



ANNUAL REPORT 2011
MAKING THE WORLD A BETTER PLACE TO LIVE



The Fraunhofer-Gesellschaft

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains more than 80 research units in Germany, including 60 Fraunhofer Institutes. The majority of the more than 20,000 staff are qualified scientists and engineers, who work with an annual research budget of €1.8 billion. Of this sum, more than €1.5 billion is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

Affiliated international research centers and representative offices provide contact with the regions of greatest importance to present and future scientific progress and economic development.

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

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.



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Ladies and gentlemen,

The past year brought deep-seated changes in the field of applied research in Germany. The nuclear disaster at Fukushima heightened awareness of the risks inherent in our own energy technology. The federal government's logical decision to carry out a reassessment of nuclear energy and to scale back its share in the country's energy mix faster than previously planned also has consequences for the research community.

For many years, Fraunhofer has been advocating a fast transition to renewable energy sources, and – even before Fukushima – we used actual scenarios to prove that this option is not only possible, but also attractive from an economic point of view. We carry out research and development work in practically all aspects of renewable energy, in particular wind and solar energy, but also hydropower, biomass and geothermal energy. Other aspects of key importance are storage technologies and energy efficiency in connection with mobility, electrical equipment and, most of all, building services technology.

We were quick to amass expertise and build up our capacities in all these fields of research. Nevertheless, much more effort will be required from science if we are to continue developing all the technologies of relevance to energy production and distribution.

In line with its own change of direction in energy policy, the federal government has dedicated its Year of Science 2012 to "Project Earth: Our Future". In so doing, the government intends to draw attention to our shared responsibility for the future. We have taken up this idea, too, and are focusing on the topic of sustainability by giving this year's annual report the motto "Making the world a better place to live". We also took the ancient Greeks' idea of a world comprised of four basic elements – fire, water, air and earth – as the basis for this year's illustrations.

Sustainability is a key topic for Fraunhofer because our research generally has to do with conserving resources. When we optimize processes and products, we reconcile economics with ecology: lightweight, economical products that consume less during their production are cheaper and sell better. We ourselves are no exception to the rule that greater efficiency reduces resource consumption and lowers cost, so we constantly strive to optimize our own research work.

Going forward, we want to bring sustainability more strongly into focus. Successes need to be made more visible – for our customers, who expect a strong commitment to sustainability from us, and for our employees, as an additional incentive to take on responsibility for enhancing efficiency and conserving resources at work.

On the rebound following the global financial and economic crisis, but in a year still marked by difficult conditions, Fraunhofer nevertheless managed to grow by 11 percent – a huge success that tracked the upswing in the German economy as a whole. This demonstrates that we are offering the right products and services, and remain a sought-after partner for business and government.

As a result, we were able to create numerous new jobs. Today, more than 20,000 employees provide our customers with top-class research and development work. It is thanks to their dedication that the world is becoming a better place to live in every year.

Sincerely,

A handwritten signature in black ink, appearing to read 'H. Bullinger', with a horizontal line extending from the end of the signature.

Hans-Jörg Bullinger
President of the Fraunhofer-Gesellschaft



REPORT OF THE EXECUTIVE BOARD

- 8 The Executive Board
- 13 Key figures 2011
- 14 Management report 2011
- 44 Report of the Senate on the financial year 2011

REVIEW OF FRAUNHOFER RESEARCH

- 48 Living with responsibility
- 52 Sustainability – the path and goal of applied research
- 64 Projects and results 2011

FINANCIAL REPORT

- 78 Balance sheet at December 31, 2011
- 80 Income statement for the financial year 2011
- 82 Reconciliation between income statement and performance statement (cash-basis accounting)

SERVICE

- 86 The groups of the Fraunhofer-Gesellschaft
- 91 The alliances of the Fraunhofer-Gesellschaft
- 96 Addresses
- 101 Editorial notes



REPORT OF THE EXECUTIVE BOARD

AIR

Air is a mixture consisting of 78 percent nitrogen, 21 percent oxygen, 0.04 percent carbon dioxide and small amounts of other gases. Organisms need atmospheric oxygen in order to breathe, while plants and some microorganisms release oxygen as a byproduct of photosynthesis. When air moves, it creates winds, which transport dust, winged seeds, pollutants, heat, water, odors and much else besides. The wide-scale combustion of fossil fuels increases the amount of CO₂ in the atmosphere, causing the greenhouse effect. It is thus considered the trigger for changes in the Earth's climate.



THE EXECUTIVE BOARD

MANAGEMENT REPORT 2011

REPORT OF THE SENATE
ON THE FINANCIAL YEAR 2011

THE EXECUTIVE BOARD



Prof. Dr.-Ing. Hans-Jörg Bullinger

Corporate Management,
President of the Fraunhofer-Gesellschaft

Hans-Jörg Bullinger is professor of industrial science and technology management at the University of Stuttgart. He founded the Fraunhofer Institute for Industrial Engineering IAO and was its director for over 20 years, before becoming President of the Fraunhofer-Gesellschaft in 2002.

Hans-Jörg Bullinger also represents the applied research community as an advisory member of Chancellor Merkel's Innovation Dialog and is chairman of the Research Union Economy – Science, which was founded to implement the German government's high-tech strategy.

“THE GERMAN GOVERNMENT’S DECISION TO SWITCH TO ENERGY GENERATED FROM RENEWABLE RESOURCES REPRESENTS A CHALLENGE WE ARE HAPPY TO TAKE UP AS A PROVIDER OF RESEARCH AND DEVELOPMENT SERVICES. WE WANT TO FOCUS OUR EFFORTS ON MAKING THE WORLD A BETTER PLACE FOR ALL MEMBERS OF SOCIETY TO LIVE IN.”

THE EXECUTIVE BOARD OF THE FRAUNHOFER-GESELLSCHAFT CONSISTS OF THE PRESIDENT AND THREE FURTHER FULL-TIME MEMBERS. ITS DUTIES INCLUDE MANAGING THE FRAUNHOFER-GESELLSCHAFT AND REPRESENTING ITS INTERESTS BOTH INSIDE AND OUTSIDE THE ORGANIZATION.

THE EXECUTIVE BOARD FORMULATES THE BASIC PRINCIPLES OF THE FRAUNHOFER-GESELLSCHAFT'S SCIENTIFIC AND RESEARCH POLICY, PLANS ITS EXPANSION AND FINANCES, ENSURES ITS BASE FUNDING AND ORGANIZES THE DISTRIBUTION OF FUNDS AMONG THE INDIVIDUAL INSTITUTES. THE EXECUTIVE BOARD IS ALSO RESPONSIBLE FOR APPOINTING THE INSTITUTES' DIRECTORS.

Prof. Dr. rer. nat. Ulrich Buller

Senior Vice President Research Planning

Ulrich Buller was head of the central research planning department, director of the Fraunhofer Institute for Applied Polymer Research IAP and chairman of the Fraunhofer Group for Materials and Components – MATERIALS prior to being elected a member of the Fraunhofer-Gesellschaft Executive Board in 2006.

“THE MOTTO OF THE CURRENT YEAR OF SCIENCE IS ‘PROJECT EARTH: OUR FUTURE’. IT REPRESENTS AN OPPORTUNITY FOR US TO SHOWCASE AND EXTEND OUR EXPERTISE IN THE RENEWABLE ENERGY SECTOR, AND IN PROCESSES AND PRODUCTS THAT CONSERVE RESOURCES.”





Prof. (Univ. Stellenbosch) Dr. rer. pol. Alfred Gossner
Senior Vice President Finance and Controlling, IT

Alfred Gossner initially pursued a career with the Allianz Group, including various international postings. Before moving to the Fraunhofer-Gesellschaft in 2002, he served as a member of the board of management of Allianz Versicherungs-AG.

“IN RECENT YEARS, THE FRAUNHOFER-GESELLSCHAFT HAS DONE EXCELLENT WORK AND CONTINUED TO ENHANCE ITS GOOD REPUTATION AS A PROVIDER OF RESEARCH SERVICES TO GOVERNMENT AND INDUSTRY. WE WEATHERED THE FINANCIAL CRISIS REMARKABLY WELL AND ARE WELL EQUIPPED TO TACKLE WHATEVER LIES AHEAD OF US.”

Dr. rer. publ. Ass. jur. Alexander Kurz

Senior Vice President Human Resources and Legal Affairs

After his legal studies, Alexander Kurz worked as a manager and board member for major research organizations such as CERN and the Karlsruhe Institute of Technology (KIT). He was appointed to the Executive Board of the Fraunhofer-Gesellschaft with effect from June 1, 2011.

“FRAUNHOFER RANKS AMONG THE MOST ATTRACTIVE EMPLOYERS IN THE FIELDS OF SCIENCE AND TECHNOLOGY; THAT IS BOTH AN HONOR AND AN OBLIGATION. OUR 20,000 HIGHLY QUALIFIED AND HIGHLY MOTIVATED EMPLOYEES TAKE PRIDE IN SOLUTIONS THEY DEVELOP FOR OUR PARTNERS IN INDUSTRY AND THE SCIENTIFIC COMMUNITY.”



Fraunhofer-Gesellschaft's business development 2007–2011

	2007	2008	2009	2010	2011
Total business volume (cash basis) in € million (operations and capital expenditure)	1320	1401	1617	1657	1849
Change	11%	6%	15%	2%	12%
Contract research ¹	1164	1291	1340	1402	1515
Defense research	39	38	87	93	98
Major infrastructure capital expenditure ¹	117	72	190	162	236
Project revenue	854	902	1031	1173	1288
Change	9%	6%	14%	14%	10%
Contract research	777	859	916	1030	1101
Defense research	10	8	31	35	42
Major infrastructure capital expenditure	67	35	84	108	145
Breakdown of expenditure in %²					
Personnel expense ratio	45	48	48	50	48
Non-personnel expense ratio	31	34	29	29	30
Capital expenditure ratio	24	18	23	21	22
Breakdown of revenue in %³					
Industry	38	36	31	34	36
Public sector ⁴	32	33	37	38	35
Project research (total)	70	69	68	72	71
International	11	12	12	13	13
EU	5	5	5	5	5
Total assets/total equity and liabilities in € million	1901	1995	2119	2287	2440
Change	12%	5%	6%	8%	7%
Employees⁵	14,348	15,823	17,907	19,002	20,326

1 Starting 2011, capital expenditure on minor building projects (2011: €30 million) is posted under major infrastructure capital expenditure and no longer under contract research.

2 Total operating expense/business volume (excluding change in license-fee revenue reserve after deduction of allocation to foundation capital)

3 Project revenue/operating budget and imputed depreciation allowance for contract research activities (including change in license-fee revenue reserve)

4 Public sector includes German federal and *Länder* governments, EU, research grants and other R&D/non-R&D.

5 Starting 2011, the basis for calculating the number of employees has been changed and now includes personnel with temporary employment contracts with a cumulative contract term of less than 18 months. The figures for the previous years were amended accordingly.

MANAGEMENT REPORT 2011

Profile and structure of the Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft is Europe's largest organization for applied research, and currently runs more than 80 research institutions in Germany, 60 of which are institutes. In close cooperation with its customers from industry and the public sector, the Fraunhofer-Gesellschaft shapes the innovation process in Germany and Europe, driving forward the development of key technologies. The organization's research focuses on the needs of people in the areas of healthcare, security, communication, mobility, energy and the environment.

Fraunhofer's international sites and its representative offices in the USA, Asia and Europe underscore the significance of research in multilateral scientific alliances and business relationships within our global society.

The organization's more than 20,000 employees handle an annual total business volume of €1.8 billion, €1.5 billion of which relates to contract research. Over 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and public-sector research projects. Just under 30 percent comes from the federal and *Länder* governments, among other things to finance pre-competitive research projects of direct benefit to both industry and society.

Economic and political background

- Global economy loses momentum
- German economy in robust condition
- Rising expenditure on research and development

The recovery of the global economy began to flag noticeably in 2011. Whereas the economies of Asia continued to deliver robust growth, the USA was held back by a weak job market, and Europe suffered under its escalating sovereign debt crisis.

On the back of exports and reviving domestic demand, Germany's gross domestic product (GDP) grew by 3.0 percent in 2011. An increase in private consumption of 1.5 percent contributed substantially to that growth. Rising by 8.3 percent, capital expenditure on equipment also made an exceptionally large contribution. Capital expenditure on construction grew by 5.4 percent compared with 2010. Exports of goods and services climbed by 8.2 percent while imports rose by 7.2 percent, so that international trade also had a positive impact on growth. In the fourth quarter of 2011, the pace of economic growth in Germany began to slacken considerably. Gross domestic product was 0.2 percent lower than in the corresponding quarter of 2010, indicating that 2012 would be a difficult year for the economy.

The German employment market performed very well. In 2011, the country's economic output was delivered by an average of some 41.1 million people in employment, around 1.4 percent more than in 2010. At the same time, unemployment in Germany fell to its lowest level in 20 years.

