Hybrid Energy Storage Hospital" (HESKH) project they are investigating the question of whether and how the supply systems of hospitals can be used for electrical energy balancing.

Objective: To compensate for supply shortfalls in the electricity grid

Supply systems are available in almost 2,000 German hospitals – from CHP plants to heat and cold storage facilities. Compared to other consumers (e.g. residential and office buildings), their size makes them ideal for compensating supply gaps in the power grid with little effort or for making economical use of an excess supply of renewable energies.

The aim of the project partners is therefore to develop the potential of hospitals for electrical energy balancing and at the same time improve the economic efficiency of their energy supply. Using the example of the Ev. Krankenhaus Hattingen (hospital) and simulation and optimization tools, they are investigating how existing storage capacities can be used to decouple the supply of heat and cold from current demand. This flexibilization makes it possible to adapt, on the one hand, electricity generation in CHP plants and, on the other hand, the electricity consumption of chillers or electrical heat generators to the current situation in the power grid. By forecasting the heat demand for the next few days, plant deployment planning ensures that no supply bottlenecks occur. The detailed data collection for the creation of the simulation model to map the energy consumption further helps to identify efficiency measures.

Environment, methods: From data acquisition to simulation

In a first step, the researchers collect inventory and consumption data of the hospital and incorporate them into a modelling of the current inventory. From this, they gain a better understanding of the composition of energy consumption and can derive efficiency measures. In addition, they measure electrical and thermal energy flows to generate input and comparative data for the modelling and use this data as a basis for forecasting heat demand. In order to be able to plan the operation of hospital facilities based on the requirements of the networks and markets, the next step is to create both an operation optimization and a forecast model.
With the help of the forecast model, the heat demand for the next few days can be predicted and incorporated into the system deployment planning. Since no ideal forecasts are possible,

this always results in an error, so that special attention is paid to the investigation of these effects on the plant deployment planning. In this way, conclusions can be drawn as to the necessary accuracy of the models and uncertainties can be taken into account in operational optimization.

For the subsequent evaluation of the energy balancing concepts, the project partners define suitable criteria – e.g. energy balancing potential, primary energy demand, costs and revenues. They also define various balancing scenarios and targets. On this basis, they develop possible balancing concepts for the subsequent optimization calculations. The results of these calculations are evaluated with regard to the selected criteria and the concepts are compared.

In a final step, the transferability of promising concepts to other hospitals will be examined and assessed with regard to their technical and economic feasibility. Stadtwerke Bochum plays an important role as a practical partner: They evaluate the results from the user's point of view and thus ensure that the methods and concepts developed are also meaningful and feasible in practical implementation.

Customer benefit: Improve the economic efficiency of energy supply

For hospitals, additional sources of revenue can arise from optimized and flexible system operation. In addition, an energy efficiency analysis can be used to identify and quantify savings measures that are easy to implement. This is another advantage of energy compensation concepts in hospitals: Old, inefficient systems can be replaced in the course of a new conceptual design, so that energy efficiency and profitability can be increased.

For network operators, this provides an opportunity to compensate for imbalances in the electricity grid to some extent by changing the use of consumption and supply systems. Hospitals are far more suitable than small-scale systems in residential buildings, as the effort required for energy management and the connection of information and communication technology is significantly lower compared to a large number of small-scale systems.

SUSTAINABLE

Hospitals offer ideal conditions for making a significant contribution to meeting the growing need for energy compensation at low cost. Due to their size, their supply systems are excellently suited to compensate supply gaps in the power grid with little effort and to economically exploit an oversupply of electricity from renewable energies. Hospitals can thus support the energy policy transition.

CONTACT

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INTERNATIONAL

1

APPLIED RESEARCH WORLDWIDE

Within the framework of academic cooperation and international projects, Fraunhofer UMSICHT works with partners worldwide. Examples of our activities are the cooperation with the universities in Birmingham (UK) and Vic (Spain) as well as projects in Kuwait, Tunisia, South Africa, and Chile.

RESEARCH PLATFORM WITH THE BIRMINGHAM ENERGY INSTITUTE

The joint research platform between the Birmingham Energy Institute/University of Birmingham and Fraunhofer UMSICHT has been extended until 2024. The aim of the coming years will be to establish international research cooperations in the field of thermochemical conversion processes and the recycling of critical raw materials and composite materials. Based on a TCR® demonstration plant developed at Fraunhofer UMSICHT, which is already in operation in Birmingham, the expansion of a joint energy and research infrastructure is to be continued in "Tyseley Energy Park".

