

Annual report 2021

Paving the way to a sustainable world

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



Annual report 2021

Fraunhofer UMSICHT


Paving the way to a sustainable world

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Information about sustainability
at Fraunhofer UMSICHT:

www.umsicht.fraunhofer.de/sustainability 





Preface

Left:
Prof. Dr.-Ing. Görgo Deerberg,
Deputy Director

Right:
Prof. Dr.-Ing. Eckhard Weidner,
Director

Europe is experiencing profound political and economic change as a result of the COVID-19 pandemic and the Russian Federation's war of aggression against Ukraine. What does this mean for our institute?

Eckhard Weidner: The pandemic and the war have revealed just how vulnerable our economic system is. Companies need to reassert control over the processes and products they have surrendered to global supply chains. We have brought together 16 Fraunhofer institutes that are working hard to develop sovereign value cycles with the aim of making the economy more resilient. To achieve this, we are looking at the entire process – from raw materials and logistics to production and end of use – and linking up the lead markets of food, chemicals, energy and health with complementary fields of research such as bioeconomy, hydrogen and artificial intelligence. This is not a feasible task for one institute, but it is for 16 working together.

The institute strategy was realigned a year ago. How is it now performing in the face of political and economic changes?

Görge Deerberg: The modular structure of the institute strategy gives us flexibility and all the strategic tools we need to not only respond to changes, but also influence them to a certain extent. It also covers highly relevant issues, such as securing the supply of hydrogen, strategies for the heat transition and the circular economy. In view of current developments in the supply of crude oil and natural gas, our approaches to the carbon circular economy are becoming much more important. Our strategy has already delivered results in this area, but we will of course be making adjustments to individual aspects where necessary.

While the climate crisis may have taken a back seat in the media, that doesn't mean research has stopped. We have a large number of interlinked climate protection projects being conducted on a range of scales. Which one stands out in particular?

Görge Deerberg: One of our most prominent projects is the Carbon2Chem® joint project, which was launched six years ago with the vision of significantly reducing the immense footprint of the raw materials industry by defossilizing production. We are now in the upscaling phase of the project, which involves ongoing and highly effective efforts to expand value chains. To give a specific example: last year we managed to continuously produce large quantities of raw methanol in the pilot plant over an extended test period using hydrogen and synthetic metallurgical gases. Now, we are in a position to optimize the operation of a production facility with a view to large-scale implementation. Our aim in doing this is to control an industrial facility in a way that ensures it can proactively respond to fluctuating material and energy flows within the cross-industrial network.

Eckhard Weidner, you will be retiring from active employment in 2022. What has defined your time as the director of Fraunhofer UMSICHT?

Eckhard Weidner: Since I first started as director, I have been inspired by the commitment of our staff to our research subjects. They strive to make life on planet Earth more sustainable within the existing constraints, and they conduct their research with enthusiasm and persistence. In the world of research, both of these aspects are essential for bringing the right people together at the right time. Many subjects that we have been researching since our foundation 30 years ago are now ready for the world to see: hydrogels and redox flow batteries are examples that have won us the Joseph von Fraunhofer Prize twice in a row. The applications of these include fire protection glass and low-cost electricity storage systems. We have an excellent team with a great deal of expertise and vision. We are agile, dynamic and bursting with ideas – the best possible conditions for creating a sustainable future.

We wish you all the best



Eckhard Weidner
Director



Görge Deerberg
Deputy director



Our institute

The basic data of Fraunhofer UMSICHT:
Profile, key performance indicators,
organizational structure

Paving the way to a sustainable world

We want a world that is worth living in. A world where nature and civilization are not mutually exclusive. Our research in the fields of climate-neutral energy systems, resource-efficient processes and circular products is making tangible contributions towards achieving the United Nations' 17 Sustainable Development Goals (SDGs).

As we pave the way to a sustainable world, we are developing solutions that are helping to establish a resource-efficient society and economy. We are developing innovative, industrially feasible technologies as well as products and services for the circular economy in the fields of energy, processes and products, and we are working hard to bring these technologies to application maturity.

Our focus is on achieving a balance between economically successful, socially just and environmentally compatible developments. For us, sustainability is a way of life. Communication about our work is important to us. We want to take a stand on social issues and connect key players from industry, science, politics and society.

In addition to its Oberhausen site, Fraunhofer UMSICHT has an institute branch in Sulzbach-Rosenberg (Bavaria) and a plastics technical shop in Willich (North Rhine-Westphalia). As an institute within the Fraunhofer-Gesellschaft, we benefit from a global network. We work with partners worldwide to exploit synergies in technology development and expand scientific value creation.

Trademarks of Fraunhofer UMSICHT

- Expertise in chemical/biological/physical conversion, materials development, component development, process technology, product development and product evaluation, energy systems, mathematical and analytical methods, and digitalization
- Creativity, quality and efficiency when generating ideas and translating them into applications and projects
- Long, market-driven exploitation chains from the idea to the consumer
- Continuous evaluation of innovations with regard to sustainability
- Involvement in shaping public discourse on the energy transition and raw materials shift

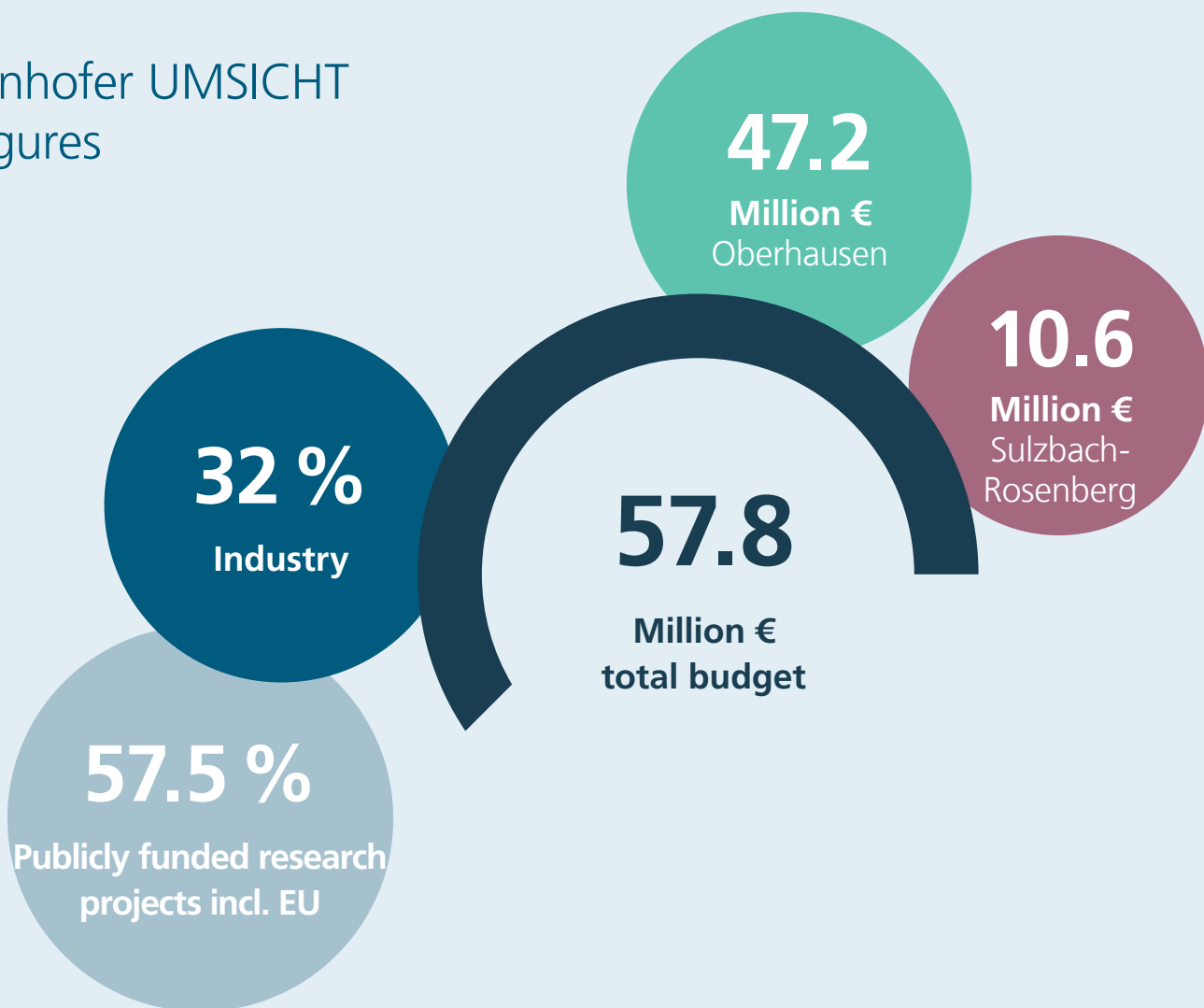
What we can do for you

- Product development and improvement (up to small series production)
- Market analysis and innovation consulting
- Introduction of new technologies
- Licensing and license acquisitions
- Optimization of processes or organizational models
- Characterization, testing and certification

More informationen about our institute:

www.umsicht.fraunhofer.de/about-us

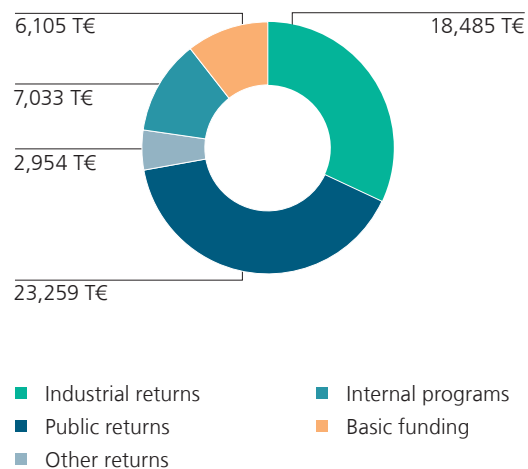
Fraunhofer UMSICHT in figures



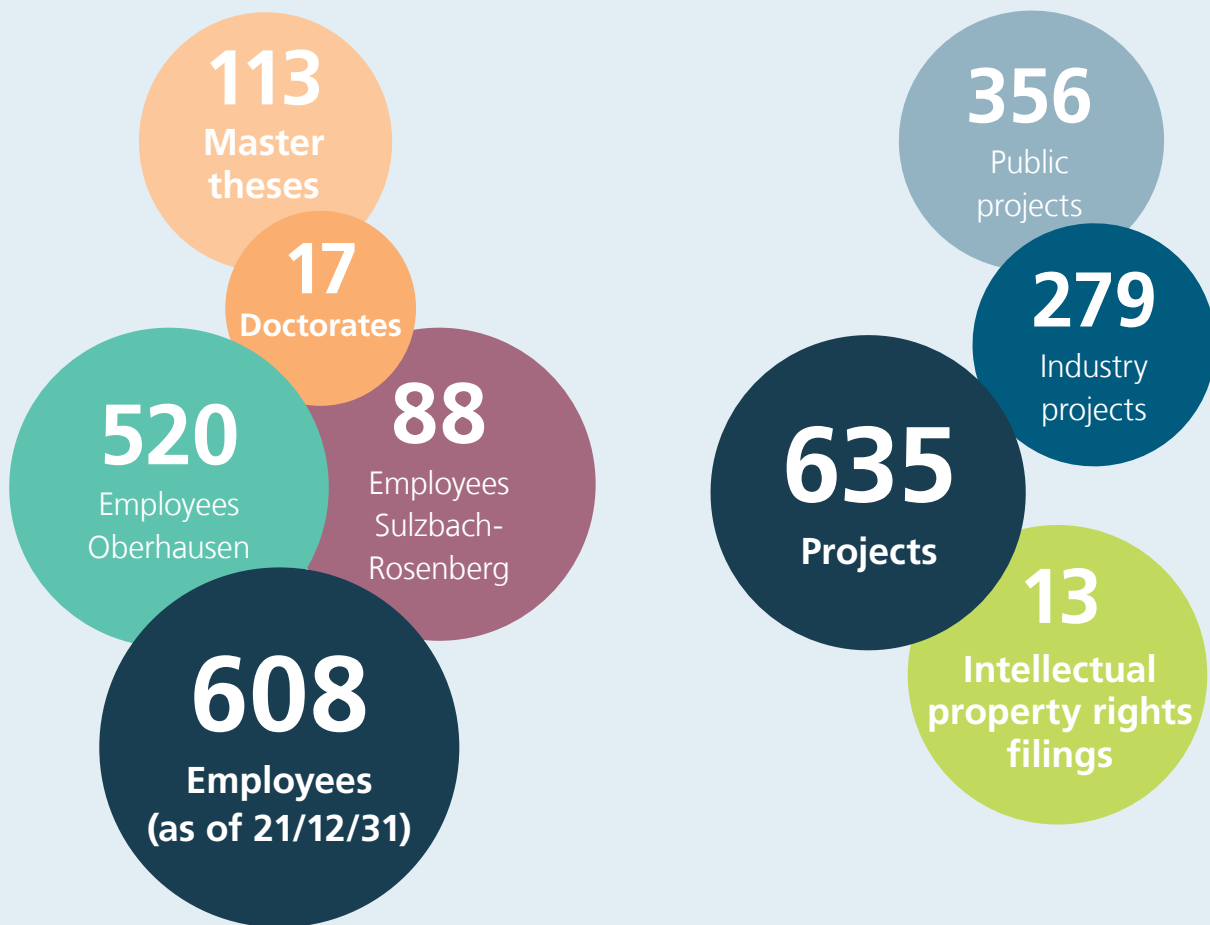
Financial statistics 2021

[in thousand euros]