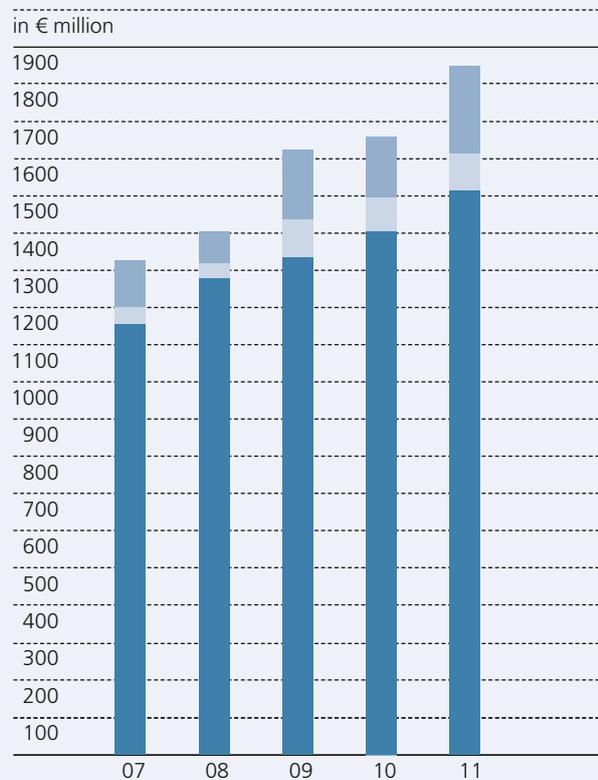
The performance of the German economy in 2011 was exceptional when viewed against that of Europe as a whole. The countries of southern Europe in particular suffered under public-sector austerity measures, with their economies stagnating and in some cases even shrinking. In response to dramatic rises in interest rates for the government bonds of the eurozone periphery and amid growing concerns of a credit crunch, the European Union (EU) introduced both a permanent European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM). The European Central Bank (ECB) began buying up government bonds in support of these measures and launched a program of long-term refinancing in an effort to combat the growing liquidity problems in the market.

At around 1.0 percent of GDP, the German government's budget deficit in 2011 remained below the upper limit of 3.0 percent allowed under the EU's Maastricht treaties. Borrowing amounted to just over €17 billion and was well below the planned figure of €48 billion. The reason for this was the robust economy and higher private consumption, both of which significantly boosted the federal government's forecast tax receipts.

In 2011, German companies are likely to have spent considerably more on research and development (R&D). Expenditure on innovation is expected to have risen by 7 percent to €130 billion. The international competition for talented individuals, technologies and market leadership has become even fiercer, underscoring the importance of research, new key technologies and innovation. Public-sector expenditure on R&D rose again, too. At a record €11.7 billion, the 2011 budget of the German Federal Ministry of Education and Research (BMBF) was over 7 percent higher than in 2010 (€10.9 billion).

In order to ensure an adequate supply of highly qualified employees and to improve the transfer of scientific knowledge from universities and research institutions to industry and society, it is necessary to create optimal financial and organizational parameters for Germany's system of science and research. By tapping new areas of innovative research, and focusing research work and public-sector funding on promising subjects and the challenges facing society, we can enhance Germany's status as a center of innovation and economic activity. That includes the systematic encouragement and nurturing of young talent as well as the international networking of research and knowledge transfer.

Fraunhofer-Gesellschaft total business volume (cash basis) 2007–2011



	2007	2008	2009	2010	2011
■	1164	1291	1340	1402	1515
■	39	38	87	93	98
■	117	72	190	162	236
=	1320	1401	1617	1657	1849

in € million

- Contract research
- Defense research
- Major infrastructure capital expenditure

Business performance

- Business volume well above €1.8 billion
- Project revenue at record levels

The Fraunhofer-Gesellschaft remained on a growth trajectory in 2011. Buoyed by the good German economy, the organization’s achievements in research and development translated directly into economic success. Project revenue climbed to €1,288 million, well in excess of the record level of 2010.

Business volume – which comprises budgeted expenditure on contract research, defense research, and major infrastructure capital expenditure – rose to €1,849 million.

In the year under review, budgeted expenditure for contract research activities delivered growth of 8 percent to reach €1,515 million. At €98 million, budgeted expenditure in the defense research sector was 5 percent higher than in the previous year. Major infrastructure capital expenditure grew by 46 percent to €236 million owing to nonrecurring factors.

In the following, we report on income and expenditure items of the performance statement for each separate type of research. For information on the accounting principles used by the Fraunhofer-Gesellschaft, please refer to the notes to the financial statements (not included in the English version of the annual report).

Expenditure and income for contract research activities 2007–2011 (in € million)

	2007	2008	2009	2010	2011
Personnel expenses	548	624	697	745	784
Non-personnel expenses	379	456	428	443	514
Change in the special license-fee revenue reserve and allocation to foundation capital	65	44	55	56	74
Current capital expenditure	172	167	160	158	143
Expenditure	1164	1291	1340	1402	1515
Imputed depreciation allowance	113	128	143	151	135
Project revenue	776	859	916	1030	1101
Industrial revenue	422	452	407	463	531
of which license-fee revenue	94	83	78	93	125
Federal and <i>Länder</i> governments	219	248	317	406	405
European Commission	55	61	65	65	71
Other income	80	98	127	96	94
Base funding including reserves	388	432	424	372	414
Income	1164	1291	1340	1402	1515

Contract research

- 73 percent of expenditure financed through project revenue
- Successful measures to boost industrial revenue
- Positive trend in license-fee revenue

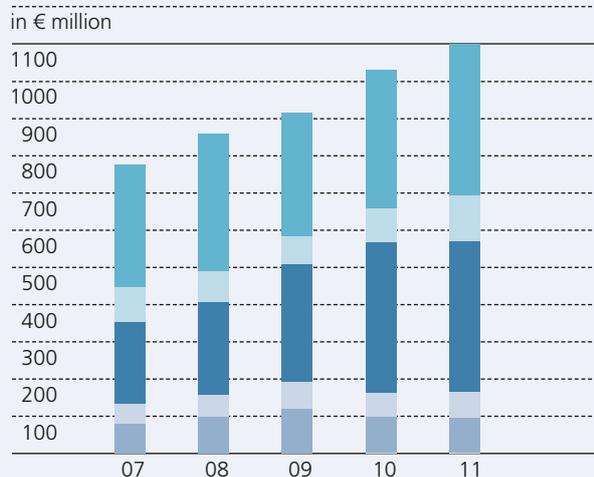
Personnel expenses for contract research rose by 5 percent to €784 million in the financial year 2011, primarily as a result of the substantial increase of 7 percent in the number of employees at the Fraunhofer-Gesellschaft. Since expenditure on employment contracts and contracts for work and

services were reallocated from personnel expenses to non-personnel expenses, growth in personnel expenditure was disproportionately lower than growth in personnel numbers.

Non-personnel expenses grew by 18 percent to €588 million as a result of the increasing volume of research and the reallocation of personnel expenses.

In 2011, for the first time, expenditure on minor building projects was allocated to major infrastructure capital expenditure instead of to contract research, thus reducing current capital expenditure by 9 percent to €143 million.

**Changes in contract research revenue
2007–2011**



	2007	2008	2009	2010	2011
Industrial revenue (excluding license fees)	328	369	329	370	406
License-fee revenue	94	83	78	93	125
Federal and Länder governments	219	248	317	406	405
European Commission	55	61	65	65	71
Other income	80	98	127	96	94
=	776	859	916	1030	1101

- Industrial revenue (excluding license fees)
- License-fee revenue
- Federal and Länder governments
- European Commission
- Other income

The Fraunhofer-Gesellschaft was able to significantly boost its income. Project revenue rose by 7 percent to €1,101 million, reaching a new record level. As a result, 73 percent of expenditure could be financed through project revenue.

The trend in industrial revenue was particularly gratifying, growing by 15 percent to a new all-time high of €531 million. Of that revenue, €406 million was attributable to contract research projects with industry, which benefited from the internal measures taken last year to boost industrial revenue. License-fee revenue made a substantial contribution of €125 million. Contrary to forecasts, revenue from mp3 technology increased, to a substantial €92 million. Other license-fee revenue grew to €33 million.

At €405 million, public-sector revenue from projects with the federal and Länder governments stabilized at a high level. Revenue from EU projects increased by 9 percent to €71 million. Public-sector projects of the federal and Länder governments and the EU often focus on improving public infrastructure in the fields of energy, transportation, health-care, etc. In addition, they make an important contribution to networking the research and education system and supporting innovation in companies. Other revenue amounted to €94 million.

Revenue generated abroad grew by 14 percent, reaching the €200 million threshold for the first time. Of this amount, €22 million was accounted for by Fraunhofer's international subsidiaries.

Defense research

- Growth in defense research

The defense research segment comprises the expertise of the seven Fraunhofer Institutes that carry out research into defense and security. The focus of defense and security research activities is on mitigating or preventing the risks arising from the increasing global networking of our modern information and services society. In addition to defense-related technologies, the Fraunhofer Institutes also successfully develop solutions for the civil sector as part of their dual-use research for customers in industry and the public sector.

Budgeted expenditure on defense research activities rose by 5 percent to reach €98 million. Personnel expenses amounted to €61 million, non-personnel expenses to €26 million, and current capital expenditure to €11 million. The German Federal Ministry of Defence (BMVg) provided €56 million in base funding.

Major infrastructure capital expenditure

- Major infrastructure capital expenditure at record levels
- Highpoint reached in funding under the economic stimulus program II and European Regional Development Fund (ERDF)

In the financial year 2011, the Fraunhofer-Gesellschaft invested €236 million in the research infrastructure of its institutes. This high volume of capital expenditure was due mainly to the fact that funding under the European Regional Development Fund (ERDF) and the economic stimulus program II of the federal and *Länder* governments reached its peak. The funds granted under the economic stimulus program II were earmarked for structural renovations and modernization work. The total volume of funds granted under the federal and *Länder* governments' economic stimulus program II amounted to €59 million in 2011. Capital expenditure unrelated to the economic stimulus programs reached a volume of €177 million, and included spending on minor building projects in the amount of €30 million, which was reallocated from contract research to major infrastructure capital expenditure.

Major infrastructure capital expenditure totaling €126 million was funded by the federal and *Länder* governments, while the European Regional Development Fund (ERDF) provided co-funding of €51 million.

The following projects exemplify how the funds were utilized. Expansion of the Application Center Polymer Nanotechnologies of the Fraunhofer Institute for Applied Polymer Research IAP in Potsdam-Golm continued in 2011 with commencement of the second construction phase. Last year, €9 million was invested in this building project.

Major infrastructure capital expenditure and funding sources 2007–2011



- Federal government and host *Länder* of the institutes
- Economic stimulus programs I and II
- ERDF (European Regional Development Fund)

The new extension will house the Application Center Polymer Nanotechnologies, which serves to support technological innovations such as flexible displays based on organic light-emitting diodes (OLEDs). The application center offers room for around 100 new employees and has usable floor space of 2600 square meters.

A total of €12.3 million in funds went toward two major construction projects at the Fraunhofer Center for Silicon Photovoltaics CSP in 2011. In the eastern German city of Halle, €8.6 million was invested in the construction of a research building at the Weinberg Campus. Total capital expenditure on this 4000-square-meter center for applied research in the fields of solar modules, solar wafers and crystallization technologies for photovoltaics is estimated at €47.2 million, of which €15.2 million is for the building itself and €32 million for the initial laboratory equipment.

In 2011, €3.7 million was invested in the module technology center in Schkopau, where total expenditure is earmarked to reach €12.7 million. At this site, Fraunhofer CSP is developing new technologies for crystallization, wafer production and the manufacture of modules, and will focus on developing new materials along the entire value chain. Due for completion in 2012, the new Fraunhofer CSP center at Schkopau will function as a partner for joint application-oriented research projects, especially with the companies in the region, thereby securing the transfer of technology from the research community to the photovoltaics and plastics industries.

Major infrastructure capital expenditure 2011 (in € million)

Institute/Research Institution		Total	ERDF ¹	Federal/Länder governments
Center for Chemical and Biotechnological Processes	Leuna	11.3	–	11.3
Applied Polymer Research	Potsdam-Golm	9.3	4.7	4.6
Center for Silicon Photovoltaics	Halle	8.6	6.5	2.1
Applied Optics and Precision Engineering	Jena	8.5	5.1	3.4
All Silicon System Integration	Dresden	8.1	5.3	2.8
Silicate Research	Würzburg	7.0	3.4	3.6
Industrial Engineering	Stuttgart	5.4	–	5.4
Industrial Mathematics	Kaiserslautern	5.0	2.5	2.5
Interfacial Engineering and Biotechnology	Stuttgart	5.0	–	5.0
Wind Energy and Energy System Technology	Bremerhaven	4.7	1.2	3.5
Modular Solid State Technologies	München	4.3	–	4.3
Material and Beam Technology	Dresden	4.2	2.5	1.7
Microelectronic Circuits and Systems	Duisburg	4.0	2.0	2.0
Mechanics of Materials	Freiburg	3.8	–	3.8
Structural Durability and System Reliability	Darmstadt	3.8	–	3.8
Cell Therapy and Immunology	Leipzig	3.7	2.3	1.4
Center for Silicon Photovoltaics	Schkopau	3.7	2.7	1.0
Toxicology and Experimental Medicine	Braunschweig	3.6	–	3.6
Clinical Research Center	Hannover	3.4	–	3.4
Integrated Circuits	Fürth	3.2	1.7	1.5
Solar Energy Systems	Freiburg	2.8	–	2.8
Machine Tools and Forming Technology	Dresden	2.7	1.8	0.9
Production Systems and Design Technology	Berlin	2.6	–	2.6
Chemical Technology	Augsburg	2.5	0.9	1.6
Nondestructive Testing	Saarbrücken	2.4	1.2	1.2
Technology Center for Semiconductor Materials	Freiberg	2.2	1.3	0.9
LOEWE Research Center AdRIA	Darmstadt	2.0	–	2.0
Integrated Systems and Device Technology	Erlangen	1.9	1.0	0.9
Machine Tools and Forming Technology	Chemnitz	1.8	1.1	0.7
Silicon Technology	Itzehoe	1.8	0.9	0.9
Integrated Circuits	Nürnberg	1.3	0.7	0.6
Ceramic Technologies and Systems	Hermisdorf	1.2	0.9	0.3
Material Flow and Logistics	Dortmund	1.1	–	1.1
High-Speed Dynamics, Ernst-Mach-Institut	Freiburg	1.1	–	1.1
Other projects		9.8	1.9	7.9
Measures financed by federal/Länder governments and/or ERDF		147.8	51.6	96.2
Economic stimulus program II, federal government		21.3	–	21.3
Economic stimulus program II, Länder governments		37.5	–	37.5
Economic stimulus program II		58.8	–	58.8
Minor building projects		29.7	–	29.7
Major infrastructure capital expenditure		236.3	51.6	184.7

1 ERDF = European Regional Development Fund

Fraunhofer Groups

- Fraunhofer Groups flourish
- Positive trend in industrial revenues

Collaboration in groups that focus on specific topics makes it possible to develop cross-institute strategies and to coordinate the procurement and utilization of strategic equipment. Through the steering committees and chairs of the groups, the institutes can play an active role in shaping the corporate policy and implementing the functional and financing model of the Fraunhofer-Gesellschaft.