WASTE MANAGEMENT PLAN FOR KUWAIT

Since 2017, the institute branch Sulzbach-Rosenberg has been developing a waste management plan for the Emirate of Kuwait in a major project supported by eleven project partners. The project will be completed by the end of 2020. The data collection on waste from households, industry, and commerce was completed as early as 2019, with the aim of describing the quantities, composition, and current management of all waste in the country.

Within the framework of the landfill exploration program, 15 of the 20 most important landfills have so far been investigated with geophysical methods with regard to their composition and extent. A comprehensive monitoring system for long-term monitoring is currently being established at all landfills. In the process, 100 "e-Noses" have also been installed to ensure comprehensive odor monitoring.

All data are integrated into the digital environmental monitoring system "eMISKWaste". Various "applications" will facilitate environmental monitoring in the future – for example, through a reporting system for illegal waste disposal. A total of 25 goals of the waste management strategy for the next 20 years were defined together with the actors in Kuwait. Based on these, the project team is currently drawing up concrete plans for measures and financing.

EU PROJECT "FERTIMANURE"

The EU project "FERTIMANURE" will develop, test and validate advanced nutrient management strategies that will enable the production of competitive fertilizers with good yield characteristics. The project aims to recycle nutrients from livestock manure to produce bio-based fertilizers.

WASTE MANAGEMENT IN TUNISIA

The project for the modernization of waste management in Tunisia under the leadership of the institute's Sulzbach-Rosenberg branch is entering the implementation phase. In three model regions, cleanliness in the municipalities and value creation through recycling will be increased. At the same time, the pollution load is to be reduced by collecting hazardous waste

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3

separately. The Bavarian State Chancellery is supporting the project with € 960,000.

STATIONARY BATTERY STORAGE FOR SOUTH AFRICA

High operational reliability, long service life and cost-effective materials and production: These are the factors that the stationary battery storage system being developed as part of the German-South African "BiNiFe" project is intended to meet. The project partners – Fraunhofer UMSICHT, Volterion GmbH, the University of the Western Cape (Cape Town) and Connect'd Energy (Helderberg) – are therefore relying on nickel-iron (NiFe) battery technology. It is extremely durable, very safe, inexpensive and environmentally friendly.

Background: South Africa needs innovative solutions for efficient and cost-effective stationary energy storage to ensure the stability of the power grid. This is especially true in the early morning and evening hours, when demand is particularly high but power generation from renewable energies is minimal. In addition, there are many mobile phone towers in South Africa that are currently not connected to the power grid and are mostly supplied by expensive and environmentally harmful diesel generators. NiFe batteries are an emission-free and safe alternative to these generators.

CATALYSTS: COOPERATION WITH CHILE

Thermochemical gasification of biomass can help to reduce greenhouse gas emissions. With the combined generation of electricity and heat, and the production of energy sources or chemical base materials, the technology offers several ways to achieve this. Catalysts are used to reform the tars occurring in the process. However, these are cost-intensive or quickly lose their activity, which delays a broad market launch of biomass gasification.

Researchers at Fraunhofer UMSICHT see a promising alternative in the use of catalysts based on carbon aerogels – a very light and highly porous material. Together with the Unidad de Desarrollo Tecnológico (UDT) in Chile, which already has many years of experience in the production of such materials, the application is to be tested in practice.

1 *New transfer stations in the Tunisia project should increase the collection rate and reduce landfilling.*
2 *Exploration of landfills in Kuwait.*
3 Cellulose aerogel (left) is carbonized, the result is carbon aerogel. Laboratory scale and scale-up of catalyst supports.

CONTACT

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Kuwait/Tunesien: *Hon. Prof. Dr.-Ing. Matthias Franke | Head of Department Recycling Management, Institute Branch Sulzbach-Rosenberg | Phone +49 9661 8155-600 | matthias.franke@umsicht.fraunhofer.de*

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Chile: *Kimberley Matschuk | Biorefinery and Biofuels | Phone +49 208 8598-1544 | kimberley.matschuk@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.

Photo: Ruhr-Universität Bochum/Katja Marquard

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Photo: Fraunhofer UMSICHT/Ilka Drnovsek

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PRIZES AND AWARDS IN 2019

Last year, Fraunhofer UMSICHT and its employees received the following honors and awards for their innovative or professional achievements.