	<i>Oberhausen</i>	<i>Sulzbach-Rosenberg</i>
Operating budget	43,765	10,167
Other costs	21,518	5,969
Staff costs	22,247	4,198
Investment budget	3,470	435
External project investments	2,549	171
Internal investments	922	264
Total returns	47,235	10601
Industrial returns	17,254	1,231
Public returns	19,002	4,257
Other returns	639	2,315
Internal programs	6,184	849
Basic funding	4,156	1,949

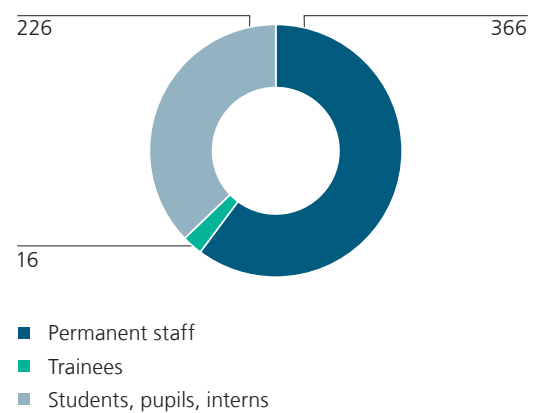


*Financial statistics
Fiscal year 2021; including all sites.*



Staffing statistic 2021

	Oberhausen	Sulzbach-Rosenberg
Permanent staff	304	62
Scientific	232	50
Administrative	72	12
Other staff	216	26
Trainees	13	3
Students, pupils, interns	203	23
Total staff	520	88



Staffing statistics
Fiscal year 2021; including all sites.

Organizational structure

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.

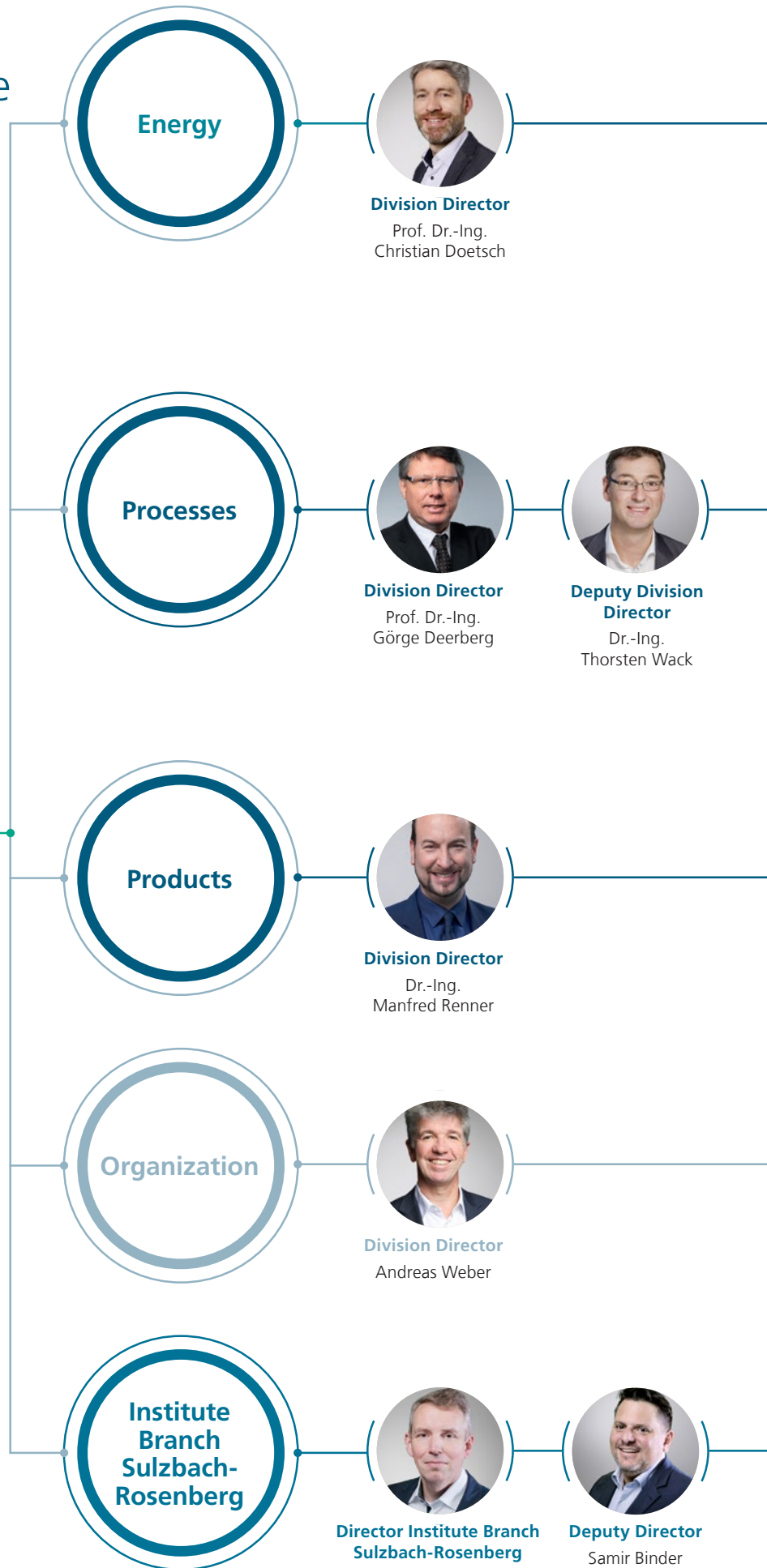
As of February 1, 2022



Director
Prof. Dr.-Ing.
Eckhard Weidner



Deputy Director
Prof. Dr.-Ing.
Görge Deerberg

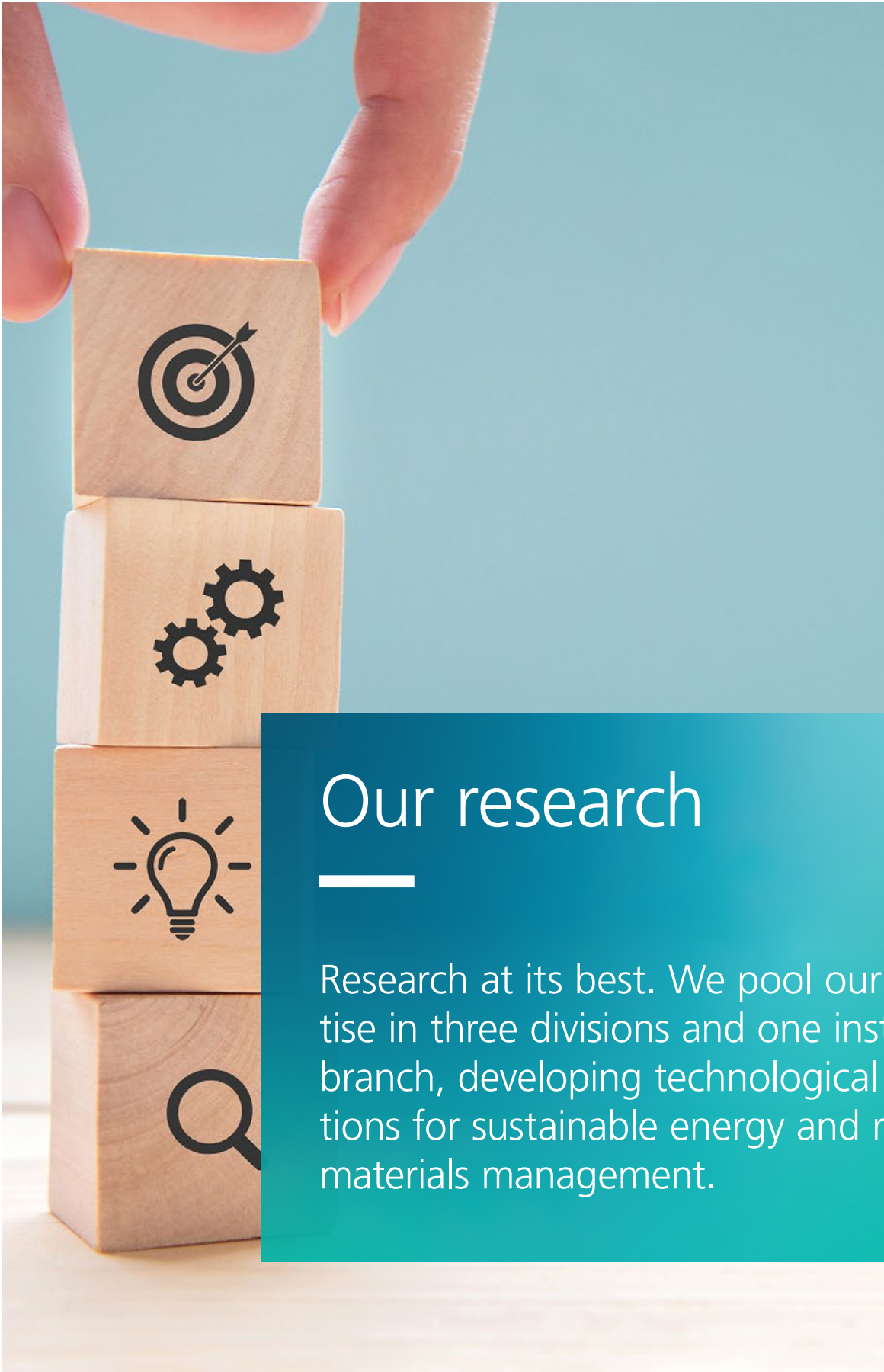


In our interviews, employees provide insights into their work and ideas, classify topics and take a stand.

Learn more (German site):

www.umsicht.fraunhofer.de/interviews





Our research

Research at its best. We pool our expertise in three divisions and one institute branch, developing technological solutions for sustainable energy and raw materials management.

Our institute strategy at one year



A strategy is only as good as its implementation. We are proud that our entire team is dedicated to making our vision a reality.”

Eckhard Weidner
Director

“We are paving the way to a sustainable world. Fraunhofer UMSICHT develops climate-neutral energy systems, resource-efficient processes and circular products.” This institute vision was formulated in 2020 as part of a strategy process that actively and openly involved all employees. The level of involvement established in this was well received and continues to be taken forward in mission teams. People from all divisions, of all ages and at all hierarchical levels are represented in these teams, which aim to devise measures for achieving our strategic goals.

Participation is part of the institute’s culture. It is a proven process in which the vision sets out where the journey should take us. The strategy provides the framework for how we achieve that goal. Mission teams develop implementation plans for sub-goals. Team structures are fluid, allowing topics and measures to overlap and complement each other. The mission teams continuously engage with the workforce, either by communicating planned activities or by enlisting colleagues to coordinate, steer and implement measures.

Strategic goals

1. Sustainable business

We establish sustainable business values together with our partners.

2. Working environment

We offer an inspiring, flexible working environment and encourage creativity and scientific freedom. Our organizational development is based on a culture of collaboration.

3. Research with responsibility

We are committed to responsible research and development. With this in mind, we create viable project portfolios, specifically focusing on two Sustainable Development Goals: “Affordable and clean energy” (SDG 7) and “Responsible consumption and production” (SDG 12).

4. Trends and expertise

We continuously adapt our research strategy based on trend analyses and shift the focus of our expertise development accordingly. This is how we achieve agility and excellence, and how we sharpen our competitive edge in development.



Now that the mission teams have been up and running for a year, we can provide a preliminary report.