The Fraunhofer Institutes belonging to the contract research segment are organized into the following six Fraunhofer Groups, each devoted to a specific area of technology:

With budgeted expenditure of €388 million, the **Fraunhofer Group for Materials and Components – MATERIALS** is the largest group within the Fraunhofer-Gesellschaft. In 2011, the group's project revenues increased by €39 million, or just under 15 percent, to €303 million. The share of industrial revenues in that amount increased from 37.0 percent to 39.2 percent. The Fraunhofer Group for Materials and Components – MATERIALS comprises 13 institutes with a focus on material sciences. The group's activities range from the development of materials and technologies, through to system integration, and extends to testing and evaluating the behavior and reliability of new materials and components. One example of the innovative solutions with future potential being developed by the group is referred to as intelligent materials, which feature sensor and actuator functions. The group is active in the fields of energy, healthcare, mobility, information and communication technologies as well as in building and housing.

The **Fraunhofer Group for Microelectronics** consists of 13 institutions that carry out research into microelectronics and microintegration. It provides support to the institutes in recognizing new trends and taking them into account in strategic planning, while joint marketing activities ensure the institutes project a uniform public image. The group's budgeted expenditure rose by €19 million or 6 percent in 2011 to reach €327 million. Project revenue climbed by €17 million to €254 million. At 83.5 percent, the proportion of the group's expenditure covered by revenue was only slightly below the very high level of 2010.

The group can offer SMEs, in particular, forward-looking research and application-oriented innovations in the areas of semiconductor technology, communication technology, ambient assistance systems, energy-efficient systems and e-mobility, as well as lighting, entertainment and security. One of the group's many inventions promising high potential benefit for society is a special image sensor for endoscopic operating procedures requiring millimeter precision. It gives doctors a perfect impression of depth inside the human body, making surgical procedures even safer.

16 research institutions have joined forces in the **Fraunhofer ICT Group**. It develops strategies and visions for medium-term research and supports the research entities in networking with companies and scientific institutions around the world. In 2011, the group generated more than €155 million in project revenue in the business areas of digital media, e-business, e-government, information and communication technology, energy and sustainability, medicine, production, as well as security, financial services and the automotive sector. The group's budgeted expenditure rose by 5 percent to €215 million.

In the field of security, for example, the Fraunhofer Institute for Software and Systems Engineering ISST developed an innovative early-warning system. In dangerous situations – such as storms, the defusing of unexploded bombs, or major accidents – the system can warn the local population and provide instructions on what to do, free of charge via text messages or e-mail.

The **Fraunhofer Group for Production** specializes in production-oriented research and development, and offers holistic solutions to customers from industry, trade and services.

The group's range of services utilizes the latest findings from production/engineering science and IT, and covers the entire manufacturing process. In 2011, the group generated a total of €140 million in revenue from projects with its partners from industry and the public sector. That corresponds to an increase of 9 percent. The group's budgeted expenditure grew by 12 percent to €193 million. Through publicly funded projects with partners from industry as well as bilateral industrial projects, the Fraunhofer Institute for Manufacturing Engineering and Automation IPA developed a high-speed powder-coating process. It increases throughput five-fold and enhances the efficiency of manufacturing companies.

Comprising 6 member institutes, the **Fraunhofer Group for Light & Surfaces** is active in the fields of coating and surface technology, beam sources, micro and nano technology, materials processing and optical measuring techniques.

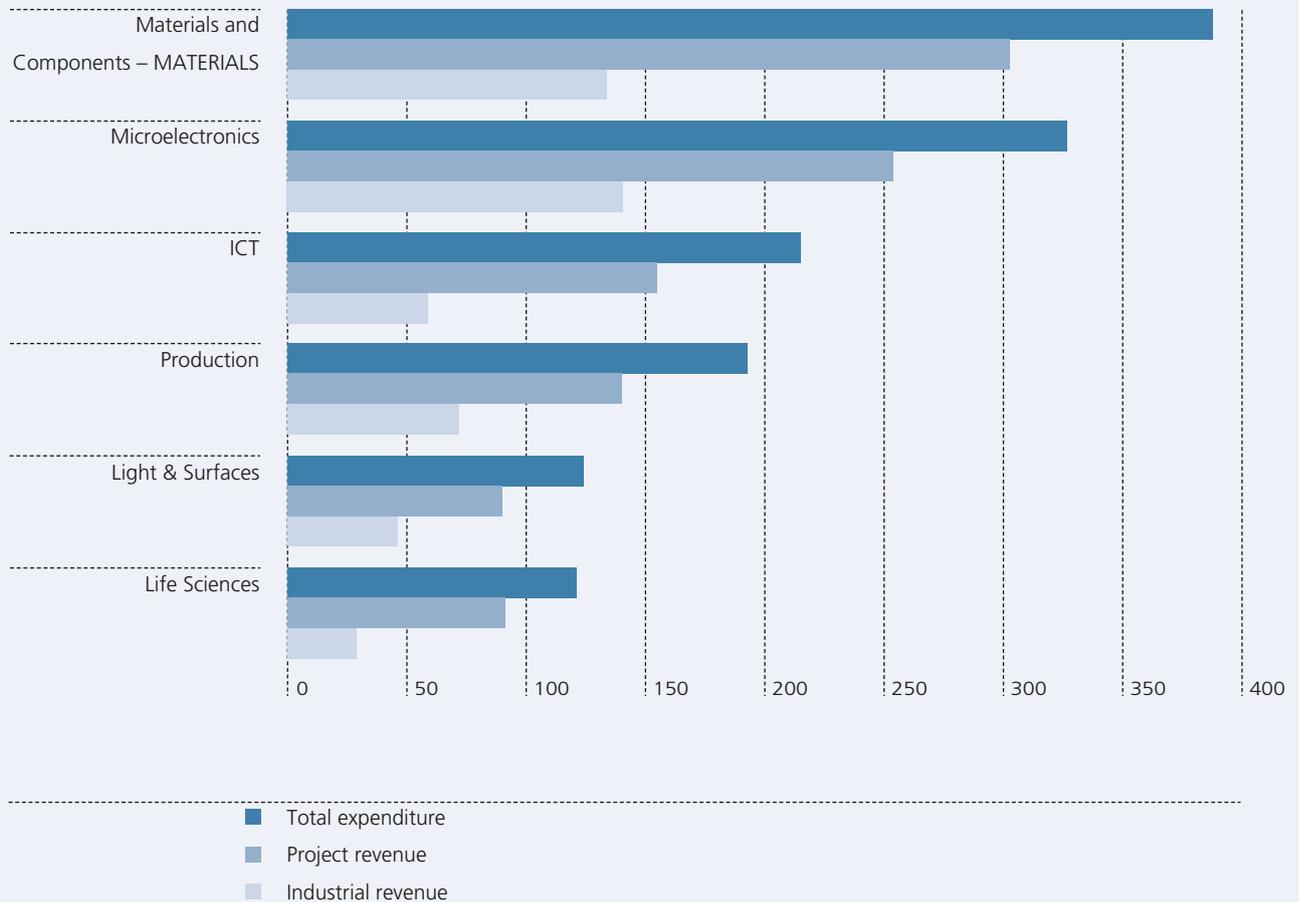
Surface technology and photonics are key technologies, and are increasingly being deployed in a wide variety of applications involving manufacturing technology, optical sensor systems, information and communication technology as well as biomedical engineering. In 2011, the group succeeded in growing its project revenue by 7 percent to €90 million and

expanded its budgeted expenditure to €124 million. The share of industrial revenues in that amount was above average at 42.8 percent.

In 2011, the group notched up a number of scientific successes. To mention just one distinction received for their work, the director of the Fraunhofer Institute for Laser Technology ILT, Prof. Dr. Reinhart Poprawe M.A., and his team of laser experts were awarded the North Rhine-Westphalian government's Innovation Prize in the category "Innovation". The group is an international leader in the field of selective laser melting (SLM), a process that Fraunhofer ILT was instrumental in developing. In keeping with the just-in-time principle, SLM enables customized components such as medical implants or functional parts for machine tools to be manufactured cost-effectively and extremely rapidly in small batches on the basis of 3D CAD data.

The **Fraunhofer Group for Life Sciences** serves its customers and partners by bringing together the know-how of 6 Fraunhofer Institutes across the fields of biology, chemistry, biochemistry, biotechnology and medicine as well as pharmacology, ecology and nutritional sciences. In 2011, project revenue of €91 million was generated by the group's business units for Medical Translational Research, Biomedical Engineering, Regenerative Medicine, Healthy Foodstuffs, Biotechnology, and Safety with Chemicals and Pesticides. At €121 million, the group's budgeted expenditure was marginally higher than in 2010. Special mention should be made of the group's "Tissue Engineering" project, the purpose of which is to develop and optimize the mass production of in vitro skin test models for trials of chemicals, drugs and cosmetics.

Budgeted expenditure, project and industrial revenues of the Fraunhofer Groups in the contract research segment in 2011 (in € million)



In the **Fraunhofer Group for Defense and Security VVS**, 7 Fraunhofer Institutes are developing innovative solutions for urgent security problems in the business areas of security research, protection and deterrence, reconnaissance and surveillance, explosives and security engineering, localization and communication, image processing, as well as decision-making support for government and industry. For this group,

the relevance of many areas of research for both civil and military applications (dual-use principle) is an important source of innovation and a means of expanding its range of services to the benefit of its customers. It ensures the group a competitive edge in both areas. In 2011, the group's budgeted expenditure increased by 8 percent to €175 million. Project revenue grew to €97 million.

Financial situation and net asset position

- Solid liquidity position
- Base funding rises by 5 percent
- Higher funding ratios needed

The Fraunhofer-Gesellschaft's cash assets (cash and cash equivalents including current bank accounts) totaled €25 million at the end of 2011. These liquid assets included an amount of €21 million (2010: €49 million) carried forward under the terms of the management statutes; that is the equivalent of 1 percent of the organization's total business volume (cash basis).

Owing to the Fraunhofer-Gesellschaft's financing structure, these funds represent an important liquidity reserve for the organization, enabling it to respond flexibly to changing market risks. Both economic developments and the research policy decisions of the funding bodies can result in unexpected fluctuations in the organization's industrial revenues and project funding. A more flexible framework for funding means that the funds made available can be deployed in a manner that is more efficient and in line with actual needs.

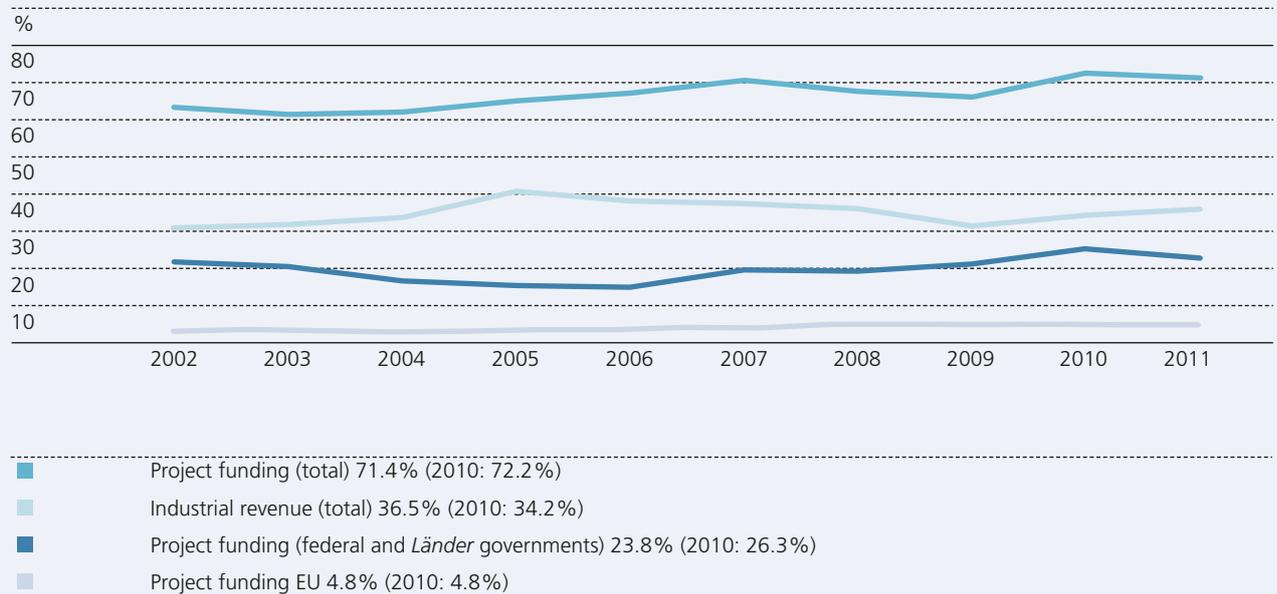
The Fraunhofer-Gesellschaft's financing model rests on three pillars – base funding, revenue from contracts with industry, and revenue from public-sector projects – each of which contributes roughly one-third of total funds. Base funding is split between the federal and *Länder* governments in the ratio of 90:10. These funds are made available for strategic initiatives of the Executive Board as well as the institutes' in-house and pre-competitive research. In the financial year 2011, base funding increased by 5 percent in accordance with the Pact for Research and Innovation.