Lecturer Award of the Fund of the Chemical Industry
Prof. Dr. Ulf-Peter Apfel received the Lecturer Award of the Fund of the Chemical Industry. The prize is awarded to outstanding young scientists from the fields of chemistry and chemical biology who have demonstrated above-average teaching performance and outstanding scientific achievements.
More information: s.fhg.de/UiV (German site)

Project outline funding
Once a year, the UMSICHT Friends and Patrons Group awards two selected project outlines. In 2019 Kimberley Matschuk and Felix Thoma received start-up financing for their projects.
More information: s.fhg.de/MbL (German site)

Promotion of bachelor's and master's theses
Every year, the UMSICHT Friends and Patrons Group awards prizes for outstanding theses. In 2019 Lukas Ingenhorst was awarded for his master thesis "Development of an agent-based simulation for the evaluation of business models of flexibility technologies at household level".
More info: s.fhg.de/H7j (German site)

Award-winning strategy for recycling construction waste
The German Sustainable Building Council (DGNB) awarded a prize to the "BauCycle" project in the research category. Scientists tested new methods for sorting construction waste, examined application options, and developed a product from the recycled material in order to save primary raw materials.
More info: s.fhg.de/adz (German site)

Young talent award MehrWert 2019
Sabrina Großkopp is the winner of the young talent award "MehrWert NRW 2019" in the category vision. She was honored for her design fiction "Schlaraffenstadt 2040" (City of Plenty 2040), in which she consistently transfers the idea of recycling to urban food production.
More information: s.fhg.de/z5A (German site)

Daidalos Münze (Daidalos Coin)
The German Academic Scholarship Foundation, the largest organization for the promotion of gifted students in Germany, has awarded Dr. Joachim Danzig the Daidalos Coin in recognition of his many years of commitment in the selection of high school graduates.

Public Utility Award 2019
Stadtwerke Herne is delighted about getting second place in the Stadtwerke Award 2019, which was awarded to the Sodingen climate quarter. There, the public utilities – with the support of Fraunhofer UMSICHT – have implemented various energy concepts for climate-neutral living, evaluated their suitability for everyday use and their economic benefits and developed new services in sustainable housing construction.
More information: s.fhg.de/B94 (German site)

1 *Researching in the field of CO_2 recycling, among others: Prof. Dr. Ulf-Peter Apfel.*
2 *The board of the UMSICHT Friends and Patrons Group congratulates Kimberley Matschuk and Felix Thoma.*

DIGITIZATION IN THE RECYCLING INDUSTRY

Prof. Dr.-Ing. Matthias Franke is Head of the Department Recycling Management, works at the institute branch Sulzbach-Rosenberg and deals with digital solutions for closing material cycles. The research approaches of his team are the data-based networking of value chains over the entire life cycle of a product – from production via use, re-use or recycling until reintroduction into the production chains.

How digital is the circular economy today?
Franke: It doesn't matter who you quote here, whether Roland Berger or other surveys: The recycling industry is said to be somewhat backward in terms of digitization. On the one hand in comparison to other leading environmental markets such as the energy industry, but above all in comparison to the manufacturing industry or logistics. However, the above findings should be treated with caution, as there are not too many surveys. From discussions with representatives of industry, however, we know that there is interest.

What are the concrete challenges?
Franke: On the one hand, the flow of data and information between producers, users, and disposal companies is often non-existent or very fragmented; i.e. not enough data is received in the individual processes to be able to optimize them. On the other hand, it is noticeable that there are already digital technologies in the circular economy. For example, smart waste bins and chip-based billing systems, digital route-planning or automated dismantling processes for IT equipment. The first waste trading platforms are also emerging. What all these good examples have in common, however, is that they are limited to individual stages of the value chain. They are insufficient for realizing efficiency gains and cost advantages that both justify the investments and make a significant contribution to higher recycling rates.

What would have to happen to get ahead here?
Franke: In order to reach the next stage of the digital transformation, but above all to link processes horizontally across the entire value-added chain, a number of points must be addressed. We need plausible cost-benefit scenarios on a business and economic level in order to safeguard companies' investment decisions. In addition, we need a more stable support framework with an incentive system for first movers and risk reduction for small and medium-sized enterprises (SME). We need concepts for secure data exchange that take into account the interests of the players and, finally, we need very good demonstration projects that make the potential of cross-process optimization tangible by means of selected material flows. We are currently working on such approaches.