Sustainable business values

In the future, a toolbox will provide support for sustainable development, strategic acquisition and reaching out to customers. The methods included in this toolbox will help us to define our goals more clearly by making us ask ourselves what customers want, what the value proposition is and how the value proposition fits into the customers' processes. We are currently developing a concept that deals with the integration of the toolbox into our everyday work.

Comprehensively strengthening and nurturing diversity

Establishing strategic diversity management in the institute's set of values is another aspect that the mission teams are addressing, with a view to promoting a reality shaped by cultural and demographic diversity. From June to September,

a diversity audit was carried out at the institute to assess the status quo. This involved creating a matrix of short-term, medium-term and long-term measures to embrace individual dimensions of diversity more fully and to increase diversity.

An inspiring, flexible working environment

To enhance the institute's attractiveness as an employer and its culture of collaboration, and to promote the creativity and scientific freedom of its employees, new work practices and flexible working opportunities have been created, allowing employees to work at flexible locations and times to suit their personal circumstances. Since the end of 2021, a co-working space with a lounge atmosphere has provided a place for informal and creative professional exchange across departments.

Agility through specialist careers

In addition to established training programs, we have developed qualifications that open up specialist career opportunities for employees. To date, it has been a prevalent notion in the Fraunhofer-Gesellschaft that scientists should be all-rounders who conduct research, acquire projects and funding, and



boast excellent employee and company management skills, all at the same time. The aim of specialist careers is to focus specifically on the strengths of individuals and to provide them with opportunities for further qualification – both to give them career options at Fraunhofer UMSICHT and to equip them with prospects for the job market. A welcome side effect of this is that the institute gains agility and excellence.

UMSICHT as a sustainability role model

Leading by example and motivating others to live and work more sustainably are the two factors driving the institute's efforts to increase the visibility of the impact that its activities have on sustainability. In carving out a profile as a role model, the institute needs to focus on project evaluation just as much as it does on the sustainability of the UMSICHT sites. Over 100 suggestions from the workforce were submitted and grouped to form packages of measures. Fact sheets have been produced in order to outline the content and underlying conditions of the measures – such as the ecological, economic and social impact they have, the expenditure and personnel expenses they involve, and the timing of their implementation.

Examples of focal points include diversity, green procurement

and infrastructure, and measuring and evaluating sustainable actions – either at the institute itself or in the services and products it offers. Whether a project involves introducing sustainable procurement, refurbishing a building to make it more energy-efficient, upgrading a vehicle fleet to include more electric vehicles, launching a bicycle scheme, planting a flower meadow or setting up beehives, it is always implemented from within the workforce.

Preparing for the future

What cutting-edge areas of interest should the institute be tackling in the future? What are some potential new fields of research that could be further explored in projects that contribute to the well-being of society and create sustainable business values? These questions are being answered by a scouting team established in 2021, whose role is to identify trends and address subjects that will lead to collaborations and projects. These subjects are further developed in task forces. A step-by-step model standardizes the process and combines scouting, task forces and the subsequent work involved in roadmapping and implementing the research subjects. Sustainability provides a guiding principle that sits at the heart of this ongoing search for trends.

Service portfolio Division Energy



Efficient energy processes are just as much the focus of our research as new storage technologies and intelligent system solutions. What's really exciting is that we work on innovations in a way that transcends disciplines and sectors."



*Prof. Dr.-Ing. Christian Doetsch,
Division Director Energy*

What will the energy system of the future look like? Will we live in self-sufficient energy districts that are networked across sectors? Which energy storage systems and power-to-X technologies will be required in the energy system, and where? Will digitalization and decentralization turn consumers, as well as industry, into prosumers? Systemic research in the field of energy revolves around these questions.

In purely technological terms, we are concerned with the development and optimization of energy conversion and energy storage technologies, as well as technologies that produce sustainable energy sources and chemical products.

Energy Systems Engineering

We develop and optimize energy plants and their applications by means of static and dynamic simulation as well as prototype/pilot plant construction and testing. Our range of services includes customer-specific concept development, calculation, design, planning and integration of energy plants, plus the evaluation of technical concepts and the creation of studies on energy efficiency and integrating renewable energy into industry.

- Energy efficiency and renewable heat in industry
- Turbomachinery development, prototype construction and testing
- Computer-aided engineering (CFD, FEM, CAD)
- Energy and pilot plant construction
- Compressed air storage systems and networks
- Non-thermal plasma

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More information about
our competencies



[www.umsicht.fraunhofer.de/
competencies](http://www.umsicht.fraunhofer.de/competencies)

Energy Systems

We develop, optimize and evaluate efficient, cost-effective and climate-neutral energy systems based on the interaction between energy supply, distribution, storage and use. Our focus is on local energy systems – these include residential districts (both existing and newly built), commercial districts (up to complex mixed-use districts such as inland ports) and industrial sites where energy supply concepts are intelligently interlinked with production processes. We also develop transformation strategies for municipal utilities and local energy infrastructures, especially heating networks.



- Model-based analysis, planning, design and evaluation of energy systems
- Integral and innovative supply and refurbishment concepts for districts
- Flexibility and storage concepts
- Scientific support for implementation projects

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Electrochemical Energy Storage

We develop innovative electrochemical energy storage systems and converters as well as concepts for coupling energy and production sectors.

- Batteries with a bipolar structure, flow batteries and metal-air batteries
- Fuel cells and stacks
- Functional components and innovative cell concepts
- Thermoplastic-based bipolar plates
- Power-to-Chemicals

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Chemical Energy Storage

By developing and applying materials for the chemical storage and conversion of energy and CO₂, we are creating innovative processes to ensure a successful raw materials and energy transition. One focus of our work is the development and testing of technical catalysts for heterogeneous catalysis.

- Catalyst development and characterization
- Scale-up
- Design
- Catalyst testing

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Electrosynthesis

We are looking into the production of hydrogen and how CO₂ can be electrochemically converted into valuable source materials for industry. We are also using electricity to systematically carry out organic syntheses, in particular hydrogenations.

- Electrocatalyst and electrode development
- Electrolysis cells and stacks
- Water electrolysis
- Co-electrolysis of CO₂
- Organo/bio-electrolysis

Contact

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Service portfolio Division Processes



We work in a way that transcends disciplines and provide solutions using state-of-the-art process engineering and digital technologies to make process technology sustainable."



*Prof. Dr.-Ing. Gorge Deerberg,
Division Director Processes*

The Division Processes develops and optimizes processes that provide eco-friendly ways of using carbon from residual materials, biomass, carbon dioxide and other resources in cycles.

The focus is on chemicals and chemical raw materials, water and wastewater and food. Our services range from analyzing existing structures to developing concepts and new technologies for practical implementation.

Low Carbon Technologies

In the area of sector coupling, we provide technologies and innovations for using, avoiding or reducing carbon emissions. To achieve this, we develop processes for producing synthetic fuels and chemicals and performing gas purification and we conduct system analyses and optimizations. In addition to running experiments in the lab and technical center, we use a number of process simulation and digitalization tools.

- Chemical technologies
- Gas purification and storage systems
- Cross-industrial production systems
- Modeling and simulation

Contact

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Environment and Resources

We are driven by our commitment to efficiently using and carefully managing water, fresh food, nutrients and reusable materials (SDGs 2 and 6). We think sustainably and with the circular economy in mind. In Germany, we are pioneers in building-integrated food production, process-integrated closure of water cycles and the removal of trace substances and microplastics.

- Light – structure and effect
- Water and adsorption technology
- Indoor farming

More information about
our competencies



[www.umsicht.fraunhofer.de/
competencies](http://www.umsicht.fraunhofer.de/competencies)



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Process Digitalization

Successful digitalization relies on new business models combined with the use of precise exploratory data analyses and custom-fit visualizations. Our technologies support companies throughout the digital transformation process, and make them stronger and more productive. Products become smarter and processes faster, more scalable and more efficient. At the heart of our work are the analysis, design and implementation of individual solutions for our customers.

- IT platforms
- Digitalization technologies

Contact

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Process Engineering

We develop concepts for process-related production. In doing so, we focus on modularizing and digitalizing process-related production. We provide models for subsequent investigation,

modeling, simulation and optimization, all in a dynamic overall system. Our main areas of research are biotechnology for the environment and energy, bioprocess engineering and fluid separation, biomass and residue utilization, plus membrane and food technology.

- Bioprocess engineering and fluid separation
- Membrane and food technology, biomass

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Strategic Projects

We pool strategic projects in the Division Processes and act as a point of contact for cross-departmental initiatives relating to the energy and raw materials transition. In the Processes think tank, we look at new technological approaches, evaluate them and develop them further with a focus on applications.

- Strategic projects
- Think tank

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Service portfolio Division Products



What will the products of tomorrow look like? What principles will underpin how they are manufactured and used? And how will the products be handled at the end of their lives? We provide answers to these exciting questions and more besides."



*Dr.-Ing. Manfred Renner,
Division Director Products*

The Division Products can be divided into three main research and development areas: I. development of new materials (SDG 12), II. development of efficient, cost-reduced processes (SDG 12) and III. evaluation of materials and processes.

More information about
our competencies



[www.umsicht.fraunhofer.de/
competencies](http://www.umsicht.fraunhofer.de/competencies)

Circular and Bio-based Plastics

We develop customized circular and bio-based plastics for a variety of applications, such as films, filaments, injection-molded parts and more. Our materials offer a specific, often innovative property profile that corresponds to or even exceeds that of fossil-based polymer materials. We cover the entire development chain from polymerization and material development to plastics processing and recycling, all accompanied by comprehensive work on material characterization.

Our plastics developments can be processed on conventional machines, and our many years of expertise enable us to adapt materials perfectly to suit the application in question. In our developments, we consider not only functionality but also cost-effectiveness, good availability of raw materials, processing and easy recycling. We can provide samples on an industrial scale.

The Circular and Bio-based Plastics department consists of three groups:

- Polymer technology
- Plastics development
- Production scale-up and materials testing

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Product Development

The department's main concern is product-focused development, modification and functionalization of material systems, especially those involving plastics and natural materials such as leather, wood and stone.

Our range of services includes compounding, crushing and adding various materials. We have accumulated many years of expertise in using compressed carbon dioxide as a solvent and dispersing agent. We support our customers from laboratory scale to industrial scale with a focus on industrial feasibility.

■ Innovative material systems for the construction sector

We use functional additives to develop self-repairing polymer and sealing systems, microcapsules, impregnated building materials, innovative paint and coating systems, plus substrates for greening or mossing.

■ Functionalized materials

The focus of our work is on using compressed carbon dioxide for material impregnation and polymer surface functionalization, and on converting carbon dioxide into various reusable materials.

Contact

Dipl.-Ing. Nils Mölders, Head of Department
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Sustainability and Participation

To ensure that our planet remains fit for present and future generations to inhabit, we need to reassess current production methods, our way of life and our resource consumption. Our aim is to enable our customers to contribute to sustainable development through their actions.

We develop customized sustainability strategies, help to close loops in the circular economy and assess the sustainability of products, processes and services. We support our customers with innovation processes through active stakeholder management and new formats for involving the general public. This makes it possible to create sustainable innovations.

- Sustainability assessment
- Urban transformation
- User-centered technology design

Contact

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Head of Department, Sustainability Manager
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Service portfolio institute branch Sulzbach-Rosenberg



We develop technologies and concepts to shape the energy transition and raw materials shift."



*Hon.-Prof. Dr.-Ing. Matthias Franke,
Director institute branch Sulzbach-Rosenberg*

The Sulzbach-Rosenberg institute branch develops industry-focused solutions in energy technology and the circular economy. With a focus on process engineering and plant construction, it supports customers from the initial project idea to pilot plants and demonstrators, all the way through to market launch. The Center for Energy Storage (CES) focuses on integrated, decentralized energy conversion and energy storage systems.

More information about our
institute branch



[www.umsicht-suro.fraunhofer.de/
en.html](http://www.umsicht-suro.fraunhofer.de/en.html)

Energy Technology

The Energy Technology department develops processes and plants for the supply and storage of energy. It provides research and development services for conversion processes such as combustion, gasification and pyrolysis, for thermal storage and for the production of energy carriers such as synthesis gas and fuels. Additional expertise in the areas of process heat, combined heat and power generation and emissions reduction leads to efficient and clean solutions. The site has plants for the decentralized use of energy from biomass, biogenic residues and waste, harnessing thermochemical processes, mobile and stationary thermal and chemical energy storage systems, plus modern catalyst test rigs and units for hydrogenation and distillation units.

In the laboratories, test rigs and measuring equipment are available for testing furnaces, filter systems and energy storage systems, as well as extensive flue gas purification and advanced online gas analysis.