That was well above the growth rate of 3 percent that had been customary for many years. At the same time, the volume of contract research projects grew by 8 percent in 2011. Direct project business with industry even rose by as much as 10 percent. This burgeoning growth is a sign of how attractive the Fraunhofer-Gesellschaft's research offerings are in the market, and is ultimately an indicator of the German economy's thirst – and potential – for innovation. When compared with the Fraunhofer-Gesellschaft's overall growth, the growth in base funding was disproportionately low. If this trend were to persist, the organization would be forced in the medium term to limit either its pre-competitive research – and thus its wellspring of innovation and growth – or its project business with industry. Neither of these options can be in the interests of the German economy, which relies more and more on its innovative strength in order to maintain a competitive edge in the global market. That is why the Fraunhofer-Gesellschaft advocates the performance-based allocation of base funding, linked to the development of total expenditure.

The Fraunhofer-Gesellschaft's financial statutes impose limitations when it comes to financing public-sector projects. In addition, its political mandate as a national research institute requires that resources it receives in base funding be utilized to develop new areas of activity of strategic interest in pre-competitive research. Funding ratios for public-sector projects that do not cover costs are problematic for the Fraunhofer-Gesellschaft as they consequently tie up resources from base funding, thus reducing the amount of pre-competitive research the institutes can carry out.

That is why binding rules for measuring funding ratios have been laid down for the project funding provided by the German Federal Ministry of Education and Research (BMBF), the key principle being that projects carried out exclusively by the Fraunhofer-Gesellschaft without external partners should be financed at a standard rate of 100 percent of the full costs.

Fraunhofer-Gesellschaft funding resources in the contract research segment 2002–2011



Even in the case of joint projects involving external partners, it is ensured that Fraunhofer’s share of the financing is covered without the organization having to dip into its own funds.

In Fraunhofer’s view, this practice has proven its worth. By contrast, project funding by the *Länder* governments is still heterogeneous owing to the wide variety of legal and financial requirements for funding. The funding ratios in some states are still below 50 percent, which has a negative impact on base funding and restricts the amount of pre-competitive research that can be carried out. Given both public-funding objectives and budgetary constraints, the project funding requirements of the *Länder* governments need to be harmonized across the board to enable full financing that actually covers costs.

Fraunhofer needs to use its base funding resources for in-house pre-competitive research, so that it can continue enhancing its innovative strength and thus contribute towards securing Germany’s growth and prosperity.

Balance sheet

- Total assets at €2,440 million
- Increase of €41 million in the special reserve for funds used to finance current assets

Total assets at December 31, 2011 stood at €2,440 million, up 7 percent over the previous year.

Fixed assets increased by €136 million to €1,629 million, of which €1,600 million was for property, plant and equipment. At December 31, 2011, property, plant and equipment represented 66 percent of total assets and was thus the predominant item on the assets side of the Fraunhofer-Gesellschaft's balance sheet. Intangible assets amounted to €14 million and financial assets to €15 million.

Accounts receivable and other current assets increased by €28 million to €498 million, while trade receivables decreased by €7 million. Receivables from the federal and *Länder* governments rose by €31 million. Accounts receivable from associated companies grew by €1 million and other current assets by €3 million.

Inventories net of advance payments by customers increased by €20 million.

Cash-equivalent, short-term marketable securities fell by €3 million to €236 million. Allocations totaled €21 million, while disposals comprised transfers to the spending capital of the Fraunhofer-Zukunftsstiftung (Fraunhofer Future Foundation) amounting to €19 million and depreciations and realized losses on the sale of securities in the amount of €5 million. In the financial year 2011, the Fraunhofer-Gesellschaft transferred a nominal amount of €70 million to the Fraunhofer Future Foundation, €14 million of which was offset against receivables from project billing. The Fraunhofer Fund's

available assets were invested in low-risk liquid securities in 2011; on average over the year, the investment split was 26 percent in bonds, 64 percent in money market instruments and 10 percent in equities. In view of the uncertain market environment, the Fraunhofer Fund's asset allocation policy favored low-risk investments, with the Fund steering and proactively containing its investment risks through dynamic, systematic management of the allocations to the individual segments and through risk overlay with threshold control.

Cash assets (cash and cash equivalents including current bank accounts) decreased by €28 million to €25 million.

Prepaid expenses and deferred charges, which include prepaid rent, maintenance contracts, and services, amounted to €6 million.

The Fraunhofer-Gesellschaft's equity on the reporting date amounted to €13 million, €0.3 million higher than 2010 in line with the net profit for the year from the association's accounts. The non-profit organization's capital is that portion of the Fraunhofer-Gesellschaft's assets that has not been acquired out of public funds. In addition to the capital of the non-profit organization and the restricted reserves, equity is also deemed to include the special reserves for license-fee revenue and for grants relating to fixed assets.

In the year under review, net license-fee revenue amounting to €74 million was allocated to the corresponding special reserve, while €70 million was transferred from the reserve to the Fraunhofer Future Foundation as spending capital. The license-fee revenue reserve stood at €242 million on the reporting date.

Funds received for the purpose of acquiring and constructing fixed assets are transferred to a special reserve, which is reduced each year by an amount corresponding to the annual depreciation expense on the related assets. The special reserve for grants relating to fixed assets increased by €136 million to €1,616 million in the year under review, in line with the carrying amount of the assets financed by such external funds.

The special reserve for funds used to finance current assets is used to account for income not yet received or expenses not yet paid by the balance sheet date. In the financial year 2011, the special reserve for funds used to finance current assets increased by €41 million to €214 million.

Provisions for pensions and similar obligations amounted to €11 million. The Fraunhofer-Gesellschaft has a reinsurance policy in place to cover its existing pension obligations, as a means of offloading biometric risks and converting uncertain long-term liabilities into foreseeable, calculable costs. The pension provisions are measured using the capitalized value calculated by the insurance company on the reporting date.

Other provisions rose by €6 million to €118 million, especially owing to higher provisions for impending lawsuits and to inventors' bonuses triggered by higher license-fee revenue. The change in other provisions has no impact on the funding situation due to the simultaneous change in the special reserve for funds used to finance current assets. In the case of pension and compensated absence provisions, corresponding balancing amounts are entered on the assets side of the balance sheet.

In the financial year 2011, liabilities declined by €34 million to €219 million, and comprised €133 million in grants from the federal and *Länder* governments still to be appropriated, €81 million in trade payables, and €5 million in other liabilities.

Deferred income rose to €7 million, and relates primarily to lump-sum license fee payments received for mp3 technology before the reporting date and not yet recorded as revenue.

No subsequent significant events have arisen since the reporting date that are material for assessing the development of the organization's business in the year under review or which have a substantial impact on its financial position, net assets or operating results.

Employees

- Over 1300 new employees
- Focus on managing and encouraging talent

At year-end 2011, the Fraunhofer-Gesellschaft had 20,326 employees. That equates to an increase of more than 1300 employees in the course of 2011 and reflects the Fraunhofer-Gesellschaft's higher number of research projects and rising contract volume. Motivated and highly qualified employees are a key factor in the Fraunhofer-Gesellschaft's ability to continue performing excellent research work. The Fraunhofer-Gesellschaft, too, has to face up to the imminent shortage of skilled workers and the possible effects of demographic change, and will need to put in place the necessary measures to recruit, retain and develop top research specialists.

In order to identify and enhance the factors that make Fraunhofer an attractive employer, the organization initiated an intensive dialog in 2011 with various target groups and internal bodies.

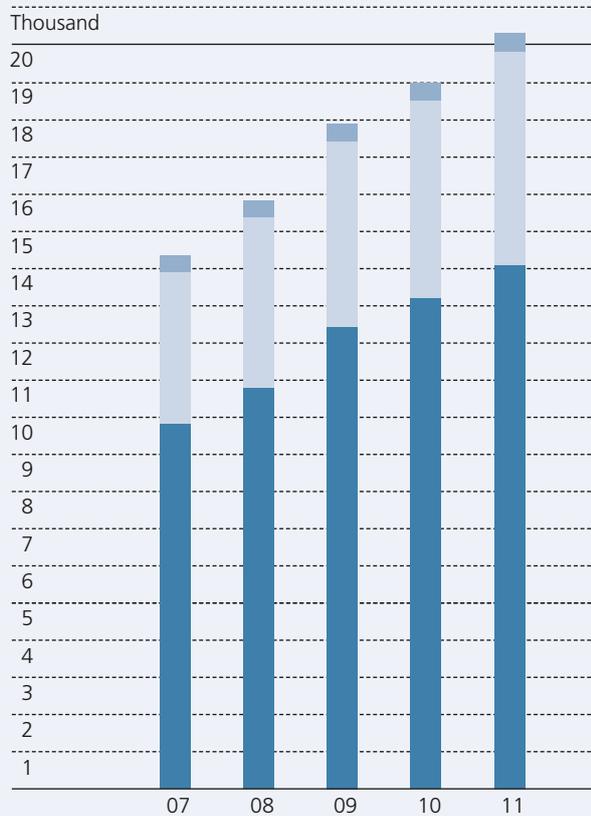
The Fraunhofer Employee Survey is expected to be a major source of information in this regard. It offers both the rank and file and management an opportunity to refine and enhance working conditions within the organization and make the Fraunhofer-Gesellschaft a more attractive employer. The response rate from employees from across the whole organization was a very gratifying 80.7 percent. That will provide a sound stock of data from which to derive our strengths and action points for all levels of the organizational hierarchy. The results will be evaluated in a comprehensive follow-up process.

End-to-end talent management is an essential component in the recruitment of highly qualified and motivated workers. That is why the "Attract" program specifically targets external scientists with innovative ideas who come from institutions of international renown or from industrial companies. It offers them the opportunity to pursue their ideas along the path toward practical applications in the role of a group manager closely tied to one of the Fraunhofer Institutes. Fraunhofer's collaboration with the German Scholars Organization (GSO) and German Academic International Network (GAIN) in the USA has also proven its worth. The organization can use these two channels to contact and recruit both foreign scientists and German applicants wanting to return to Germany after a stint of study or research abroad.

The "Vintage Class" program is something quite different. Developed with Fraunhofer's own managers in mind, its purpose is to promote succession planning and groom potential candidates for senior management positions at the institutes. Apart from being offered tailored personnel development measures, the members of the program form a network that also functions as a think tank for the Fraunhofer-Gesellschaft. A good example of the program's success was the promotion of Prof. Dr. Albert Heuberger, who for four years was a member of and spokesperson for the Vintage Class, to director of the Fraunhofer Institute for Integrated Circuits IIS.

To safeguard Germany's status as a center of research and innovation, it is important to promote mathematics, IT, science and technology as attractive subjects of study and to awaken young people's interest in these subjects at an early stage. Apart from the recruitment of young talent for its own purposes, the Fraunhofer-Gesellschaft recognizes that it has a responsibility to society as a whole in this area.

Growth in the Fraunhofer-Gesellschaft's workforce 2007–2011¹



	2007	2008	2009	2010	2011
■ Scientific, technical and administrative personnel	9815	10784	12410	13202	14073
■ Graduates, students, school pupils	4087	4584	5009	5313	5765
■ Trainees	446	455	488	487	488
=	14,348	15,823	17,907	19,002	20,326

- Scientific, technical and administrative personnel
- Graduates, students, school pupils
- Trainees

¹ New basis for calculation: workforce also includes personnel on temporary employment contracts with terms of less than 18 months. Figures for previous years have been amended accordingly.

That is why a central part of the Fraunhofer-Gesellschaft's promotion of young talent has been to establish and expand long-term programs that are designed to encourage school students' interest in science and engineering subjects. In addition to its active participation in the annual "Girls' Day", an event designed to get more young women interested in science and engineering, the Fraunhofer-Gesellschaft also organizes summer events for young people from Germany, Italy, Liechtenstein, Austria and Switzerland in cooperation with the Bavarian Junior Academy and the European Talent Academy in Lindau. What is more, the organization offers workshops with its researchers at selected institutes in its "Fraunhofer Talent Schools".

When it comes to securing young talent, the recruitment of trainees is a central concern. For the Fraunhofer-Gesellschaft, providing occupational training to young people is not only a responsibility we bear toward society, but a key component in safeguarding our non-scientific workforce. At the moment, the organization has 490 trainees and apprentices in 34 different occupations. The annual "Honor the Best" award marks the achievements of the top trainees/apprentices and their teachers in each training year. Most of the Fraunhofer-Gesellschaft's trainees remain with the organization as a talent pool for non-scientific workers.