1 *Hon. Prof. Dr.-Ing. Matthias Franke develops solutions for the digital circular economy.*

CONTACT

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CATALYSTS AND THERMAL STORAGE

In her department catalytic processes meet thermal storage. The result: Dr.-Ing. Barbara Zeidler-Fandrich and her team work on a wide variety of projects involving both industrial customers and other UMSICHT departments. These include, for example, "ElkaSyn – Increasing the energy efficiency of electro catalytic alcohol synthesis" and "FlexKälte – Flexibilization of cooling supply systems for electrical energy balancing in Germany".

What are the current research priorities of the Department Chemical Energy Storage?
Zeidler-Fandrich: One focus is on catalyst testing and screening. In other words, we look at catalysts from other research institutes or companies and examine how they react under real conditions. We do this, for example, in three subprojects of "Carbon2Chem®". The catalyst preparation is relatively new. Using an extruder, honeycombs or pellets are produced from catalyst powder, which cannot be optimally used in the process. In the future, we want to expand the development of catalyst materials. This will be done in the "ElkaSyn" project, among others. One example of new approaches to thermal storage is the development and use of electrochemical compressors.

What is special about "ElkaSyn"?
Zeidler-Fandrich: We want to develop a one-step process for the electrochemical production of methanol, ethanol, propanol and butanol from CO_2 and water. Existing concepts often envisage a two-stage process. It starts with an electrolysis process in which hydrogen is produced with the help of regenerative electricity. This is followed by a catalytic process step. Here, the hydrogen is converted with CO_2 into the desired end product – alcohols, for example. The disadvantages: Firstly, the intermediate product hydrogen has to be stored, and secondly, energy losses occur during electrolysis to produce hydrogen.

On the way to a one-step process, we work closely with companies and other research institutions. The UMSICHT team headed by Prof. Dr. Ulf-Peter Apfel with a focus on electrosynthesis is also involved. I would like to further expand such interdepartmental cooperation in the future.

Such cooperation is also taking place in the "FlexKälte" project – with the Energy Systems Department ...
Zeidler-Fandrich: In the FlexKWK project, the Energy Systems Department has developed a new concept of combined heat and power generation in which the operation of a combined heat and power plant is flexibly adapted to the demand for electricity. We have practically investigated the grid operation of heat pumps in combination with heat storage units. We are jointly transferring this topic to refrigeration – an area in which we are traditionally active. And a glance at the installed cooling capacity suggests that there is much greater potential for flexibility than with heat pumps. How this potential can be exploited is something we are trying to answer together in the "FlexKälte" project.

More Info: *s.fhg.de/uer (German site)*

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URBAN AGRICULTURE: NOVEL CONCEPT OF FRAUNHOFER UMSICHT

The "ALTMARKTgarten" on the roof of the Oberhausen job center produces fruits, vegetables, and herbs in the middle of the city. Production and building infrastructure are linked in such a way that the building's material and energy flows are sustainably used for cultivation. For this project, Fraunhofer UMSICHT relies on an interdisciplinary team of scientists and thus successfully combines the expertise of the institute.

Why is urban agriculture becoming increasingly important?
Dipl.-Ing. Volkmar Keuter, Head of the Department Photonics and Environment: Forecasts assume that in 2050, about 75 percent of the population will live in cities. This not only has an impact on climate change, but at the same time the population's awareness of food production will continue to decline. Already today, about 45 percent of perishable food is disposed of before it even reaches the dining table – mostly due to long distances and inefficient supply chains. This is where urban agriculture comes in, bringing food production to the city, thereby generating regional cycles and increasing the value added in the inner city. Shorter transport distances mean minimized CO_2 emissions; at the same time, the quality of plant products can be improved, which in turn has a positive impact on the health of consumers.

What is special about the "ALTMARKTgarten" in Oberhausen?
Dipl.-Geogr. Simone Krause, Group Manager Spatial Analysis and Raw Material Systems: Through local distribution structures embedded in the local community, food production is carried out here on a good 1,000 m^2 of inner-city land. Various hydroponic cultivation systems are installed in three climate chambers. The systems function without the use of biocides and automatically control temperature, water, and nutrient supply, among other things. The "ALTMARKTgarten" is based on the inFARMING® concept developed by Fraunhofer UMSICHT, i.e. the material cycles of the building are virtually closed: Waste heat, grey and rainwater generated in the job center are currently or will be used for the production of plants. A fourth climate chamber is reserved for further research and development activities in the field of urban agriculture.