- Thermochemical processes
- Energy from biomass
- Process heat and storage integration

Contact

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Recycling Management

The Recycling Management portfolio includes establishing waste management strategies, developing innovative recycling processes and producing powder materials. Feasibility and profitability studies, sustainability assessments, resource strategies and concepts for recycling waste are developed in the field of waste management strategies, with a particular focus on international contexts.

The Recycling Technologies group develops new plants and processes for recycling waste containing plastics, composite materials and minerals. This includes processes for the chemical recycling of plastics. In the field of powder materials, the focus is on processes for powder production, material development and material recycling – with an emphasis on additive manufacturing.

- Waste and resource strategies
- Recycling technologies
- Materials for additive manufacturing

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Industry Lab

The Industry Lab in the Sulzbach-Rosenberg CES Technical Center, which opened in 2019, offers companies a digital development, testing and application environment. Its technical focus is on energy technology, recycling, plant construction and process engineering.

The Lab is an ideal location for agile project teams or corporate start-ups seeking scope for creativity and freedom. To develop prototypes, companies can use the mechanical workshop with additive manufacturing, the institute's own digital framework, plus laboratories and test areas. Collaboration with IT specialists and experts in other disciplines leads to rapid results in optimizing processes and developing new products or services, with a scope covering everything up to digital business models.

Contact

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*Top:
Since July 1, 2012, Fraunhofer
UMSICHT has had an
institute branch located in
Sulzbach-Rosenberg in the
Nuremberg Metropolitan
Region.*

SUSTAINABLE DEVELOPMENT GOALS

Our contribution to the Sustainable Development Goals of the United Nations

Our projects in the fields of climate-neutral energy systems, resource-efficient processes and circular products are making tangible contributions towards achieving the United Nations' 17 Sustainable Development Goals (SDGs). Our work focuses primarily on the following six goals.

- SDG 6:
Clean Water and Sanitation
- SDG 7:
Affordable and Clean Energy
- SDG 11:
Sustainable Cities and Communities
- SDG 12:
Responsible Consumption and Production
- SDG 13:
Climate Action
- SDG 14:
Life Below Water

Project examples found in the annual report

Climate-neutral energy systems

- Making inland ports climate-neutral (p. 36)
- Producing chemical products sustainably (p. 37)
- Climate-friendly thermal energy for an Oberhausen district (p. 37)

Resource-efficient processes

- Digitalization as a driver for cross-industry networks (p. 38)
- New fuel for climate-neutral energy (p. 39)
- Resource-saving wastewater treatment (p. 39)

Circular products

- Bio-based, recyclable and durable bottles (p. 40)
- How sustainable are artificial turf pitches? (p. 41)
- Resource-saving glass-film roofs (p. 41)

Lines of research presented in the annual report


- Fraunhofer Cluster of Excellence Circular Plastics Economy CCPE (p. 26/27)
- IN4climate.NRW – think tank for a climate-neutral future for industry (p. 28/29)
- Carbon2Chem® joint project – a key building block for the climate protection (p. 30/31)
- H₂Giga lighthouse project – industrializing electrolysis (p. 32/33)
- Performance Center DYNAFLEX® – shaping transformation sustainably (p. 34)
- Fraunhofer Group for Resource Technologies and Bioeconomy VRB (p. 35)

More information about our lines of research

www.umsicht.fraunhofer.de/en/lines-of-research.html 

This might also interest you

International projects

www.umsicht.fraunhofer.de/international 

Examples of ongoing projects

- DigitalFire – digitalization of biomass furnaces
- ElkaSyn – energy-efficient electrosynthesis of alcohols
- ELuStat – iron-air battery as stationary energy storage
- Farming the Uncanny Valley – Participatory discourse on bioeconomy (ended March 2021)
- FlexKaelte – making cooling supply systems more flexible
- FungiFactoring – mushroom-based sound insulation
- Geothermal paper drying
- HESKH – hybrid energy storage hospital
- HYPKomp bundles system services
- iMulch – plastics in soils
- InKa – intermediates from industrial spent coffee grounds
- IsoSTOR^{Retrofit} – increasing the efficiency of industrial compressed air systems
- KompEx – compressed air energy storage for site-independent use
- LowCH₄-MDT-Module – use of coal mine methane
- LUZI – laboratory for urban future questions and innovations
- Power2C4 – by catalysis from ethanol to butadiene
- PyroMar – innovative environmentally friendly fuels for shipping
- Sci4climate – climate-neutral industry in North Rhine-Westphalia
- SW.Developer – new strategies for municipal utilities

More projects in our overview


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

Get in touch

The best references for our work are the projects we are working on and have successfully completed. However, some of our research is subject to confidentiality, preventing us from showcasing it.

With this in mind, please feel free to contact our departments directly, if you cannot find any information on a specific subject you are interested in.

Information about our competencies

www.umsicht.fraunhofer.de/competencies 



*Left:
Guiding principles of
Fraunhofer CCPE*

Fraunhofer Clusters of Excellence combine the expertise of different institutes in order to research important subjects with scientific excellence. The aim is to establish virtual institutes with international visibility.

Fraunhofer Cluster of Excellence Circular Plastics Economy CCPE

The aim of Fraunhofer CCPE is to make the plastics value chain circular – and switching from a linear to a circular plastics economy requires a multi-stakeholder approach. That is why six Fraunhofer institutes – IAP, ICT, IML, IVV, LBF and UMSICHT – have been working together since the end of 2018 to research systemic, technical and social innovations across the entire life cycle of plastic products.

In a circular plastics economy, resources can be saved, products can be intelligently designed for long-term use, and end-of-life losses can be reduced. Around 80 employees are working towards these goals through their interdisciplinary research in the three divisions of Fraunhofer CCPE: Materials, Systems and Business. Research conducted in the Division Materials includes formulations for circular polymers and compounds, plus new additive systems that create stable recyclates or multiple recycling cycles. The Division Systems develops intelligent collection, sorting and recycling technologies with the aim of establishing optimum value-added cycles. In the Division Business, new system solutions for plastics in the circular economy are being developed, such as assessment tools and circular business models.

Strengthening internationalization

Fraunhofer CCPE has been established as a center for transformational research into the circular plastics economy and has acquired around 60 industry projects since its launch in 2018. In 2021, the cluster underwent an interim evaluation, the results of which were very positive.

“The interim evaluation was an important milestone for us. We have shown that Fraunhofer CCPE has established itself as a central hub and pool of expertise for the circular plastics economy at Fraunhofer. This cluster is helping us to shape the transition to a circular economy – which means that we are working with our partners to create innovations in the production, product design, use and recycling of plastics,” summarizes Dr. Hartmut Pflaum, Head of Office Fraunhofer CCPE.

The next milestone is the internationalization of the cluster, which will be boosted through activities such as cooperation with European R&D institutions, the CCPE Summit on February 8 and 9, 2023, and a Springer Handbook (to be published in 2023).

From collection to chemical recycling

In 2021, researchers from CCPE succeeded in developing an innovative recycling process for waste plastics. The pilot project, which also involved SABIC and Procter & Gamble, set out to demonstrate that disposable face masks are suitable candidates for closed-loop recycling. To this end, P&G initially set up collection containers for disposable masks from employees and visitors at all production and research sites in Germany, then sent these to Fraunhofer UMSICHT for further processing. "Single-use medical devices such as face masks are subject to strict hygiene requirements during both disposal and production. Mechanical recycling would not be a viable solution for them," explains Dr. Alexander Hofmann, Head of Department Recycling Management at Fraunhofer UMSICHT. "Our concept starts with automatic shredding followed by thermochemical conversion into pyrolysis oil. The pressure and heat break down the plastic into molecular fragments during pyrolysis, a process that destroys elements including pollutant residue and pathogens such as the coronavirus. Subsequently, new raw materials for plastics production can be obtained from the masks, and these materials also meet medical device requirements," adds Hofmann, who is also Head of the Research Department Advanced Recycling at Fraunhofer CCPE. The entire recycling project – from collection of the face masks to new production – was developed and implemented within just seven months.

Circular Readiness Level®

The newly developed self-check tool named Circular Readiness Level® has also made its mark. Companies can use the tool to subject their products, services or business models to a self-check that focuses on circularity. This involves an evaluation process with 15 categories and provides answers to questions including the following: Is the product multi-functional, repairable or able to be dismantled? Is end-of-life recycling possible? Does the product consist of secondary, renewable or biodegradable plastics? In a second step, companies receive both an assessment of their product's Circular Readiness Level® and recommendations for further action.

The Fraunhofer CCPE compact series of events was launched in 2021 with much success. In three two-hour online workshops, key aspects of the circular plastics economy were presented to experts and the general public, with the floor then opened for discussion. All the events were met with a highly positive response and drew over 400 participants from industry, associations, politics and the wider community.




Dr.-Ing. Hartmut Pflaum

Fraunhofer CCPE Summit 2023

A major conference is being planned for February 8 and 9, 2023: the Fraunhofer CCPE Summit, which will also see the unveiling of the Springer Handbook on the circular plastics economy. Researchers from the cluster are working in a team with internationally renowned authors to achieve this. "The summit is an excellent opportunity to showcase our expertise in the world of circular plastics, something that aligns perfectly with our long-term goal of establishing Fraunhofer CCPE as a center of innovation and solutions for the plastics industry," explains Dr. Hartmut Pflaum.

More information: www.ccpe.fraunhofer.de/en.html 

Face masks recycling: s.fhg.de/an5 

Circular Readiness Level®: <https://ccpe.Impl.fraunhofer.de/selfcheck> 

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IN4climate.NRW – think tank for a climate-neutral future for industry

Immense efforts are required, if we are to meet the targets of the Paris Climate Agreement, and they need to be addressed as a matter of urgency. Now is the time to develop a structure for a sustainable world in which it is possible to do business in a way that is both climate-neutral and competitive. The IN4climate.NRW initiative is pursuing a mission of shaping this process of change together with companies, scientists and politicians.

Creating an industrial site that is both competitive and climate-neutral demands fundamentally new production processes and methods, along with improved infrastructures and parameters. To this end, the IN4climate.NRW project is designing cross-sector solutions and is creating synergies between different sectors. The project partners are identifying and evaluating different technologies and are considering the infrastructure needs. One of the main areas of focus is on gas networks – for gases including hydrogen and, in the long term, CO₂ – and on components linked to these, such as storage technologies and renewable energy plants. At the same time, necessary adjustments are being made to the political and legal framework.

Fraunhofer UMSICHT is the scientific advisor for the overall project, working under the auspices of SCI4climate.NRW. Its tasks have included compiling studies and discussion papers and developing new conceptual approaches. A look at publications from 2021:

Strategy for the heat transformation

Process heat generated during the production of important basic materials such as metal or cement accounts for around two thirds of the energy required by German industry. Although the heat transition is a significant part of the energy transition, it is currently stagnating. “Industriewärme klimaneutral: Strategien und Voraussetzungen für die Transformation” (“Climate-neutral industrial heating: strategies and prerequisites for the transformation”) is a discussion paper that illustrates ways of achieving the conversion to a climate-neutral supply. It identifies key challenges as interdependencies between companies, higher-level network planning and political frameworks, along with how these areas interact with the development of suitable technologies on an industrial scale. It states that the most important courses of action are to increase

Left:

Circular economy in the basic materials industry: high potential for saving resources and reducing greenhouse gas emissions.

Middle:

IN4climate.NRW partner GMH uses waste heat for applications such as steel production or heating water.

Right:

Discussion paper by the IN4climate.NRW hydrogen working group on the development of Germany's National Hydrogen Strategy.



efficiency, develop renewable heat sources, use renewable electricity for heat generation and use alternative energy sources.

Securing the hydrogen supply

Sustainably produced hydrogen is essential to the energy transition, as it can replace coal and gas in industry, heating and power supplies. Since national generation is not expected to be able to meet the projected demand for hydrogen, the German government is relying on large-scale imports from regions that are rich in wind and sun. Even if all the exports from these regions were supplied to Germany, however, the demand for hydrogen would still not be fully covered by 2030.

This is the conclusion of a study by the German Economic Institute, Fraunhofer UMSICHT and the Wuppertal Institute, which states that domestic hydrogen production must continue to be increased on a massive scale until demand can be met by imports. The study emphasizes that infrastructures for hydrogen production and for logistics and conversion into derivatives must be planned, and approval procedures must be initiated as a matter of urgency. A joint European approach is being recommended as a means of setting global standards with regard to certifying guarantees of origin.