The Fraunhofer-Gesellschaft's human resources policy is geared to values. Innovative research topics, dynamic markets and ever shorter economic cycles, however, make short-term employment contracts inevitable. That constitutes a particular challenge for Fraunhofer's personnel policy and an element of uncertainty for the employees themselves. Against this backdrop, a personnel policy that is geared to values means ensuring transparency in human-resources planning at the institutes, offering timely and professional career planning tailored to the individual employees' needs, and making sure that staff can earn the optimum qualifications at all Fraunhofer Institutes.

The Fraunhofer-Gesellschaft pursues an active equal opportunities policy across all phases of its employees' lives. Last year, the organization pointed the way by becoming a signatory to the "Charter of Diversity" of German companies. The Fraunhofer-Gesellschaft has successfully put into practice the principles of the agreement and implemented the research funding framework agreement on gender mainstreaming. In addition to a central Gender Mainstreaming Officer, local officers at the institutes work to ensure equal opportunities in all personnel, organizational and social matters related to gender mainstreaming, a healthy work-life balance and anti-discrimination in the workplace. In spite of all the measures put in place, it is evident that the efforts made to win over women for scientific professions in general and to recruit more women for positions at the Fraunhofer-Gesellschaft, to retain them in the organization's workforce and to promote them to management posts, have thus far failed to deliver the level of success we had envisaged. That is why the Fraunhofer-Gesellschaft has made a voluntary commitment to formulate a quantitative target for the share of women scientists in Fraunhofer's workforce over the next few years. We will endeavor to raise the number of female scientists at Fraunhofer from the current level of 1650 to 2300 over the next half-decade, so that one in four vacancies for scientific staff will be filled with female candidates.

In the international race to recruit excellent scientists, the ability to offer performance-related remuneration packages – especially ones with variable salary components – is a key criterion alongside providing optimal working conditions. The possibility that has existed since introduction of the new wage agreement for public-sector employees (LeistungsTV-Bund) of offering workers an additional variable salary component can be understood only as the first step along the path toward performance-related remuneration.

Scientific institutions need to be given more options in order to remain competitive vis-à-vis industry. In particular, the potential additional remuneration payable to managers below the level of institute director is too low compared with similar positions in industry.

The Fraunhofer-Gesellschaft still has no possibility at all of paying bonuses to administrative staff. This inability to reward outstanding performance is leading to grave imbalances. In order to recruit talented young staff and managers and to ensure that their expertise is retained, the Fraunhofer-Gesellschaft must be able to offer competitive remuneration, which is why a permanent dispensation for a corresponding bonus system is required from the funding bodies for the administrative sector too.

Risk management and risks

- No anomalies in the overall risk situation

The Fraunhofer-Gesellschaft's risk management system is designed to identify existing and potential risks at an early stage and to manage them by means of appropriate measures in such way that they do not materialize at all or do not have consequences that could jeopardize the fulfillment of Fraunhofer's mission in accordance with its statutes or its ability to meet its own business objectives. The risk management process is set down in the Fraunhofer-Gesellschaft's risk management manual.

The central departments at headquarters are responsible for risk management. Within their respective spheres of competence, they are tasked with monitoring and controlling all risks which, in terms of their effects and the potential damage they might cause, are of relevance to the Fraunhofer-Gesellschaft as a whole. The decentralized risk management processes at institute level are integrated with the headquarters' risk management function through the reporting channels to the central departments. The central departments inform the Executive Board of risks via the reporting channels in place – both routinely and on an ad-hoc basis. The Fraunhofer-Gesellschaft supplements these activities by preparing an annual risk report based on the results of an independent expert survey.

The **overall** assessment of the Fraunhofer-Gesellschaft's risk situation contains no notable events that could severely endanger the organization's future performance.

The Fraunhofer-Gesellschaft understands "risk" to mean all internal and external events and developments jeopardizing the fulfillment of its business objectives.

This includes both direct financial risks (e.g. institute budget deficits) and qualitative risks (e.g. loss of reputation or losing ground as an attractive employer).

Fraunhofer distinguishes the following three classes of risk:

Business risks include those risks arising out of changes in the political, legal and economic framework of applied research.

Political decisions can affect Fraunhofer financially, for instance through a reduction in planned funding contributions or restrictions placed on transferring unused portions of the previous year's funding. From today's perspective, the annual 5 percent increase in base funding from the federal government that was agreed until 2015 as part of the Pact for Research and Innovation does not appear to be in danger. However, under pressure to balance their budgets because of the debt brake anchored in the German constitution, some of the *Länder* governments are examining the potential for savings in the area of research. We are currently proceeding on the assumption, however, that if the agreed increase were reduced, enough time would remain for us to take countermeasures.

As a non-profit organization and beneficiary of public funds, Fraunhofer is also subject to federal and *Länder* government regulations and wider EU legislation. The organization counters changes in its regulatory framework conditions through the ongoing development of the Fraunhofer model in dialog with the relevant funding agencies. With public-sector funding, amendments to, or a disadvantageous interpretation of, the funding guidelines in respect of the reimbursement of costs could lead to a drop in income. The Fraunhofer-Gesellschaft is making every effort at both European and national level to gain full recognition for its full-cost computation basis.

The diversification and ongoing enhancement of Fraunhofer's research portfolio makes it possible to spread risks and thus limit the danger of strategic misjudgments. Tried-and-tested strategy processes are in place that ensure a permanent feedback loop with market players – for instance via technology audits or boards of trustees.

Financial risks are those that are rooted in the non-profit association's financial activities.

The non-profit organization capital and reserves of the Fraunhofer-Gesellschaft are invested in medium- to long-term interest-bearing securities and are therefore exposed to capital market risk. The organization pursues a risk-averse investment policy and keeps a constant watch on the risk situation in view of the uncertainty prevailing in the money and capital markets. The assets are managed using a multi-method approach and the associated risks are comprehensively measured and controlled in real time, thus making it possible to respond to market changes promptly.

Potential taxation risks include Fraunhofer or parts of its organization being deprived, for their operational activities, of the status of a non-profit organization or a business entity. We are closely monitoring the risk of being deprived of our status as a business entity, as the tax authorities are beginning to take a more restrictive approach to this subject. To this end, the Fraunhofer-Gesellschaft has decided on a package of measures, and is maintaining a dialog with the relevant tax authorities so as to keep abreast of possible changes in the tax framework.

The Fraunhofer-Gesellschaft channels the results of its research – such as patents and exploitation rights – into existing companies or its own start-ups. This may involve subsequently disposing of the equity investments or generating income for Fraunhofer through research contracts. The performance of these investments is closely monitored by means of an investment controlling process.

Continual monitoring of prefinancing and accounts receivable, coupled with effective dunning and contractually agreed payment terms, help to minimize credit risk, which essentially relates to project prefinancing and unrecoverable payments.

Operational risks include the risk of losses being incurred as a result of the unsuitability or failure of internal processes, people and systems, or due to external events. Recruiting highly qualified scientists and encouraging them to stay with the organization is the key to preserving and expanding Fraunhofer's research expertise. The Fraunhofer-Gesellschaft is well placed in this respect, a fact borne out not only by numerous scientific awards, but also by its very positive image as an employer both inside and outside the organization. Fraunhofer intends to continue enhancing its standing through measures such as regular employee surveys or initiatives for improving the situation as regards equal opportunities and work-life balance. Through closer integration with a growing number of universities, the organization can raise awareness of the professional opportunities within the Fraunhofer-Gesellschaft among talented young potential candidates at an early stage.

Fraunhofer depends extensively on a reliable, secure IT infrastructure to provide research services. As the centralized provision of IT services becomes more and more the norm, risk management requirements in respect of such services are changing. Risks relating to IT are limited through specific measures, which are also set out in a binding IT security manual.

Through its contract research projects, the Fraunhofer-Gesellschaft is exposed to liability and performance risks such as product liability and warranty. It manages these through a system of risk-oriented project management, suitable liability restriction clauses in its standard terms and conditions of business and in its standard contracts, as well as through a multi-tier approval process based on competent legal advice.

Fraunhofer has also recently established a compliance management system to ensure that adequate attention is devoted to this topic. The Compliance Office is the central point of contact within the organization in matters related to the compliance management system. The system's underlying organization and associated processes are described in the manual published in 2011.

Technology transfer

- Systematic support for the innovation process
- Three inventions per working day
- Over 6130 active rights and patent applications
- Strengthening of the Fraunhofer-Zukunftsstiftung (Fraunhofer Future Foundation)

One of the Fraunhofer-Gesellschaft's main objectives is to put ideas and inventions to commercial use to the ultimate benefit of society. To achieve this objective, the Fraunhofer-Gesellschaft is active at different levels. That includes not only working in close cooperation with industry, but also patenting and licensing valuable technologies or taking a share in spin-offs.

In many countries, such as the USA, China, Taiwan, and also Germany, there is a financing gap in the innovation process. Many technologies and ideas for products fail to make the transition from publicly funded R&D to privately funded market launch, ending up in the so-called valley of death. At the same time, established companies shy away from the risks involved in promoting new technologies at an early stage if their functionality has been proven only in laboratory conditions.

In order to strengthen the sustainable transfer of knowledge and technology by means of licensing and spin-offs, Fraunhofer's Executive Board initiated a pilot project called "Fraunhofer 4D". The goal of the project is to systematically

assess the marketability of individual product ideas that could be suitable for licensing or the creation of a spin-off, and to use Fraunhofer funds to develop these ideas with the firm goal of marketing them.

Fraunhofer 4D is an integrated, structured, multi-phase process. Numerous ideas are screened, with only the most economically viable being selected and developed to the point of market launch. Every phase of the process is professionalized and optimized using state-of-the-art methods. The process concludes with the setting up of a spin-off or management team. That raises the chances of successful implementation because promising ideas can be pursued even before a team has been found that is willing to set up a spin-off. From the very outset, coordinators from head office lend active support for the project ideas. Fraunhofer 4D is a four-phase model. In the first two phases, the product ideas are systematically identified (discovered) and their underlying concepts developed further (defined). In phase 3 (develop), the product is developed to the point of marketability. Business and sales models form part of the fourth, market-oriented phase (deploy). Of the roughly 40 product ideas in phase 1, the Executive Board selects seven to be funded as pilot projects.

Given the dynamic nature of technological progress, the ability to innovate quickly has become a decisive competitive factor. Short, expensive innovation cycles mean that technical solutions have to be made available as fast as possible. In order to safeguard a competitive lead that is based on innovation, the technical solutions have to be protected with patents, allowing solutions to be turned into commercially viable goods.

The Fraunhofer-Gesellschaft is one of the most important sources of patent applications in Germany. In 2011, the Fraunhofer Institutes applied for patents for 673 new inventions. That equates to around three inventions every working day. At 494, the number of patent applications for these

Growth in inventions and patents

	2007	2008	2009	2010	2011
Active rights and patent applications ¹	5165	5446	5713	5945	6131
Invention disclosures	663	691	687	702	673
Patent applications	537	566	564	539	494

1 As of Dec. 31

inventions was slightly lower than the previous year. One reason for this reduced number was a more critical assessment of the inventions' potential economic success on the part of the institutes. The number of active rights and patent applications increased to over 6130, with a total of 2860 patents having been granted for the German market at year-end 2011. The number of active exploitation contracts grew to over 2800.

In order to better compensate the fluctuations in its traditional sources of income, the Fraunhofer-Gesellschaft has implemented a results-oriented system of intellectual property (IP) management. Its main instrument – a patent strategy process – has already been introduced at 20 Fraunhofer Institutes. This process enables the institutes to better manage their IP and taps additional sources of income by strengthening the licensing of IP outside the field of contract research.

Following an analysis of their patent portfolios, the institutes involved were given recommendations for reducing the patent-related costs of less attractive patent clusters and for stepping up their patenting and exploitation activities for economically attractive ones. Whereas the recommendations for cost reductions were largely put into practice, it became evident that the institutes need further support in implementing the recommendations for stepping up their patenting

and exploitation activities. For this reason, a three-year phase was launched that will target the enhanced exploitation of patents. In addition, in the pilot institutes, structures are to be created and tested to perpetuate the patent strategy process and support the systematic generation of license-fee revenue.

Although mp3 license-fee revenue had been expected to decline gradually, it in fact reached €125 million in 2011 and was thus well above the figure of the previous year. However, this high figure contains lump-sum license fee payments both for audio encoding and in other technical fields.

When Fraunhofer cooperates with companies to carry out research into new subjects at an early stage, it becomes difficult to make the know-how generated in the process available to a large number of companies. In the interests of Fraunhofer's own future, it is thus necessary for the organization to protect certain attractive areas of technology with industrial property rights so as to be able to generate new license-fee revenue further down the line. These goals are pursued by the Fraunhofer Future Foundation.

On the basis of the framework agreement between Fraunhofer and the Fraunhofer Future Foundation, a total of €218 million in three tranches has been transferred to the foundation since its establishment. The third tranche of €70 million was transferred in 2011. A total of nine foundation projects have now been approved, which together tie up just under 35 percent of the foundation's capital. The projects that have been approved or are in preparation are regularly reviewed by the application committee and the foundation's advisory council, and assessed to see whether they are on track to meet their targets.

Subsidiaries, shareholdings and spin-offs

- Positive development of international subsidiaries
- Shares in 86 companies
- Growing number of spin-off projects

Fraunhofer's three subsidiaries continued to perform well in the financial year 2011.

Fraunhofer USA, Inc., is a wholly owned, non-profit subsidiary of the Fraunhofer-Gesellschaft, with headquarters in Plymouth, Michigan. The chief motivation for this engagement in the United States is to intensify scientific expertise by cooperating with internationally renowned research centers, and to strengthen the Fraunhofer R&D portfolio. The U.S. market represents an important benchmark for the Fraunhofer-Gesellschaft.