What were the advantages of interdisciplinary cooperation?
Dr. rer. nat. Holger Wack, Deputy Head of the Department Material Systems and High Pressure Technology: Fraunhofer UMSICHT operates its own research and development department in the "ALTMARKTgarten". Here we test interdisciplinarily and together with partners the requirements for sustainable professional food production in integrated plant production systems. The expertise from the individual departments of Fraunhofer UMSICHT helps us to fully understand and describe systems. Through interdisciplinary cooperation, we also extend our services sustainably for subsequent project developments.

More Info: s.fhg.de/Hbe (German site), www.infarming.de/en

1 *View into the "ALTMARKTgarten": The plants are supplied with water and nutrients in a time-controlled manner.*

CONTACT

Public Relations | presse@umsicht.fraunhofer.de

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REFLECTIONS ON BIOLOGICAL TRANSFORMATION

From scientific assistant in the analytical laboratory to the Head of Department Think Tank in the field of energy – Dr. Thomas Marzi has held a variety of positions during his 27 years at Fraunhofer UMSICHT. His current focus is on the topic of biological transformation. His goal is to further develop interdisciplinary cooperation in this field in order to give applied researchers a new perspective on their work.

Why biological transformation?
Marzi: In applied research, we naturally tend to look at things primarily through scientific or engineering glasses. With a topic like biological transformation, that is not enough in my eyes. What is needed is a superordinate, a meta-perspective: What happens when something living and something technical come together? Is the result something living or technical? Of course, this also raises ethical questions that researchers should ask themselves.

How did you develop the topic of biological transformation?
Marzi: In the beginning, there was a so-called theme booklet entitled "Questions about a biological technology". In it, my colleagues and I looked at the idea of integrating biological components and principles into technical and economic processes through technical and bio-philosophical glasses and reflected from this perspective. We defined terms, looked at differences between biological and technical processes and devised possible forms of adaptation.

The next step was the organization of an interdisciplinary conference in Berlin. In November 2019, experts from the Fraunhofer-Gesellschaft and specialists from other institutions met in the Museum of Natural History. The subjects represented were engineering and natural sciences, biomimetics, sociology, economics, psychology, and philosophy of technology and biology. The exchange focused on the boundaries between biology and technology, and the transfer of the concept of evolution, ethics, and sustainability.

What follows the conference?
Marzi: I would like to continue the interdisciplinary dialogue – whether with further events or interdisciplinary research projects. I am currently thinking about a new theme booklet. The connection between the bio-economy and circular economy or biosphere and techno-sphere seems to me to be an interesting and important topic for Fraunhofer UMSICHT.

More Info: s.fhg.de/6D3, s.fhg.de/bioltransf-nachlese-tagung (German site)

1 *In the Think Tank Energy, Dr. Thomas Marzi deals with topics that are close to his heart – including biological transformation.*

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NETWORK

LUCKILY, WE ARE NOT ALONE ON THIS EARTH.

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

THE FRAUNHOFER-GESELLSCHAFT

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

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 74 institutes and research institutions in Germany,
- has approx. 28,000 employees, primarily with degrees in natural sciences or engineering,
- generates an annual research budget of 2.8 billion euros, of which nearly 2.3 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 State 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 2020*

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.

MORE INFO

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

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

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Photo: Fraunhofer UMSICHT/Ilka Drnovsek

BOARD OF TRUSTEES

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

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Ruhr-Universität Bochum
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1 *Offers competent consulting and acts as multiplier: UMSICHT Board of Trustees (As of: November 14, 2019).*

MORE INFO
s.fhg.de/board-of-trustees

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***

European Biocarbon Conversion Technologies EBCT
Products containing biocarbons
Foundation: 2019

FKuR Kunststoff GmbH
Development and sales & distribution of a broad range of bio-based plastics
Foundation: 2003 | info@fkur.com | ***www.fkur.com***

RSL Recycling Solutions Lippetal GmbH
Recycling of electronic scrap fractions
Foundation: 2018 | info@rsl-recycling.de

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
Coating for heat insulation and safety applications in Mons, Belgium
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***

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@vsmsolar.com | ***www.vsmsolar.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

RESEARCH AND TEACHING/ INSTITUTIONS OF HIGHER LEARNING

1 *Applied research requires close ties with science. Fraunhofer UMSICHT sent 20 lecturers to four universities and four colleges in the winter semester 2018/2019. In the summer semester 2019, there were 21 lecturers at six universities and four colleges.*

Fraunhofer UMSICHT operates at the interface between university research and industrial practice. Therefore, strategic partnerships with colleges and universities in Germany and Europe are of central importance. Through close cooperation, we promote knowledge transfer, joint projects and thus the connection between research and practice. Many Fraunhofer UMSICHT employees teach at colleges and universities in the region.