Circular economy in the basic materials industry

Establishing a circular economy for raw materials could be a major contributor to defossilization. In the discussion paper “Circular Economy in der Grundstoffindustrie: Potenziale und notwendige Rahmenbedingungen für eine erfolgreiche Transformation” (“Circular economy in the basic materials industry: opportunities and essential prerequisites for a successful transformation”), IN4climate.NRW provides an overview of the current situation and presents a vision of the circular economy in the energy-intensive industrial sector. Building on this, specific proposals for measures are determined along with regulatory and political recommendations for action that will continue to close material cycles. The study’s authors see significant potential in the development of technology for material separation and recycling and in the increased use of by-products and residual materials.

More information: s.fhg.de/xLw 

s.fhg.de/nxL 

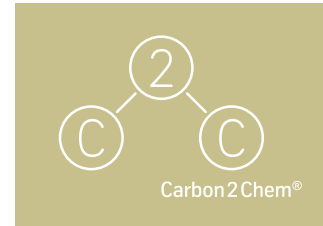
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*Left:
The Carbon2Chem® laboratory, measuring
500 square meters, at Fraunhofer UMSICHT
in Oberhausen.*

*Bottom:
The logo of the research project*



Carbon2Chem® – a key building block for the climate protection

SPONSORED BY THE



Federal Ministry
of Education
and Research

The Carbon2Chem® research project, funded by the German Federal Ministry of Education and Research, was launched six years ago with the aim of reducing the footprint of the basic materials industry by defossilizing production. The intention is to produce carbon-based basic chemicals such as methanol, urea, higher alcohols and polymers on an industrial scale through cross-industry production networks using carbon dioxide-containing process gases and renewable energies. Important milestones have been reached along the way – from the expansion of value chains to the successful launch of the next stage in the planned upscaling phase.

Expansion of value chains

The research project coordinated by Fraunhofer UMSICHT, the Max Planck Institute for Chemical Energy Conversion and thyssenkrupp AG has been in its second phase since 2020. “This means we are aiming to implement previous developments in industry,” explains Dr. Torsten Müller from the Carbon2Chem® project office.

“Part of this involves thinking about how to add more value to the products that are produced. In the new L-VIII subproject, we are doing this with a focus on the methanol car.” Methanol is a main product of Carbon2Chem®. It has the potential to provide another environmentally friendly alternative in the transportation sector for regions without sufficient charging infrastructures or hydrogen supplies. To this end, a concept for a hybrid drive for cars is being refined, optimized and implemented as a demonstrator.

Upscaling phase

Reflecting this work, in 2021 it was possible to move on to a subsequent stage that involved demonstrating the production of methanol based on hydrogen and synthetic metallurgical gases. More specifically, the Fraunhofer UMSICHT pilot plant was able to produce methanol continuously over a period of five weeks. “The plant initially ran for 20 days on carbon dioxide and hydrogen. We then varied the composition of the feed gas and adapted the proportions of carbon monoxide, carbon dioxide, nitrogen and hydrogen to the composition of metallurgical gases,” explains UMSICHT scientist Dr. Andreas

Menne. A total of 1,700 liters of raw methanol was obtained during this test series.

To optimize the processes further, the researchers merged the data from the experimental studies conducted on a laboratory and demonstration scale and on the basis of synthetic and real metallurgical gases with process simulations. With each test series, the process simulation maps reality more and more accurately and makes it possible to calculate the economic efficiency and carbon footprint, thus optimizing the production plant operation with a view to large-scale implementation. Establishing further links between the process simulation and plant operation creates what is known as a digital twin of the plant. The idea is that, in the future, this will make it possible to control the plant in a way that enables it to react proactively to fluctuating material and energy flows within the cross-industrial network, for example.

Opening a dialog with society

To make developments such as these accessible to the general public, the Coordination and Communication (L-KK) subproject initiated a number of different formats, including a June 2021 workshop entitled “Every day for future: Wie sich Forschung für den Klimaschutz engagiert” (“Every day for future: how research is contributing to climate protection”). Around 80 participants gained insights into the work of Carbon2Chem® scientists – from analytics to gas purification. The workshop was concluded with a lecture by Prof. Harald Welzer from the FUTURZWEI Stiftung, a foundation for future viability, who addressed the question of how these research activities are perceived by society. The discussion that accompanied his lecture ran along different lines than expected. Climate change, Prof. Welzer said, is a dominant subject in the media but one that the world at large has no real interest in. He added that no connection is made between climate change, the planet’s dwindling resources and people’s everyday lives – and this is where the problem lies.

Establishing this connection is the objective of a second communications format launched in 2021 with the involvement of Carbon2Chem®: the “WissKomm Energiewende project” for communicating scientific information on the energy transition also funded by the German Federal Ministry of Education and Research (BMBF). At its core is an exhibition on research into the energy transition, being shown at various locations in Germany including the Industrial Museum in Hattingen and the Klimahaus Bremerhaven. It presents changes that the energy transition is set to bring, using examples of ongoing research and development projects relating to energy networks, material cycles, the transport sector and the political environment.



Dr.-Ing. Torsten Müller

Expert discussion

The project was among those presented at the “4th Conference on Sustainable Chemical Conversion in Industry” in November. In keeping with 2021’s theme of sharing expertise, almost 200 participants came together virtually and in person in Düsseldorf to learn about and discuss the latest Carbon2Chem® results. The results of the joint project were used to illustrate the position it has established as a cornerstone of climate protection measures. At the beginning of the conference, the then Federal Minister of Education and Research Anja Karliczek highlighted the importance of the project in her video message: “Carbon2Chem® captures the spirit of the times.” She reported that the G20 climate summit in Glasgow had shown that carbon emissions are still too high and that the ability to change this lies with industry. “That’s why using unavoidable carbon dioxide to make basic chemicals like methanol or higher alcohols is precisely the right approach.”

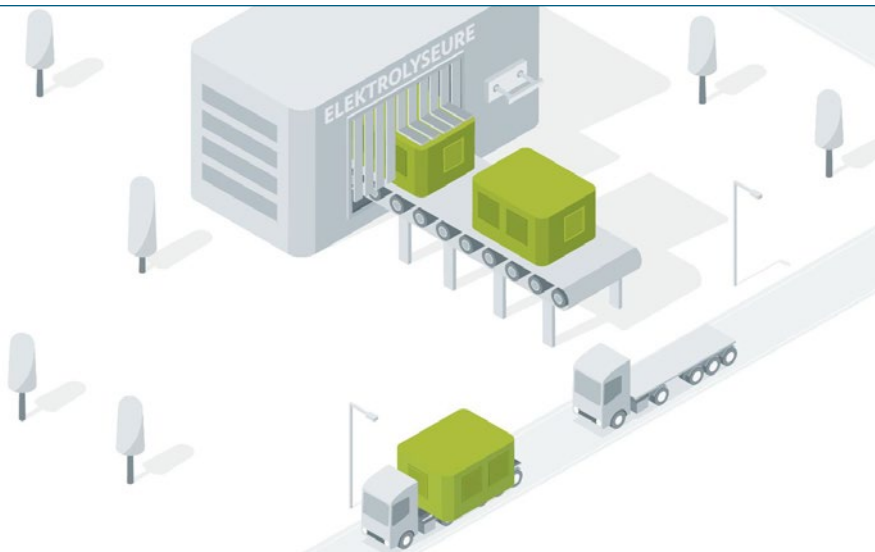
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The H₂Giga lighthouse project is aiming to introduce series production of electrolyzers for creating green hydrogen.

Lighthouse project H₂Giga – industrializing electrolysis

The H₂Giga lighthouse project is aiming to series-produce electrolyzers that will make it possible to create green hydrogen. Initiated and supported by the German Federal Ministry of Education and Research, it unites approximately 30 independent groups. In one of these, Fraunhofer UMSICHT is leading a work package labeled “Design of Tomorrow” – and is gaining an opportunity to venture down entirely new paths in its research.

With more than 130 participating institutions from industry and science, funding of up to 500 million euros and a duration spanning four years, H₂Giga is a truly gigantic lighthouse project. To industrialize the production of electrolyzers and make it more cost-effective, the project partners are working on reinventing individual components or assembling them in a way that allows them to be manufactured automatically. “At the moment, these devices are still being produced by hand, which is not very cost-effective,” says Prof. Ulf-Peter Apfel.

Research with a “license to fail”

The UMSICHT scientist is working together with his colleague Dr. Anna Grevé on the “Industrialization of PEM Electrolysis Production” (PEP.IN) research project coordinated by MAN Energy Solutions. There are essentially two parts of this project, one of which focuses on areas including automation, industrialization of production and processes that are mass production-ready, fast and inexpensive. “The other part has the lovely name ‘Design of Tomorrow’, and it’s where we come in,” explains Dr. Anna Grevé. “It revolves around the question of what a completely different system to the one being created in the first part might look like. Could it involve entirely different designs that provide significantly more benefits – like seal-free stack designs? Or is there potential for other designs that are still simply inconceivable with the materials we have available today? The best part of working on all of this is that our design doesn’t even have to work at the end of the project – so we essentially have a license to fail and do whatever we like!”



We're also thinking about recycling already, because a cell like this won't last forever."



Dr.-Ing. Anna Grevé

Market-standard performance parameters at a glance

This does not mean that the research will involve taking stabs in the dark, however – in fact, quite the opposite is true. "We have a very precise idea of where we want to go," states Prof. Ulf-Peter Apfel. "We definitely have to meet the performance parameters that are currently on the market. This means that our design must be able to easily withstand current densities of 1.2 to 1.8 amps per cm², at a cell voltage of approximately 1.6 volts per cell." The researchers are hoping to achieve a single module with a cell area of 600 cm². The system that they develop also needs to be stackable.

Wanted: a more sustainable alternative to current systems

Another special feature of the "Design of Tomorrow" work package is that the researchers are pursuing a minimalist approach. "Specifically, this means we are replacing or reducing cell components that are currently very expensive or rare," says Dr. Anna Grevé. "We're also thinking about recycling already, because a cell like this won't last forever – it's likely to break down after 50,000 hours." With this in mind, work to develop a sustainable alternative to current systems is underway.

To achieve this goal, the researchers are trying to completely eliminate seals in the construction of the new electrolysis cells and simplify assembly by reducing the number of individual components. Their focus is on both the design of the individual components, such as the membrane-electrode unit, and on characterization.

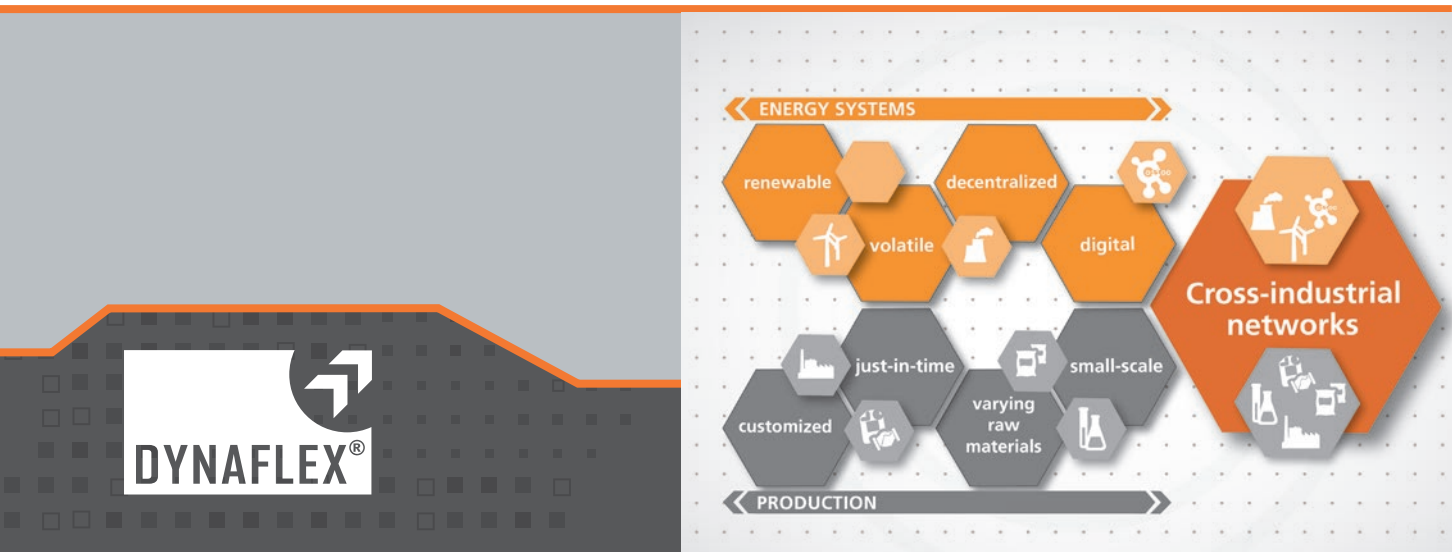
More information

www.wasserstoff-leitprojekte.de/projects/h2giga 
s.fhg.de/5pn (German site) 

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Performance Center DYNAFLEX® – shaping transformation sustainably

The energy transition and raw materials shift is one of the key elements in structural transformation and requires a shift in mindset in many respects. There is an increasing focus on technologies whose purpose is to increase efficiency and eliminate carbon emissions, as well as on cross-sector and cross-industry approaches. To ensure that successful ecosystems relating to innovation and industry can continue to evolve in a dynamic and volatile environment, coordinated and adaptable solutions are needed at the interface of the energy and basic materials industries.