At the present time, there are 6 Fraunhofer Centers operating as research and development units under the auspices of Fraunhofer USA. Each works in close collaboration with one or more of the Fraunhofer Institutes in Germany on development projects for industrial firms, public-sector clients and academic institutions. Fraunhofer USA, Inc., posted provisional total revenues of €37.5 million for 2011, well above the level of

2010. With total revenues of €16.1 million, the Fraunhofer Center for Molecular Biotechnology CMB, Delaware, was the best-performing Fraunhofer Center in the USA, followed by the Fraunhofer Center for Sustainable Energy Systems CSE, Massachusetts, with total revenues of €7.3 million.

2011 was the second complete financial year of **Fraunhofer Austria Research GmbH**, which is headquartered in Vienna. The Fraunhofer-Gesellschaft is the sole owner of this non-profit, limited-liability company, which was set up for the exclusive purpose of directly promoting applied research and science. The legal entity Fraunhofer Austria Research GmbH comprises the Austrian activities of the Fraunhofer Institute for Manufacturing Engineering and Automation IPA and the Fraunhofer Institute for Computer Graphics Research IGD in two separate units. The company has sites in Vienna (for the Production Management and Logistics unit) and Graz (for the Visual Computing unit). With a workforce of 31 and budgeted expenditure in 2011 of €2.4 million, Fraunhofer Austria generated industrial revenues of €0.9 million as well as public-sector and other revenues of €0.6 million.

Fraunhofer's subsidiary **Fraunhofer Italia Research Konsortial-GmbH**, a non-profit joint venture with the South Tyrol Employers' Association with headquarters in Bolzano, celebrated its first anniversary in January 2011. The Fraunhofer-Gesellschaft holds a 99-percent stake in this subsidiary, which functions as legal representative for the legally dependent centers located in Italy, including the Fraunhofer Innovation Engineering Center IEC, which the government of the state of South Tyrol is providing with base funding for an initial period of four years. The Fraunhofer Innovation Engineering Center remains on a successful course. It not only exceeded its targets in terms of both personnel growth and third-party revenues, but received positive coverage in the South Tyrolean media. The center in Bolzano is well on the way to becoming a permanent fixture in the region.

Due to the negligible effect of the revenues generated by the subsidiaries on the overall organization's net assets, financial situation and operating results, the Fraunhofer-Gesellschaft does not draw up consolidated financial statements.

At the balance sheet date, the Fraunhofer-Gesellschaft held equity investments in 86 companies in a wide variety of sectors.

The total carrying amount of these investments was €6.4 million. In the financial year 2011, the Fraunhofer-Gesellschaft acquired shares in the equity capital of eight spin-off companies, while exiting a further six.

Spin-off companies are rapidly developing into important R&D partners for the Fraunhofer-Gesellschaft and represent one of the main avenues through which it exploits its industrial property rights. The Fraunhofer-Gesellschaft typically provides support and contributes its know-how during the preparation phase of the spin-off; in return, it receives a minority share in the equity of the fledgling company. As well as generating return from the technology transfer, spin-offs also help to promote entrepreneurial thinking and the establishment of cooperative networks with businesses operating in the same sphere as the respective Fraunhofer Institutes. Moreover, spin-offs are of great economic benefit to the national economy in that they lead to the creation of new jobs and enhance Germany's competitiveness through product innovation. In 2011, the Fraunhofer-Gesellschaft provided support for 30 new spin-off projects, and helped establish eight companies.

Since the Fraunhofer-Gesellschaft first launched its support program for spin-offs, known as "FFE – Fraunhofer Fosters Entrepreneurship", 85 teams have received help in starting up their own companies. In 2011, funds totaling €0.8 million were granted to six new projects. All in all, the Fraunhofer-Gesellschaft is confident that it will be able to go on expanding its spin-off activities in the medium term.

As from 2012, the pilot program "FFM – Fraunhofer Fosters Management", which was previously funded by the German Federal Ministry of Education and Research (BMBF), will continue as Fraunhofer's own spin-off support program. The goal of this program is to strengthen the management skills of the new executives and guide them through the highly critical early phase of their business. Thus far, the program has supported more than 35 projects. The BMBF is currently revising its "Guideline for the Participation of Research Institutions in Spin-Off Companies for the Purpose of Knowledge and Technology Transfer", with the goal of supporting and strengthening its activities in the area of spin-offs.

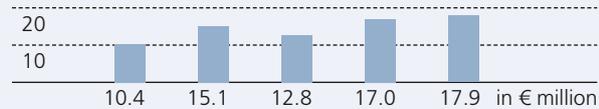
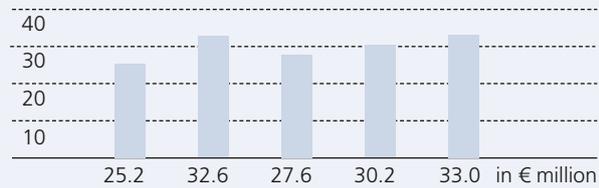
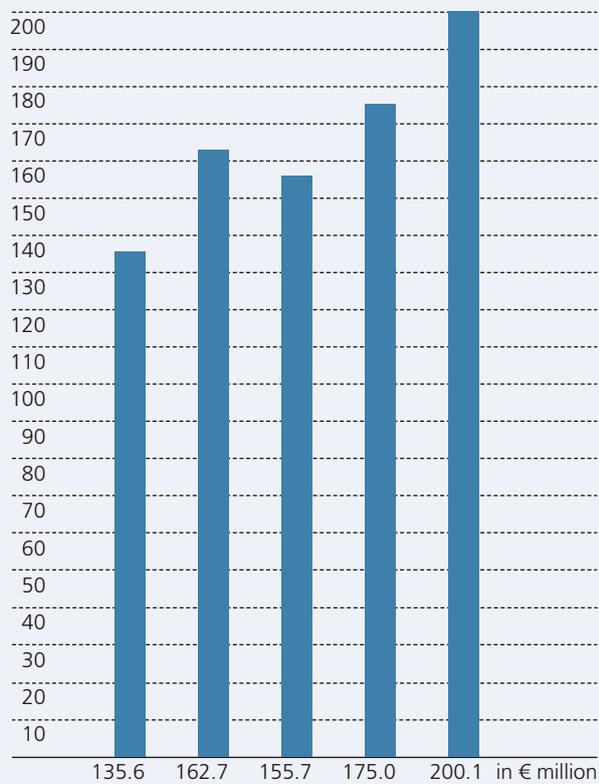
International activities

- International revenues reach €200 million
- First Fraunhofer Center opened in South America

Having established itself as an international player in the innovation arena in recent years, the Fraunhofer-Gesellschaft continued to expand its international activities in 2011. Cooperative ventures with partners of excellence and the establishment of institutions form the main thrust of these activities. Its representative offices abroad help to integrate the Fraunhofer-Gesellschaft in the regions of greatest importance to present and future scientific progress and economic development. Fraunhofer research services are much in demand worldwide.

In the financial year 2011, the organization's project revenue from international partners (excluding license-fee revenue) amounted to €200.1 million, €22.3 million of which comprised revenues from Fraunhofer's foreign subsidiaries. That corresponded to an increase of more than 14 percent over 2010.

International revenue of the Fraunhofer-Gesellschaft 2007–2011



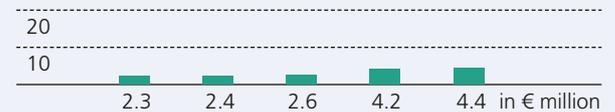
2007 2008 2009 2010 2011

■ Total international revenue ■ USA ■ Asia



■ Europe	54.6	60.8	64.4	65.1	70.4
■ European Commission	43.1	51.8	48.3	58.5	74.4
=	97.7	112.6	112.7	123.6	144.8

in € million



2007 2008 2009 2010 2011

■ Europe
 ■ European Commission
 ■ European countries excluding the European Commission
 ■ Other countries

In 2011, revenues from collaborative projects with European customers and as a participant in EU-funded joint research projects increased by 17 percent to €144.8 million. Of that figure, €74.4 million was attributable to contracts with European partners, 27 percent more than in 2010, while revenues from EU-funded joint research projects accounted for €70.4 million in revenues.

In the European Research Ranking published in 2011 on the basis of key figures provided by the EU Commission, Fraunhofer was the most successful participant in EU-funded programs in Germany and took second place Europe-wide.

Like the subsidiaries in Austria and Italy, Fraunhofer's representative office in Portugal also performed well in 2011, and succeeded in expanding both its research activities and customer relationships. Despite the financial and political crisis in Portugal, the new government there still considers Fraunhofer to be a core component of its policy of national innovation.

As part of the collaboration between the Fraunhofer-Gesellschaft and the Association des instituts Carnot, seven new projects were chosen in the call for projects for the Franco-German "Programme Inter Carnot Fraunhofer (PICF)" at the end of 2011. An array of joint publications and patent applications as well as the industrial revenues earned are testimony to the success of the program's total of 26 projects. The program was declared a great success in the presence of the French and German research ministers at the Forum for Franco-German Research Collaboration. One high point in 2011 was the awarding of the Franco-German Business Award in the "Innovation" category to the "Solar Bond" project, as being emblematic of the entire program.

The Fraunhofer-Gesellschaft's revenue from projects in the United States amounted to €33 million in the financial year 2011, of which €20.1 million stemmed from our subsidiary Fraunhofer USA, Inc.

In recent years, the Fraunhofer Center for Manufacturing Innovation CMI has become a bridgehead to Boston, a leading international biotechnology center. Together with its long-standing partner Boston University, Fraunhofer is forging ahead with its successful medical technology alliance. The Fraunhofer Institute for Production Technology IPT is lending support from Germany to the U.S. medical technology alliance. Building on the pioneering work and experience of Fraunhofer CMI in Boston, Fraunhofer IPT has succeeded in establishing a similar network in Aachen as well as a future-oriented joint business area "Life Sciences Engineering". At the close of 2011, Fraunhofer and Boston University decided to continue their successful partnership for a further five years.

The successful track record of the Fraunhofer Center for Molecular Biotechnology CMB in recent years prompted the U.S. state of Delaware to renew its financing commitment to the center for a further six years.

The center's ties to the University of Delaware have been formalized since 2011, enabling joint appointments of staff and the utilization of the university's comprehensive resources.

The Fraunhofer Project Centre for Composites Research, a partnership between the Fraunhofer Institute for Chemical Technology ICT and the Canadian University of Western Ontario, was set up in London, Ontario, in July 2011 for an initial period of five years. For the first time on North American soil, the partnership will establish a research infrastructure for large-format fiber-composite components for lightweight construction in automobile manufacturing.

In Asia, Fraunhofer generated revenues of €17.9 million, thus achieving a year-on-year increase of 5 percent. Japan remains the most important market in Asia with revenues of €6.8 million, followed by China with €3.3 million and South Korea with €2.8 million.

In conjunction with the Fraunhofer Institute for Manufacturing Engineering and Automation IPA, the Fraunhofer-Gesellschaft opened the Fraunhofer Office for Process Engineering of Functional Materials and Robotics OPER in Osaka in March 2011. OPER is an extension of the Representative Office Japan, which celebrated its tenth anniversary last year. The activities of this specialized subsidiary will focus on benefiting from the advanced knowledge of Japanese scientists and enterprises in the field of functional nanomaterials and robotics. In addition to regions like Europe, the USA and Asia, to which it has traditionally accorded strategic priority, the Fraunhofer-Gesellschaft is increasingly focusing its international activities on the new growth region of South America.

September 1, 2011 saw the opening of the first Fraunhofer Center in South America, the Fraunhofer Center for Systems Biotechnology CSB in Santiago de Chile. After a successful lead-in phase, Fraunhofer Chile already employed over 70 people at the end of 2011. The collaboration between the Chilean and German scientists covers subjects such as aquaculture, carbon sequestration, agriculture and bioinformatics. Among its goals are the early detection of fish diseases and the development of new vaccines for use in aquaculture. The center is thus making a valuable contribution toward solving urgent global problems such as securing food supplies and achieving sustainable growth.

Strategic development

- Strategy process 2025 launched
- Establishment of new research units
- The “Morgenstadt” systemic approach
- Sustainability as guiding principle

Diminishing stability is a characteristic consequence of the rapid pace and growing complexity of economic development and social change. Faced with a constantly changing research

environment and ever shorter innovation cycles, research organizations are being compelled to adopt more flexible strategy planning processes that are geared to probable framework scenarios. Fraunhofer's strategy process 2025 describes various alternative, individually consistent scenarios for the observation date 2025, which were derived on the basis of a scenario analysis.

In close cooperation with the Fraunhofer workforce, different framework scenarios were examined in order to analyze internal factors in 2025. These factors range from the Fraunhofer-Gesellschaft's mission, national and international growth strategies and changes in the employee's working environment, through to market changes, new forms of partnership with industry, and the Fraunhofer-Gesellschaft's internal organization. The Fraunhofer-Gesellschaft's senior executives discussed and elaborated an orientation scenario 2025, which contains statements and estimates in respect of these factors.

In order to decide on and implement the strategies derived from this orientation scenario, the Executive Board of the Fraunhofer-Gesellschaft set up working groups focusing on particular topics. Each under the leadership of a Presidential Council member, these working groups proposed projects and measures aimed at drawing up a roadmap to achieve the prescribed objectives. At the end of 2011, the working groups presented their proposals for refining and advancing the Fraunhofer model, which included strengthening the formation of cross-institute groups and developing binding strategies for those groups.

In order to meet both the requirements of the market and the demands of society in its research work, the Fraunhofer-Gesellschaft needs to have in place a permanent process of renewal and evaluation.