RESEARCH AND TEACHING

Prof. Dr.-Ing. Eckhard Weidner
Prof. Dr.-Ing. Eckhard Weidner heads Fraunhofer UMSICHT as well as the Chair of Process Technology at the Ruhr-Universität Bochum. He is fostering the scientific networking of research institutions, industry and politics.

Prof. Dr.-Ing. Görge Deerberg
The Deputy Director of Fraunhofer UMSICHT is professor in the field of "Environmental Sciences" at the Faculty of Cultural and Social Sciences of the FernUniversität in Hagen (distance learning University of Hagen). He is also the scientific director for the infernum distance learning course, jointly offered by the FernUniversität in Hagen and Fraunhofer UMSICHT under the umbrella of the Fraunhofer Academy.

Prof. Dr. rer. nat. Andreas Hornung
The 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
The Director of the Division Energy is also Professor of "Cross Energy Systems" at the Faculty of Mechanical Engineering at the Ruhr-University Bochum. In addition, he is a member of the Research Department "Closed Carbon Cycle Economy" at the Ruhr-University Bochum.

MORE INFO
s.fhg.de/umsicht-directorate

Photo: 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.*

SUPPORT

Within the framework of the Code of Conduct* of the Fraunhofer-Gesellschaft, Fraunhofer UMSICHT commits itself to regular support meetings and to ensuring that further training is tailored to requirements. Our institute was selected as an example of good practice within the framework of the Code of Conduct.

QUALIFICATION

Doctoral coaching and special continuing education courses tailored to the needs of the doctoral students ensure that their skills are developed in line with their requirements. These offers form a qualified basis for the time after the doctorate – at or outside Fraunhofer UMSICHT. Doctoral students are also offered colloquia and regular informal meetings.

NETWORKING

Fraunhofer UMSICHT encourages communication and exchange through an internal website especially created for doctoral students, regular excursions to companies, barbecues, and joint visits to Christmas markets. Networking with other scientists and employees of the institute as well as with other Fraunhofer Institutes and various external research facilities also supports a broad integration of the doctoral candidates into the national and international scientific community.

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UMSICHT
Research School

* ***Code of Conduct:*** *s.fhg.de/29x*

MORE INFO

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

Photo: Fraunhofer UMSICHT/Ilka Drnovsek

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INTERDISCIPLINARY DISTANCE LEARNING ENVIRONMENTAL SCIENCES

The successful and scientifically-substantiated solution for complex challenges in the fields of environment and sustainability requires 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 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 took place within the framework of the joint project "mint.online", which is funded by the BMBF (Federal Ministry of Education and Research) from 2011 to 2017. The goal shared by Fraunhofer UMSICHT and the FernUniversität in Hagen is to further align infernum with the specific needs of the students from the working world.

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 2018, infernum received yet again rewards from the German UNESCO commission and the Federal Ministry of Education and Research as "Official Project" of the "UN Decade of Education for Sustainable Development".

MORE INFO

www.umweltwissenschaften.de German site)

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Foto: Fraunhofer UMSICHT/Ilka Drnovsek

1

UMSICHT SCIENCE AWARD

UMSICHT FÖRDERVEREIN
Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik e.V.

The UMSICHT Science Award celebrated its tenth anniversary in 2019: Once again, the UMSICHT Friends and Patrons Group honored people who have carried out outstanding research in close contact with industry and markets and who have reported on scientific topics in the media in a comprehensible manner. Dr. Kai Mainzer's research work on urban energy systems convinced the jury of experts in the science category. In the journalism category, Christopher Schrader received the award for his article on the life cycle assessment of e-mobility.