Cross-industry networks

Sustainable and environmentally friendly value creation means a change of mindset for the stakeholders it affects, but it also gives them a competitive edge. Experts believe that the future will see joint action by players in regional cross-industry networks. In the Performance Center DYNAFLEX®, technological solutions and system proposals are being developed for this purpose alongside operating and business models. Together with its partners, DYNAFLEX® is continuously promoting the importance of transferring research, expertise and technology to industrial applications in the fields of sector coupling, cross-industry production systems, multimodal networks, power-to-X, flexible production, digitalization technologies and more.

Making a difference through transfer

To ensure that the Performance Center DYNAFLEX® is able to continue developing over the long term, strategic fields of action that focus on market needs and bring innovations to the market are being expanded.

The center revolves around transfer to industry and society across a whole gamut of subject areas, using specific application and research projects as well as accompanying measures. Most of all, it is aiming to achieve direct, short-term effectiveness. For SMEs in particular, it offers numerous services in the areas of contract research, licensing, spin-offs, standardization, transfer via minds, infrastructure and science communication. With demonstrators, industrial test environments and digital platforms available, it is driving forward the process of transfer to industry and ensuring competitiveness as a result.

More information

dynaflex.de/index.php/en  s.fhg.de/5cE 

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*Left:
The Performance Center
DYNAFLEX® is making an
active and essential contribu-
tion to a future-focused and
socially compatible energy
transition and raw materials
shift.*

*Right:
Key visual of the Fraunhofer
Group for Resource Techno-
logies and Bioeconomy.*

Fraunhofer Group for Resource Technologies and Bioeconomy VRB

The aim of the Fraunhofer Group for Resource Technologies and Bioeconomy VRB is to develop solutions for the responsible management of natural resources. The focus is on technologies that make it possible to use resources efficiently and safely, convert the linear economic system to a circular one, decouple economic growth from resource use within the context of a bioeconomy and safeguard the health of humans, animals and the environment.

Sustainable development requires the responsible use of natural resources. Resource productivity is an important consideration in this context and allows us to determine how efficiently raw materials are being used in our industry over an extended period. Germany's Sustainable Development Strategy is aiming to achieve growth in raw materials productivity amounting to an average of 1.6 percent per year from 2010 to 2030. However, the rate of growth has slowed significantly.

As a result, the Fraunhofer Group for Resource Technologies and Bioeconomy was founded in 2021 with the aim of counteracting this trend. In its inaugural year, the four member institutes conducted an expertise screening to identify areas of focus and accepted two guest members to enhance the group's portfolio.

The Fraunhofer for Resource Technologies and Bioeconomy develops system solutions in the following fields:

- Technologies for efficient and safe resource use
- Converting the linear economic system to a circular one (circular economy)
- Decoupling economic growth from the use of resources and reducing the associated environmental impact within the context of a bioeconomy
- Relationships between the health of humans, animals and the environment (circular health/one health)

Members

Fraunhofer IGB, Fraunhofer IME, Fraunhofer IVV, Fraunhofer UMSICHT

Guest members

Fraunhofer IAP, Fraunhofer IWKS

Group spokesperson

Prof. Dr.-Ing. Eckhard Weidner, Fraunhofer UMSICHT

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Climate-neutral energy systems – project examples

The switch to renewable energies requires sustainable solutions to coordinate energy supply and demand. Efficient energy processes, new storage technologies and intelligent systems are all essential. This is where Fraunhofer UMSICHT comes in through its role in researching solutions for a sustainable, climate-neutral energy supply. These three examples provide insights into what we are currently working on.

“
Inland ports are special urban areas with their own energy requirements.”
”



Making inland ports climate-neutral

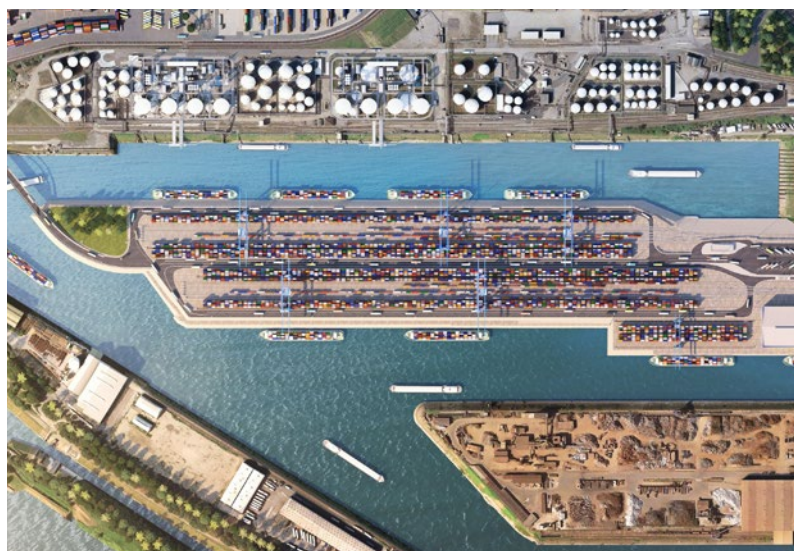
There are over 170 inland ports in Germany. What makes them special is their combination of freight transport and logistics companies with commercial and residential areas. In the “ener-Port” project, Fraunhofer UMSICHT and Duisburger Hafen AG (Duisport) have been investigating how districts such as these can be further developed while taking the challenges of the energy transition into account.

One of the outcomes is a method that optimizes and evaluates the combination of different energy plants and power-to-X technologies. Focusing on implementation and bringing additional partners on board, the follow-up project will involve selecting technologies and developing appropriate operator

*Left:
Visualization of the planned terminal – planning status in March 2019*

*Middle:
Electrochemical cell for the conversion of organic chemicals on a laboratory scale*

*Right:
Four flexible local heating islands are being built in the Tackenberg district of Oberhausen as part of the QUENTIN project.*



and business models for the design of a new container terminal in the port of Duisburg. A sustainable energy system will be installed on the former coal island, which will combine renewable energies, energy storage systems and consumers. In the long term, it will also be able to supply neighboring districts.

More information: s.fhg.de/8JR (German site) 

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Producing chemical products sustainably

Many manufacturing processes in the chemical industry are based directly or indirectly on fossil fuels – and this is something that the junior research group “H₂Organic” is hoping to change. Harnessing an electrochemical synthesis process, its aim is to use electricity from renewable sources to produce chemical products with a “green footprint”.

The researchers are focusing on hydrogenation – a standard reaction on both a laboratory and industrial scale, in which hydrogen is transferred to organic chemicals. This means giving consideration to all the steps required to design and optimize a process like this – from the basic design of the electrochemical reactor to specially adapted catalyst materials acting as reaction accelerators and the manufacture of corrosion-resistant reactor components.

More information: s.fhg.de/33m (German site) 



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Climate-friendly thermal energy for an Oberhausen district

Four flexible local heating islands are being built in the Tackenberg district of Oberhausen as part of the “QUENTIN” project. In the future, they will supply environmentally friendly thermal energy to more than 800 residential units provided by the housing associations, Osterfeld and Oberhausen-Sterkrade plus two local schools and a sports hall.

The project is based on an energy supply concept developed by energy service provider Energieversorgung Oberhausen AG (evo) and Fraunhofer UMSICHT, with support provided through building renovations carried out by the housing associations. At the heart of the concept is a combined heat and power plant of the district with an intelligent storage management system featuring centralized and decentralized heat storage units. Combining heat and power generation both saves energy and reduces carbon emissions.

More information: s.fhg.de/tmL 
s.fhg.de/4J7 (German site) 

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Resource-efficient processes – project examples

Resource-saving and efficient processes are essential, if we are to achieve the UN's climate goals and Germany's national targets. Fraunhofer UMSICHT is expanding the spectrum of possible conversion processes, as well as developing them, adapting process steps and optimizing them.



The goal is to integrate the existing biogas plant into the material and energy supply of the industrial park.”

Digitalization as a driver for cross-industry networks

Biogas plants are a key component of the energy transition. But can they be economically viable without government funding? In the “DIANE” project, Fraunhofer UMSICHT is conducting research into the potential of these plants in a cross-industrial network. The aim is to integrate existing biogas plants into the material and energy supply of industrial parks in order to provide neighboring companies with raw materials. Before this can happen, however, the value chain needs to be fully digitalized. The project hopes to produce a guideline for increasing flexibility and optimize energy efficiency and material usage in existing biogas plants that are no longer subsidized by the German Renewable Energy Sources Act (EEG). New business

*Left:
Biogas plant in an industrial park in Hünxe*

*Middle:
Large quantities of leaves accumulate in the fall and can potentially be recycled in a closed loop.*

*Right:
ZeroTrace activated carbons being used in a pilot test at the Wuppertal-Buchenhofen wastewater treatment plant*



models are also being developed. “DIANE” is part of the “Spitzencluster industrielle Innovationen” (SPIN), an alliance of industry, the energy sector, digital technology and applied research, which promotes future technologies in pilot projects.

More information: s.fhg.de/sr2 (German site) 

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New fuel for climate-neutral energy

Cities and municipalities accumulate enormous quantities of leaves on a seasonal basis, which are removed by street cleaners. Once collected, this biomass usually ends up in composting plants. However, this is a problematic approach as leaves usually have poor rotting properties and take up space in the plants in fall and winter. Despite this, they do have good incineration properties if pretreated appropriately. Researchers at Fraunhofer UMSICHT are using the “LaubCycle approach” to address these properties and are developing a closed cycle for the municipal recycling of leaves. The aim is to use regional fuels for energy production in biomass furnaces and as nutrients on soils.

More information: s.fhg.de/9Fq (German site) 

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Resource-saving wastewater treatment

Wastewater and other water bodies are often very highly contaminated with trace substances such as pharmaceutical residues, especially in densely populated regions and industrial conurbations. To remove these trace substances, wastewater treatment plants primarily use powdered activated carbon based on coal, which is incinerated once fully loaded. In the “ZeroTrace” project, Fraunhofer UMSICHT has adopted a holistic approach in its efforts to sustainably optimize the use of activated carbon. At the core of this are electrically conductive composite activated carbons made from renewable materials such as wood or coconut. They are reactivated at high temperatures using an innovative process based on electric field swing adsorption (EFSA). Low-wear regeneration takes place continuously on site at the wastewater treatment plant, which means that a relatively small reactor is sufficient and there is no need for transport to central reactivation plants.

More information: s.fhg.de/G4A (German site) 

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Circular products – project examples

Sustainable product development requires the use of environmentally compatible materials and a holistic view of the entire value chain, providing the basis for a circular economy. A comprehensive sustainability assessment needs to address these needs in order to identify any conflicting goals. These project examples illustrate how this can be achieved

“Combining recycling and biological degradation is not a contradiction and can be of genuine value to the circular economy.”



Bio-based, recyclable and durable bottles

In the “Bio2Bottle” research project, Fraunhofer UMSICHT is working with four partners to conduct research on bio-based and recyclable plastics. The aim is to develop bio-based bottles that are recyclable and suitable for storing cleaning agents and agricultural soil additives. In addition to being recyclable, the materials being developed also need to be biodegradable when disposed of outside industrial composting facilities. This requirement is particularly important when packaging or bottles are discarded improperly (littering). Combining recycling and biological degradation is not a contradiction and can be of genuine value to the circular economy.

*Left:
The twin-screw extruder
can be used to produce
compounds from bio-based
components, for example.*

*Middle:
Circumferential metal sheet
to retain infill*

*Right:
In the ALTMARKTgarten
Oberhausen rooftop green-
house, researchers are testing
the glass-film roof under real-
life conditions.*



The three main material requirements for bio-based bottles are the ability to be processed in conventional bottle production plants, a high level of mechanical stability and improved gas barriers compared to the current state of the art. In order to meet these requirements, the researchers are selecting bio-based polymers and modifying their properties by compounding them with other components.