In addition to evaluating new market trends or sociopolitical topics, this involves the establishment of new research units, either by setting up new project groups in complementary research fields or integrating external research units of academic excellence. The financial year 2011 again produced impetus to put important new specialist topics and new structural units on the map, and to drive forward research activities in the fields of healthcare, the environment, energy and mobility.

Plastics and plastics-based hybrid materials harbor huge innovation potential in the current fields of healthcare, security, communication, mobility, energy and the environment. In the fields of mobility, security and energy, the Fraunhofer Institute for Structural Durability and System Reliability LBF and the Deutsches Kunststoff-Institut (DKI – German Plastics Institute) in Darmstadt both see good opportunities for tapping this potential with their joint expertise. To this end, Fraunhofer needs to establish permanently linked expertise and value creation in the field of plastics engineering. By integrating the DKI in Fraunhofer LBF, the latter gains an additional core competence in engineering and functional plastics and, going forward, will be able to cover the entire value chain for plastics – from the material itself through to high-performance lightweight construction – so that what it offers the market is more comprehensive and attractive. The German *Land* of Hesse is providing €12.5 million in funding to integrate the DKI into Fraunhofer LBF.

A prime example of establishing a new project group in a complementary area of expertise and taking up a new topic of relevance to both the economy and society is the founding of the Fraunhofer Project Group Material Recycling and Resource Strategies (IWKS) within the Fraunhofer Institute for Silicate Research ISC at its locations in Alzenau and Hanau. As an industrial nation and export-driven economy, Germany is particularly dependent on reliable supplies of raw materials. Access to raw materials is decisive for the ability of German

industry and its workforce to innovate and to secure their own future. The goal of the project group's work is thus to safeguard the long-term availability of raw materials for the manufacturing and processing industry.

In view of the huge economic significance of the Rhine-Main industrial region, both the Bavarian and Hessian governments will contribute tens of millions of euros in funds over the next five years to set up the project group. The project group ensures that expertise is built up rapidly, while forming an excellent basis for a future Fraunhofer Institute.

In its quest to identify new, innovative fields of research with future promise, the Fraunhofer-Gesellschaft examines both short-term technological and social developments, and long-term trends. Special attention is being devoted to the worldwide urbanization trend and the growing significance of cities as humankind's central living environment. The growth of cities and urban areas calls for a transformation in numerous areas of technology, such as energy and mobility, which interact with and depend on one another. Especially against the backdrop of the necessary transition to a new energy regime, the holistic and systemic examination of cities as society's key living areas will be a critical success factor in future development.

Fraunhofer uses the term "Morgenstadt" to describe its vision of a sustainable, forward-looking "city of tomorrow" that promises a high quality of life. "Morgenstadt" is based on a systemic approach, examining cities from a technological, organizational and systemic perspective and deriving sustainable, long-term guiding principles for the forward-looking transformation of our cities, towns and urban regions.

The Fraunhofer-Gesellschaft sees the complexity of the "Morgenstadt" as a subject of research – with all the technical, process-related, needs-based and systemic questions it poses – as one of the biggest challenges being faced on the path toward a sustainable society. Thanks to the sheer breadth of its R&D expertise, the Fraunhofer-Gesellschaft is well placed to make an outstanding contribution toward achieving the "Morgenstadt" vision.

The opportunity and goal this opens up for the Fraunhofer-Gesellschaft entail developing, implementing and supporting an end-to-end systemic approach for the transformation of our urban centers into "cities of tomorrow". The Fraunhofer-Gesellschaft is ideally equipped to play a key role in implementing the "Morgenstadt" project formulated for the Research Union's High-Tech Strategy 2020, and to deliver a strategic action model for synchronizing so far unrelated urban systems, including research into and development of relevant complementary key innovations.

Although the main thrust of this systemic approach envisages "Morgenstadt" in terms of Central European urban structures, the approach can also deliver an important thrust towards establishing Germany as a lead market and leading provider in extending the approach to other markets and regions. If government, industry and the research community pull together, it will be possible in the short term to develop solutions and innovations in this still relatively untapped research area – namely the convergence of urban systems – that underscore Germany's claim to be a global provider of sustainability technologies and their implementation.

The key challenge for the future does not lie in optimizing individual technologies, but in integrating these systems in the long term within the framework of the sustainable city of the future.

In order to anchor sustainability as a guiding principle in the careful handling of the environment and society, and to develop a holistic sustainability concept that forms an integral part of the organization's overall strategy, the Executive Board of the Fraunhofer-Gesellschaft commissioned a network of 17 institutes to carry out the project. In early 2012, the network delivered proposals for implementing the idea of sustainability, including the rapid introduction of a transparent and standardized sustainability reporting system in line with the internationally recognized standards of the Global Reporting Initiative.

The Fraunhofer-Gesellschaft has also determined how the topic of sustainability is to be anchored in organizational terms. The President of the Fraunhofer-Gesellschaft will set the corresponding goals and monitor their achievement, while many of the activities on the operational side will be conducted by the Fraunhofer Sustainability Network.

The Fraunhofer-Gesellschaft is also planning dialogs with stakeholders on the topic of "Ethics, technology and innovation" in cooperation with other national and international organizations.

On a variety of different platforms, the Fraunhofer-Gesellschaft wants to discuss how, as a research organization, it can fulfill its product stewardship responsibilities.

In June 2011, Dr. Alexander Kurz became a member of the Executive Board of the Fraunhofer-Gesellschaft with responsibility for human resources and legal affairs. Prior to his appointment, he was Vice President of the Karlsruhe Institute of Technology (KIT).

In 2011, Fraunhofer's dynamic growth was funded to a large extent through external projects. The performance-based allocation of base funding and transparent methods of evaluating the performance of the individual institutes are, and will remain, key factors in the success of the Fraunhofer model. Partnerships between different players in the research system – whether universities, other research institutions or industrial companies – have proved themselves to be an important element. Fraunhofer is thus an integral part of – and an integrating force in – the research community. Going forward, the Fraunhofer-Gesellschaft will continue to adapt its structures on an ongoing basis to meet the demands of applied research, and exploit the opportunities it offers. The Fraunhofer 2025 strategy process played an important role in this context in 2011. As part of this process, each institute will have to submit to a strategy audit in the period 2011 through 2014, which will ensure that our research continues to be predominantly driven by the needs of industry.

In view of the current volume of new contracts, Fraunhofer cannot discern any negative effects of the European sovereign debt crisis on its income thus far in 2012. However, economic uncertainty may prompt market players to adopt a more restrictive approach when awarding contracts for research and development. Fraunhofer is optimistic that the value of innovation is recognized and accepted at the political level and indeed across society as a whole. That is why Fraunhofer considers the goals it has set for the coming year to be realistic – namely to achieve business volume of around €2 billion and to create some 1000 additional jobs. With the topics of energy, healthcare, mobility, security and communication, the Fraunhofer-Gesellschaft has a portfolio studded with areas of promise. No other research institution can call on such a large amount of research capacity in the fields of renewable energy production, energy storage and distribution as well as energy utilization and utilization efficiency. Fraunhofer has thus taken on a leading role in the transition to a new energy regime that is just beginning in Germany.

In line with national interests, there are plans afoot to establish a scientific institution for public information technology under the auspices of the Fraunhofer-Gesellschaft in 2012. This would enable Fraunhofer to serve the federal and *Länder* governments as an independent center of competence in the fields of public-sector IT and e-government. The establishment of such an institution would further underscore Fraunhofer's high level of expertise in the fields of homeland security and information and communication technology.

Its success of recent years provides the Fraunhofer-Gesellschaft with the motivation to continue systematically building up its research expertise so that it remains in a position to fulfill its central objective of providing research dedicated to the future and making a contribution to growth and prosperity in Germany and in Europe.

The Executive Board would like to thank the organization's members, patrons, friends and, most of all, its staff for their support and dedicated work during the past year.

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

The Executive Board

Prof. Dr. Hans-Jörg Bullinger
Prof. Dr. Ulrich Buller
Prof. (Univ. Stellenbosch) Dr. Alfred Gossner
Dr. Alexander Kurz

REPORT OF THE SENATE ON THE FINANCIAL YEAR 2011

While the year 2011 was overshadowed by the sovereign debt crisis in the eurozone, German industry still performed exceptionally well in this uncertain climate. This was because German companies continued to focus on research and development as a key to upholding their competitiveness. This situation enabled Fraunhofer to continue expanding its role as Europe's leading provider of research services and thus keep growing in 2011. The Fraunhofer-Gesellschaft's financial statements for 2011 again received an unqualified audit certificate from its auditors.

In 2011, the Senate fulfilled the tasks it is charged with under the statutes of the Fraunhofer-Gesellschaft. It convened twice in the course of the financial year, on May 26 at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen and on October 18 at the Fraunhofer Institutes for High Frequency Physics and Radar Techniques FHR and for Communication, Information Processing and Ergonomics FKIE in Wachtberg. In the course of these meetings, the Senate finalized the annual financial statements and the financial planning in accordance with the statutes of the Fraunhofer-Gesellschaft, discussed the organization's risk management and investment practices, the status quo and changes at the units, and the principles of the Fraunhofer-Gesellschaft's science and research policy.



The main decisions taken in accordance with the statutes concerned structural changes:

- On July 1, 2011, the “Security and Reliability” project group of the Fraunhofer Institute for Secure Information Technology SIT was transformed into an independent Fraunhofer Research Institution in Garching under the leadership of Prof. Dr. Claudia Eckert.
- The Fraunhofer Center Nanoelectronic Technologies CNT in Dresden, which is a temporary Fraunhofer Research Institution, will continue to operate until at least December 31, 2012.
- The Senate decided that the Fraunhofer-Gesellschaft would establish Fraunhofer UK Research Ltd as a company limited by guarantee; the new company will act as legal entity for the planned Fraunhofer Centre for Applied Photonics and any future research facilities of the Fraunhofer Institutes to be set up in the U.K.

On June 1, 2011 Dr. Alexander Kurz was appointed to the position of Senior Vice President Human Resources and Legal Affairs at the Fraunhofer-Gesellschaft. We are delighted at being able to secure Alexander Kurz for this position. He is an outstanding personality with a proven track record in management positions at other research organizations.

On October 18, 2011, the Senate reappointed Prof. Dr. rer. pol. Alfred Gossner as Senior Vice President Finance and Controlling, IT for a further period – from September 1, 2012 to August 31, 2017 – and confirmed him in office.

The Senate takes this opportunity to thank the entire staff of the Fraunhofer-Gesellschaft for their commitment and their very successful work in the financial year 2011.

Prof. Dr.-Ing. Ekkehard D. Schulz
Chairman of the Senate of the Fraunhofer-Gesellschaft

REVIEW OF FRAUNHOFER RESEARCH

FIRE

Fire symbolizes warmth, light, power, but also destructive force. Fire can be described as a rapid chemical oxidation process that releases large amounts of energy. It is usually organic materials such as wood, oil or natural gas that burn. But other materials – like aluminum, iron or sulfur – can also combust. Humankind's mastery of fire represented a milestone in our cultural development. The ambiguous nature of fire is evident in its use for heating, mobility and preparing food on the one hand, and as a weapon of destruction on the other.

LIVING WITH RESPONSIBILITY

SUSTAINABILITY – THE PATH
AND GOAL OF APPLIED RESEARCH

PROJECTS AND RESULTS 2011

The background features a complex, abstract design with overlapping geometric shapes in various colors including orange, yellow, purple, blue, and red. In the lower-left quadrant, there are three concentric white circles. Three white, V-shaped or bracket-like symbols are positioned on the innermost circle, pointing towards the center of the circles.

LIVING WITH RESPONSIBILITY

Responsibility begins with people. This sentence sounds like a commendation, as if it could apply only to important people – people who are movers and shakers, who exercise power, who occupy positions of responsibility. The reality is different: all of us bear responsibility. The only time that we do not bear responsibility is very brief: it is restricted to those few short years of childhood during which our understanding of the world is very limited and we have hardly any possibility of influencing our environment through our own decisions.

Responsibility grows as we grow

We get a feeling for responsibility at the very latest when we begin to attend school: we either do something or do not do something, and neither option is without consequences. During our school years we gradually learn to adopt a more long-term approach – the amount we have to learn is soon so big that it is no longer enough simply to do some quick revision the night before the exam. At this point in time, we still bear responsibility mainly for ourselves alone.

That changes as soon as our lives become more mobile. When we drive an automobile – or even just ride a bicycle – we are taking clearly defined risks, both for ourselves and for other drivers and pedestrians. Here, at the very latest, the concept of responsibility has to be redefined: it now includes the health and well-being of the people around us. The same applies when we enter the working world, for very few of us are really soloists in the professional arena. We work in teams, as employees or managers, and our own personal performance has consequences for the success of our colleagues.

Starting a family represents a particularly big step toward greater responsibility. From this point in time onward, it is no longer a question of the direct effects of our own actions, but of long-term consequences even across generations. Every decision we make has to be carefully considered, and even what follows when our life comes to an end is in many ways the subject of our thoughts and planning.

Is responsibility always something good?

It is at this point that the ambiguous nature of responsibility becomes apparent. On the one hand, people crave responsibility because it means more influence, more options to shape things, greater importance for their own person. More responsibility gets you noticed as someone clearly up front. People learn and grow with responsibility, acquiring new skills. And, in the event of success, the consequences of responsibility are enjoyable.

Living with responsibility

On the other hand, responsibility is also a burden. Success is worth celebrating only if failure, too, was a possible outcome. People who are called to account for their errors or failure may curse their status of importance, and would rather shun the limelight and leave the stage to someone else.