AWARD WINNERS

SCIENCE CATEGORY: **Dr. Kai Mainzer**
Small municipalities in particular often lack the expertise to identify local potentials for emission reduction. Dr. Kai Mainzer has developed a model in the course of his doctorate that allows automated analyses to determine, among other things, energy demand and the potential for renewable energies. This model takes into account both investment and deployment planning for energy conversion technologies on the supply and demand side. The methods of the "RE³ASON" model (Renewable Energies and Energy Efficiency Analysis and System OptimizatioN) are transferable so that they can be applied in as many cities and municipalities as possible.

JOURNALISM CATEGORY: **Christopher Schrader**
Are electric cars a crucial part of the energy transition? Or do they benefit the climate far less than expected? In his article "The Life Cycle Assessment of E-mobility" (Spektrum der Wissenschaft, 5/2018), Christopher Schrader looks at the life cycle of an electric car and provides information on when its ecological advantage over diesel or gasoline cars takes effect. The subject of batteries in particular is put to the test in detail, as experts see the Achilles' heel of the drive concept here. Schrader also critically reports on the range of products offered by car manufacturers and the changes in driving behavior that often accompany the purchase of an electric vehicle.

UMSICHT FRIENDS AND PATRONS MEMBERSHIP

The "Verein zur Förderung der Umwelt-, Sicherheits- und Energietechnik e. V." (UMSICHT Friends and Patrons Group) 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 2019 winners, former and current board members of the UMSICHT Friends and Patrons Group.*

MORE INFO
s.fhg.de/8r3

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FRAUNHOFER SPECIALIZED PUBLICATIONS AND PATENTS

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

At **publica.fraunhofer.de/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.

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www.umsicht.fraunhofer.de/newsletter (German Newsletter)
www.umsicht.fraunhofer.de/en/press-media.html (German mailing list)

SCHEDULE 2020

To find current information regarding our events and participation in trade fairs, please visit our homepage on the Internet at:
www.umsicht.fraunhofer.de/en/events-trade-fairs.html

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FUNDING INFORMATION

Page 16

Funded by the Ministry of Economics, Innovation, Digitization and Energy of the State of North Rhine-Westphalia under the funding code FKZ EFO 0001B.

Page 22/23

Funded within the framework of the Fraunhofer-Gesellschaft's internal programs under the funding code WISA 833908.

Page 26/27

The project "InKa – Intermediates from industrial coffee grounds" is funded by the Federal Ministry of Education and Research (BMBF) under the funding measure "National Research Strategy Bio-economy 2030" of the German government under the funding code FKZ 031B0665A.

Page 30/31

The joint project "TyreWearMapping" is funded by the Federal Ministry of Transport and Digital Infrastructure (BMVI) via the project management agency TÜV Rheinland under the funding code FKZ 19F2050A.

Page 34/35

The "DigitalFire" project is funded by the Federal Ministry of Food and Agriculture (BMEL) via the Agency for Renewable Resources (FNR) under the funding code FKZ 22039618.

Page 38/39

The joint project "EnEff:Wärme – HESKH: Use of energy supply systems in hospitals for electrical energy balancing with special consideration of heat load curve forecasts – sub-project: Modelling, Simulation and Transmission" is funded by the Federal Ministry of Economics and Energy (BMWi) under the funding code FKZ 03ET1591A.

Page 41

The "BiNiFe" project is funded by the Federal Ministry of Education and Research (BMBF) under the funding measure "CLIENT II – International Partnerships for Sustainable Innovations" under the funding code FKZ 01LZ1715A.

Page 41

The projects were funded by the Federal Ministry of Education and Research (BMBF) under the funding codes FKZ 031B0176 ("ComCatTar") and FKZ 01DN16037 ("Reforming").

Page 45

The "ElkaSyn" project is funded by the Federal Ministry of Economics and Energy (BMWi) under the funding code FKZ 03ET1642C.

The project "FlexKälte" is funded by the Federal Ministry of Economics and Energy (BMWi) under the funding code FKZ 03EI1007.

The "FlexKWK" project was funded by the Federal Ministry of Economics and Energy (BMWi) under the funding code FKZ 03ET1337A and implemented by Energieversorgung Oberhausen AG.

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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.

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REPORTING PERIOD

January 1, 2019 – December 31, 2019

EDITORIAL DEADLINE

March 30, 2020

TRANSLATION

Stefanie Bergel, M. A.

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Lund Languages Translation Agency (GmbH), Cologne, Germany

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LAYOUT, TYPESETTING AND PRODUCTION

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ONLINE PUBLICATION OF THE ANNUAL REPORT

www.umsicht.fraunhofer.de/en/publications/annual-reports.html

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