More information: s.fhg.de/TjD (German site) 

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How sustainable are artificial turf pitches?

The main argument in favor of artificial turf pitches is that they can be used in any weather conditions, making it possible to play sports outdoors on them all year round. However, they are also associated with negative environmental impacts due to properties such as emitting microplastics. This is because artificial turf pitches contain rubber granules (performance infill) in addition to sand (functional infill). Wind and rain as well as the players themselves, cause rubber granules to contaminate the soil and waterways. Fibers are also rubbed off and released from the artificial turf surface as a result of game play. However, a system analysis carried out by Fraunhofer UMSICHT is now reporting on the environmental impact of this material and providing recommendations on how pitches can be made more sustainable. The researchers believe that there is significant potential for optimization in the material selections made for the substructure and infill, the choice of location for the pitch, the structural integration of barriers and recycling.

More information:

s.fhg.de/Cv2 

Download german study:

publica.fraunhofer.de/dokumente/N-640390.html 

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Resource-saving glass-film roofs

Although light and bright on the surface, glass roofs are actually heavy structures that use significant amounts of resources. Transparent overhead glazing usually consists of several panes of insulating glass. With this in mind, Fraunhofer UMSICHT is researching film-based materials that can be used to cover roofs in a way that allows light to pass through. In the “Light-Light-Roof” project, researchers are developing an innovative, modular lightweight system in cooperation with Wolfgang Block Industrie- und Gartenbau GmbH & Co. KG. This combines a glass-film modular system with an inner roof made of mobile, light-permeable and infrared-reflecting material. The modular system achieves weight savings of up to 75 percent compared to conventional multi-pane glass systems.

More information: s.fhg.de/Ku6 (German site) 

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Institute branch Sulzbach-Rosenberg – project examples

In 2021, almost 100 scientific projects were completed at the institute branch Sulzbach-Rosenberg. Three examples in the areas of chemical recycling, thermochemical conversion processes and waste management plans and concepts are described below.

“
Chemical recycling can produce high-quality secondary raw materials suitable for medical devices.”

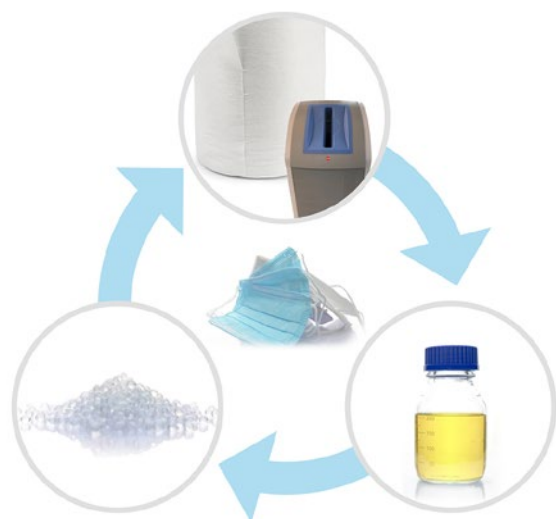
Closed-loop recycling of disposable face masks

A pilot project conducted by Fraunhofer CCPE and Fraunhofer UMSICHT, together with the companies SABIC and Procter & Gamble, has investigated how used disposable face masks can be returned to the mask production value chain. Disposing of single-use face masks in public places can have a negative impact on the environment. At the same time, simply disposing of them in landfills or incinerators means losing valuable raw materials that could be used to produce new materials. Researchers at UMSICHT have demonstrated how used face masks can be returned to the recycling loop with the iCycle® process. This thermochemical process for material separation

Left:
A closed loop from used masks through to chemical recycling, new plastic and non-woven fabric for new masks

Middle:
Technical center for thermochemical conversion of biogenic residues into renewable crude oil

Right:
Opening of the first collection island for recyclables in Siliana (Tunisia)



can also be used to recycle other medical devices, composite materials such as electronic and electrical waste, and sorting scraps from Lightweight packaging.

More information: s.fhg.de/t6y 

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Refueling using paper residues

Fraunhofer UMSICHT is producing a sustainable fuel using paper residues in the “Reststoff2Kraftstoff” project. Involving seven partners from industry and science, the project is processing original feedstock from the paper industry into carbon-neutral crude oil and then further processing this outcome into standard-compliant gasoline and diesel. The product is then tested on a test rig and in a series-produced truck. Dr. Robert Daschner, Head of the department Renewable Energy Technology Department at Fraunhofer UMSICHT in Sulzbach-Rosenberg, says: “In order to achieve climate targets in the mobility sector, we need carbon-neutral fuels – and fast. If nothing else, we have to find a rapid solution for achieving climate neutrality in the thousands of trucks that will still need to be operated for many decades to come.” In total, fuels based on residues from the pulp and paper industry could save up to one million tonnes of carbon emissions each year. In addition to technical feasibility, the legal framework that applies to a fuel made from paper residues is also taken into account.



More information: s.fhg.de/m4S (German site) 

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Sustainable waste management in Tunisia

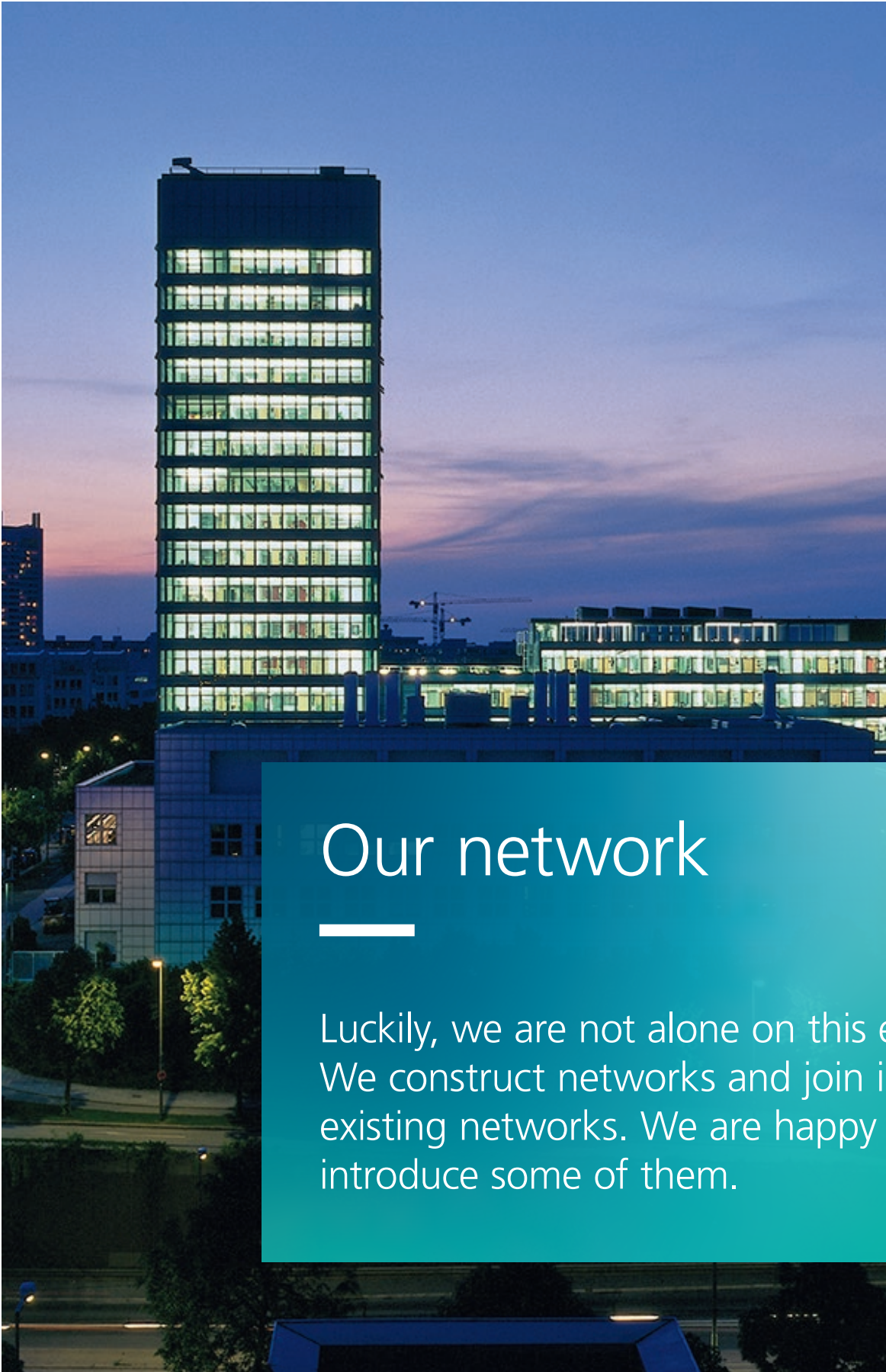
The development project for modernizing waste management in Tunisia, headed by Fraunhofer UMSICHT in Sulzbach-Rosenberg, is in its implementation phase. Three model regions are improving cleanliness in municipalities and value creation through recycling. It is also hoped that separating the collection of hazardous waste will reduce pollution. With the opening of the first collection island in Siliana back June 2021, the project has now reached the point of implementation. In the future, the other pilot communities of Tabarka and Douar Hicher will also see improvements in cleanliness. Waste can now be collected and disposed of in a controlled manner, allowing recyclable materials to be separated for recycling and pollutants to be disposed of safely in order to protect people and the environment.

More information: s.fhg.de/i5a 

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Our network

Luckily, we are not alone on this earth. We construct networks and join into existing networks. We are happy to introduce some of them.

The Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft, headquartered in Germany, is the world's leading applied research organization. With its focus on developing key technologies that are vital for the future and enabling the commercial exploitation of this work by business and industry, Fraunhofer plays a central role in the innovation process. Based in Germany, Fraunhofer is a pioneer and catalyst for groundbreaking developments and a model of scientific excellence.

As a source of inspirational ideas and sustainable scientific and technological solutions, the Fraunhofer-Gesellschaft provides science and industry with a vital base and helps shape society both now and in the future.

Facts and figures at a glance

Last updated: 1/2022

Research with a view to practical applications is the key mission of the Fraunhofer-Gesellschaft, which was founded in 1949. Fraunhofer ...

- conducts applied research for the benefit of industry and society.
- currently operates 76 institutes and research units throughout Germany.
- employs approximately 30,000 people, most of whom are trained in scientific or engineering fields.
- generates a research budget of 2.9 billion euros. Of this sum, 2.5 billion euros are obtained through contract research. Around two thirds of Fraunhofer's contract research revenue are derived from industry contracts and from publicly funded research projects. The remaining third comes from the German federal and state governments in the form of base funding. This enables our institutes to work on solutions that are likely to become vital for industry and society in the coming years.

Contracting parties and customers include industrial and service companies as well as the public sector.

The building of the Fraunhofer-Gesellschaft in Munich.

Fraunhofer as an employer

Fraunhofer offers its researchers the opportunity to undertake independent, creative and, at the same time, targeted work. We provide our employees with a chance to develop the professional and personal skills that will enable them to take up positions of responsibility within Fraunhofer itself or at universities, in industry and in society.

Students who work on projects at Fraunhofer institutes have excellent career prospects in industry on account of the practical training they enjoy and the early experience they acquire of dealing with contract partners.

Fraunhofer president


Prof. Reimund Neugebauer is the 10th president of the Fraunhofer-Gesellschaft and is responsible for the research, science policy and international affairs board divisions. He has been president of the Fraunhofer-Gesellschaft since 2012.

As the first president of non-university research institutions, he uses the business network LinkedIn as an important channel for digital science communication and to provide updates on current developments.

Go to Prof. Neugebauer's articles in the business network LinkedIn:

de.linkedin.com/in/reimund-neugebauer 

More information about Fraunhofer:

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

Board of Trustees

Since 2002, Fraunhofer UMSICHT has been advised by a board of trustees which includes members from science, economics, politics and administration.



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Trustees and its members:**

[s.fhg.de/board-of-trustees](https://www.s.fhg.de/board-of-trustees) 

UMSICHT Science Award



*Left:
Dr. Jörg Schube*



*Right:
Wolfgang Richter*

Marking its 12th outing, in 2021 the UMSICHT Science Award was presented to individuals who promote dialog between science and society. Dr. Jörg Schube impressed the expert jury in the science category, while Wolfgang Richter received the award in the journalism category. The award ceremony took place virtually.

**Award winner in the science category:
Dr. Jörg Schube**

Dr. Jörg Schube has developed an innovative metal printing process called "FlexTrail" for next-generation silicon solar cells. Thanks to the significantly reduced structural width of the printed metal contacts, far less silver needs to be consumed in the production of the solar cells. He has also refined the Intense Pulsed Light (IPL) process so that it can be used to bond solar cells with passivating contacts.

**Award winner in the journalism category:
Wolfgang Richter**

Attribution research can now work out how much more likely a specific event, such as a flood, heat wave or forest fire has become a result of the increase in greenhouse gases in the atmosphere. Will the major emitters of greenhouse gases have to pay compensation for extreme weather events that occur more frequently due to climate change?

Wolfgang Richter sheds light on the entire chain of evidence for the first time, something that could even result in legal action against the major oil and energy companies.

Members of the UMSICHT Friends and Patrons Group

The members of this group support the institute in its pursuit of research and development concepts in the fields of environmental technology, process engineering and energy technology. It also participates in organizing conferences and seminars, supports young and visiting scientists and grants the UMSICHT Science Award.

You too can become a member of the UMSICHT Friends and Patrons Group or sponsor the award. Please get in touch.

More information about the UMSICHT Friends and Patrons:

www.umsicht-foerderverein.de (German site) 

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Interdisciplinary Distance Learning Program in Environmental Sciences: infernum



infernum was named a Place of Progress 2014 and, in 2021, received a commendation from the German UNESCO Commission and the German Federal Ministry of Education and Research for its commitment to education in sustainable development – its sixth accolade of this kind.

Finding successful and scientifically sound solutions to complex tasks in the fields of environmental matters and sustainability requires an interdisciplinary way of thinking and acting. infernum, the interdisciplinary distance learning program dealing with environmental sciences, provides students with the knowledge they need and helps them understand the languages of the different disciplines.

infernum is a joint program offered by the FernUniversität in Hagen and Fraunhofer UMSICHT under the auspices of the Fraunhofer Academy. It combines aspects such as economic performance, social responsibility and ecological compatibility, and in doing so offers students professional further education in the field of sustainable development.


The distance learning program was established in 2000 as a way of enabling students to work independently yet with structure, to continue their scientific education alongside their career and family responsibilities, and to improve their prospects on the job market. Custom courses of study can be compiled from modules on specific disciplines or interdisciplinary modules, and students can join the program at any time.

The following degrees can be obtained:

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

“For more than 20 years now, infernum has enabled us to succeed in establishing a scientific course of study that has been providing our students with the knowledge and the tools they need to make the world a little bit more sustainable. The motivation, dedication and idealism that our students show inspire us to continuously improve infernum and incorporate the latest research and development findings into the program,” says Laura Oehmigen, the course coordinator.

More information about infernum:

www.umweltwissenschaften.de (German site) 

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UMSICHT Research School



The UMSICHT Research School is a support service for doctoral students at the institute, designed to help them to focus on their doctorate and acquire additional qualifications that will prepare them for a career in science and research. In 2021, there were 74 doctoral students in Oberhausen and 12 at the institute branch in Sulzbach-Rosenberg.

The UMSICHT Research School offers UMSICHT doctoral students coaching, qualification programs, personal mentoring, discussion forums with other doctoral candidates, plus networking opportunities at Fraunhofer and in the world of research. Due to the coronavirus pandemic, few in-person events were able to take place last year, but there were plenty of virtual interactions. Coaching sessions were held twice a month, and conferences and further education courses were available as online or hybrid events. "Even though there were few face-to-face gatherings, there were still regular opportunities for communication between the coordinator and the doctoral students in biannual status meetings or in counseling sessions. A separate team channel called Chill-out-Research-School also helped strengthen contact among the doctoral students," says Volker Knappertsbusch, Coordinator of the UMSICHT Research School.



12 Fraunhofer UMSICHT employees received their doctorate in 2021: congratulations to Kai Girod, Jan Girschik, Markus Hadam, Nils Kemen, Kimberley Matschuk, Tim Nitsche, Michael Prokein, Lukas Rüller, Mathias van Beek, Thorsten Wack, Markus Wäsker and Clara Watermann."


Volker Knappertsbusch
Coordination
UMSICHT Research School

Positive feedback from doctoral students

Markus Wäsker: "Interdisciplinary discussions with fellow doctoral students has helped me to make good progress with my doctoral thesis. Everyone encounters problems during their doctoral studies, that others have already experienced and overcome."

Markus Hadam: "One of the biggest challenges I faced during my doctoral thesis was definitely staying motivated throughout the entire project. There comes a point when you can't see the wood for the trees and it's hard to stay focused. Regular communication with my supervisor and my fellow doctoral students was really helpful."

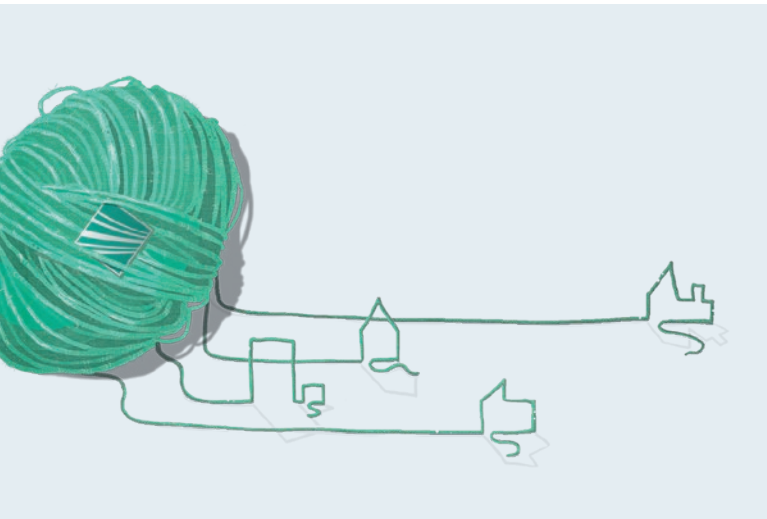
More information about the UMSICHT Research School:
www.umsicht.fraunhofer.de/en/jobs-career/promotion.html 

More information about the link to the university:
s.fhg.de/5iC 

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Spin-offs



Spin-offs provide an opportunity for Fraunhofer researchers to commercialize technologies developed at the institute. Fraunhofer UMSICHT currently has 12 spin-offs in which the combination of a good business idea, a solid financing base, investment and the right management has led to success. In partnership with the institute, the spin-off Volterion won the Joseph von Fraunhofer Prize in 2021.

Spin-off Volterion receives Joseph von Fraunhofer Prize

Volterion produces and sells small-format redox flow batteries. These innovative energy storage devices can be used to retrieve self-generated electricity from fluctuating renewable energy sources, even at night and when the sun is not shining. Redox flow batteries are a particularly exciting prospect because they are cycle-stable, non-combustible, recyclable, scalable and free from critical materials. Until now, however, they have been too expensive for the mass market.

Prof. Christian Doetsch and Lukas Kopietz of Fraunhofer UMSICHT, together with Dr. Thorsten Seipp of Volterion, have completely redesigned the heart of a redox flow battery – the stack – to make it suitable for the mass market and resolve other issues. This involved changing the material composition

Middle:

Were delighted to receive the Joseph von Fraunhofer Prize 2021: Lukas Kopietz, Thorsten Seipp und Christian Doetsch (f.l.).

Right:



Jan Girschik made first place with "SpaceFlow" in the Europe-wide innovation competition "INNOspace Masters".



and manufacturing method of the individual stack components – the bipolar plates – so that they could be welded together. The result is that the new stack is 80 percent lighter, only half the size and, most importantly, significantly less expensive than conventional models. The spin-off Volterion GmbH was founded to bring this new product to market. The "successful exit from Fraunhofer, a prime example of how new manufacturing technologies can be commercialized" was one of the points cited by the jury in its decision to award Volterion the Joseph von Fraunhofer Prize.

Volterion was founded in 2015 as a spin-off of Fraunhofer UMSICHT and is now one of the world's leading suppliers of high quality, high-performance stacks. Its high-tech design is based on weldable, innovative, flexible bipolar graphite electrodes that result in compact, lightweight and reliable stacks.

More information:

s.fhg.de/spinoffs-en  s.fhg.de/LjQ 

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Prizes and awards



We had plenty to celebrate once again in 2021.

Role model for sustainable development

The infernum distance learning program offered by the FernUniversität in Hagen and Fraunhofer UMSICHT once again received the national award of the German Federal Ministry of Education and Research and the German UNESCO Commission, recognizing its commitment to education in sustainable development.

More information: s.fhg.de/687 (German site) [↗](#)

Recognition of theses

Sonja Frerich and Hannah Brenner were delighted to receive a total of 750 euros in prize money from the UMSICHT Friends and Patrons Group for their outstanding bachelor's and master's theses. Their research focused on, respectively, the formability of thermoplastic-based film bipolar sheets and a method for studying plastic emissions on agricultural land.

More information: s.fhg.de/2GH (German site) [↗](#)

Project outline funding

Laura Huwald and Tobias Rieger each received start-up funding of 10,000 euros from the UMSICHT Friends and Patrons Group for their projects on novel fuel cells and an innovative recycling process for plastic waste.

More information: s.fhg.de/2GH (German site) [↗](#)

Innovative energy storage concept for space travel

What might resource-efficient innovations look like in

sustainable infrastructures in space and on earth? The German Space Agency at the German Aerospace Center (DLR) made this question the focus of its INNOspace Masters 2021 challenge. Jan Girschik developed a highly space-efficient flow battery system for satellites and space stations. Named "SpaceFlow", it earned the UMSICHT scientist third place in the Europe-wide innovation competition.

More information: s.fhg.de/2LG (German site) [↗](#)

Zinc-polyiodide flow batteries as emergency power storage systems

In the wake of the coronavirus pandemic, the Fraunhofer-Gesellschaft initiated the "Ramp Up Resilience" ideas competition. Entrants were invited to submit applied solutions and project proposals designed to prepare us for future crises. The best entries were selected at the Netzwert Symposium 2021. On the first day of the event, Jan Girschik was awarded first place with his concept based on self-sufficient zinc-polyiodide flow batteries as a safe and eternal emergency power storage system.

Joseph von Fraunhofer Prize

Redox flow batteries are perfect for storing large amounts of renewable energy. Researchers at Fraunhofer UMSICHT received the 2021 Joseph von Fraunhofer Prize for their full stack redesign (see also p. 50).

Mehr Informationen: s.fhg.de/LjQ [↗](#)

Services

Bibliography/information

Fraunhofer specialized publications and patents

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

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

Information

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

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

UMSICHT-newsletter and press distribution

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www.umsicht.fraunhofer.de/de/formulare/presseverteiler.html

Schedule 2022

Current information about our events/trade fair participations can be found on the internet at:

www.umsicht.fraunhofer.de/en/events-trade-fairs.html

Funding notes

Page 26

The Fraunhofer Cluster of Excellence Circular Plastics Economy CCPE is funded by the Fraunhofer-Gesellschaft.

Page 28

The IN4climate.NRW initiative is funded by the Ministry of Economic Affairs, Innovation, Digitalization and Energy of the State of North Rhine-Westphalia (MWIDE.NRW). Funding code: EFO 0001B.

Page 30

The Carbon2Chem® joint project is funded by the German Federal Ministry of Education and Research (BMBF) under the funding code 03EW0004D (Fraunhofer UMSICHT's part of the project).

Page 32

The Industrialization of PEM Electrolysis Production (PEP.IN) research project is funded by the German Federal Ministry of Education and Research (BMBF) and has received more than 20 million euros. PEP.IN is part of the H₂Giga lighthouse project, one of three hydrogen lighthouse projects that form the main contribution of the BMBF to the implementation of Germany's National Hydrogen Strategy. Funding code 03HY120G (Fraunhofer UMSICHT's part of the project).

Page 34

The Performance Center DYNAFLEX® is funded by the Fraunhofer-Gesellschaft.

Page 36

enerPort is funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWi) within the framework of the EnEff:Hafen initiative. Funding code: 03EN3002A. enerPort II is funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWi) as part of the Hydrogen Technology Offensive. Funding code: 03EN3046C.

Page 37

The Innovative Materials for the Electrocatalytic Hydrogenation of Organic Substrates (H₂Organic) research project is funded by the German Federal Ministry of Education and Research (BMBF) as part of the From Material to Innovation program. Funding code: 03XP0421.

Page 37

The research project titled "District development based on local heating islands with flexible CHP systems and partial renovation" – or QUENTIN for short – is funded by the German

Federal Ministry for Economic Affairs and Climate Action (BMWi) within the framework of the EnEff:Stadt initiative. Funding code: 03EN3003C.

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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 several ways.



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