Despite this ambivalence, it is likely that every person aspires to exert influence and achieve something through their actions. It is a natural urge, and one that cannot be completely suppressed by the prospect of possible failure. Ultimately, responsibility is what defines every person in their social environment – that is why it is something good and important.

What does responsibility have to do with sustainability?

If you feel a sense of responsibility not only for yourself, but for others – and also take a forward-looking approach to life – you will inevitably be confronted with the notion of sustainability. After all, sustainability represents our sense of responsibility for future developments.

The concept of sustainability originally comes from forestry: trees grow slowly, which is why people had to plan for periods spanning decades if they wanted to draw long-term profit from their forests. So they did not just cut down trees, they also planted new ones, even though young trees did not generate revenue for one or even two generations. This approach – taking on responsibility for the welfare of future generations – defines the concept of sustainability. Nowadays, the concept is defined thus: a system is being used sustainably if it has a chance to regenerate itself and its main component parts remain intact.

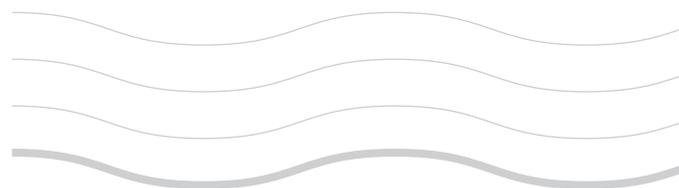
With reference to the forest, that means that we accept responsibility for ensuring that, in the long-term future, this natural system can still be utilized as a forest – for the production of timber, as a recreation area, for climate protection and as a habitat.

Where is sustainability needed?

In short, a resource that is used sustainably remains intact – not just for us, but for everyone and forever. That sounds a bit like a fairytale, like a bowl of porridge that remains full no matter how much of it you eat. But it is not as simple as that. Sustainability makes demands on us too – we are called upon to exercise moderation.

A prime example of a resource being used in a sustainable manner is Alfred Nobel's financial assets. The benefactor stipulated that the Nobel Prizes he set up were to be financed solely from the interest earned on his estate and that the capital itself was to remain untouched. In this way he made sure that the Nobel Prize can be awarded for all time to come. However, that also limits the amount of prize money available.

So money is a resource, too. Used sustainably, it can be a blessing and even multiply. By contrast, taking on debt is a sensible approach only if the money borrowed is invested and thus, in the foreseeable future, generates more profit than loss.



Energy supplies are one example of this. Fossil fuels cannot be sustainable as they cannot regenerate themselves. Over time, they can only be exhausted. Sustainable energy use is possible only with renewable energy sources such as the wind, sun, water and biomass. We have to accept, however, that the production of a liter of biofuel is more expensive than pumping a liter of crude oil out of the ground.

It is the same situation with other raw materials – like fossil fuels, they exist only in finite amounts. It is nevertheless possible to use them in a sustainable manner, for instance if we perfect the recycling process, extracting all precious metals, heavy metals and rare earths from our electronic scrap and reusing them. This, too, calls for an investment on our part, but in many cases it is already less expensive now to extract raw materials from electronic scrap than to dig them out of the ground.

A further example is our social welfare. We live in a society whose basic tenet is the principle of merit. If you do something for the good of the community, you receive remuneration and recognition. However, if someone is unable to make a contribution, e.g. because they are too young or too old, because they are sick or do not have the right education, then society invests something in that person. That enhances social equity and harmony, making society more cohesive. This, too, is a sustainable approach: investments in social benefits ensure that our social system functions and is productive both now and in the future.

Can we overdo sustainability?

Constantly thinking of the future in everything we do and do not do can be pretty tiring. Should we not concentrate more on looking after ourselves rather than the next generation?

That is of course right in essence. After all, if we neglect our own well-being, there will not be a next generation. As is so often the case, it is not a question of an “all or nothing” approach. We can and should look after ourselves, but in doing so we should act rationally and with farsightedness.

Farther down the track, when science and research have made even more progress, there are certain to be better technical solutions available than there are today. By the same token, we do not know what problems – of whose existence we have absolutely no idea at present – we will then have to face. It is fair to assume, however, that future generations will have enough problems on their plate without our leaving behind even more for them to deal with. The rule that “everyone should put their own house in order first” applies not only among neighbors, but also between different generations.



Are we responsible for regions stricken with poverty?

Striking a balance between the interests of today's population and those of future generations is only *one* aspect of sustainability. Even in today's world, there are regions whose inhabitants suffer dreadful poverty because of a lack of resources or catastrophic living conditions. We do not need to project our thoughts into a future time in order to recognize the need to act sustainably. Even if we have no direct influence on many of the circumstances triggering such chronic emergencies, we should still acknowledge our potential responsibility for them.

One particularly flagrant contradiction, for example, can be found in our use of foodstuffs for the production of biofuels. Our utilization of plant foods for other purposes causes the price of foodstuffs to rise around the world, in turn aggravating the already dire situation in the world's poverty regions. But it does make sense to use waste to produce energy – in that way we are not only not causing any damage, but also saving the world's climate from avoidable CO₂ emissions.

We need respect

Mahatma Gandhi aptly summed up the basic idea of sustainability: "Earth provides enough to satisfy every man's need, but not every man's greed."

Respect for other human beings, e.g. for our ancestors, is the key to recognizing the right measure for ourselves. Our forefathers had to work incomparably harder and take greater risks in order to provide for themselves and their families. We should also show respect for the needs of future generations. They will not understand why we squandered resources to the point of exhaustion.

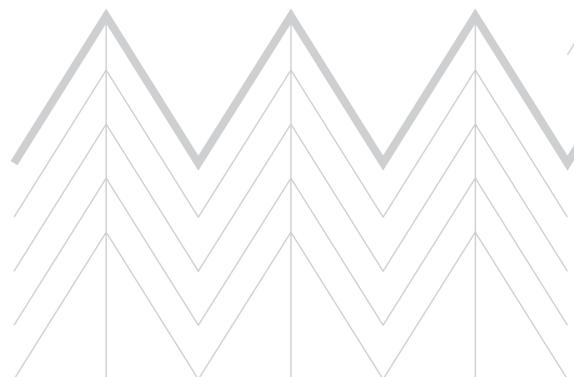
If we bear this in mind, we are more likely to discover respect for ourselves – and this is far more important for our feeling of satisfaction than the fulfillment of ephemeral desires. Perhaps it has something to do with the fact that humankind and nature are not opposing forces: humankind forms part of nature, so that, in the final analysis, using natural resources carefully means having a bit more respect for ourselves.

We bear the responsibility

Our behavior is crucial. But we need not see our responsibility as a burden – it is more like an opportunity to shape things. Our actions can make a difference.

Today, research gives us valuable knowledge and effective tools. We should make use of all available possibilities to work, do business and live in a reasonable and sustainable manner.

We can learn from the past, use that knowledge to act in the present, and thus shape the future. Taking on responsibility in this way is well worth the effort – in every respect and for each and every one of us.





SUSTAINABILITY – THE PATH AND GOAL OF APPLIED RESEARCH

Thomas Hirth



Sustainability – the path and goal of applied research

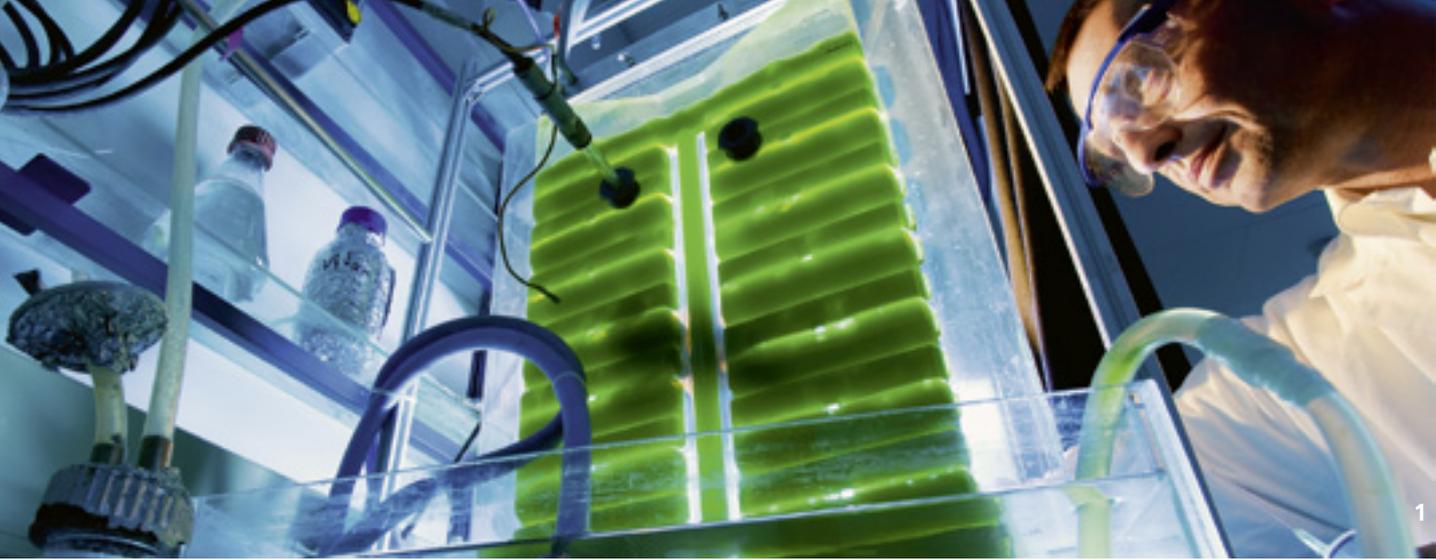
Key raw materials, especially fossil fuels, are available on Earth in only limited amounts. The increasing use of these raw materials makes them scarcer and more expensive. Above and beyond this, climate change and the instability of financial markets pose highly complex challenges and dangers to people everywhere. Dealing with these challenges calls for dynamism, unconventional thinking and action and, above all, inventiveness, innovation and a host of different partnerships – in short, a “master plan for a sustainable economy”. When it comes to tackling these huge tasks, it is to science and applied research that people look for ideas and strategies. By aligning itself more closely with the guiding principle of sustainability and acting as a driver of sustainable development, science has every chance of strengthening its role as leader and shaper in the social debate.

Sustainability in politics, business and science

In recent years, society has become ever more aware of the guiding principle of sustainability. At various levels, politicians have developed sustainability strategies and set up corresponding institutions. Their goal is to establish interconnections between environmental protection, the conservation of resources, economical behavior and social problems as part of a global, intergenerational approach to responsibility. The topics addressed include climate change, eco-friendly energy production, mobility, consumption and manufacturing, the conservation and management of natural resources, global healthcare, and the education of future generations. This also covers global challenges such as the fight against poverty, securing the basic means of living and, last but not least, the interrelationships between affluence, technology and sustainability.

In the business world, the subject of sustainability is frequently mentioned in the context of an enterprise’s “corporate social responsibility”. This trend has led more and more companies to publish sustainability reports.

While some of the principles of sustainability are less than specific, a few key guiding principles and interpretations are now widely recognized. According to the United Nations’ Brundtland Commission, “lasting (sustainable) development means satisfying the needs of the current generation without putting at risk the ability of future generations to satisfy theirs”. Accordingly, sustainability covers three areas: ecology, economy and society. Special attention is given to the basic needs of the poor around the world and to our Earth’s finite resources. That is why the link between social and ecological justice is one of the central challenges of the future.



If we are to achieve sustainability in our everyday lives, it is imperative that we accept responsibility for the current population of the world as well as for the generations to follow and that we leave behind for them a world worth living in. Above and beyond this, the Brundtland definition for the first time addresses the topics of limited resources and human needs.

Sustainability at Fraunhofer

The concept of sustainability also forms part of the Fraunhofer-Gesellschaft's self-image. In accordance with its guiding principles, Fraunhofer supports "the sustainable development of society, industry and the environment". In its brochure "The future needs research", the organization underscores its special role in Germany when it comes to safeguarding the future through innovation and research that is of use to people.

Both in the mission statement and under the heading of "Fraunhofer research", Fraunhofer's current guiding principles lend expression to the organization's commitment to make a contribution to sustainable development. Today, many Fraunhofer Institutes are already developing products and processes that are directly or indirectly connected with sustainability. This is clearly demonstrated, among other things, by their successful participation in corresponding European and national research and development (R&D) programs as well as by their project work for industrial customers.

Fraunhofer is a partner to international industry for innovations that are already making a big contribution toward sustainable development, and the organization is also interested in promoting change within society. In its role as trend-setter and driver, Fraunhofer will be able to influence the industrialized economies in a stronger and more active manner in the near future. We have recognized that technology-driven affluence can be a durable model for survival only if sustainability criteria are taken into account.

Fraunhofer's Sustainability Strategy project

In late 2010, the Executive Board tasked the internal Fraunhofer Sustainability Network with developing a sustainability concept and identifying the areas in which action needs to be taken in order to implement sustainability at the Fraunhofer-Gesellschaft.

The overriding goal of the Sustainability Strategy project was to align the Fraunhofer-Gesellschaft with the objectives of sustainable development and to strengthen the organization in the long term through the resulting innovation processes. The project aims to generate new ideas that will help to shape Fraunhofer's future development, and to show that Fraunhofer is addressing the questions of the future in a responsible manner and exploiting the opportunities that arise. As much as anything, the project is a prime example of inspiring collaboration between people from different disciplines at the Fraunhofer-Gesellschaft.

¹ *Algae produce a large number of base materials that can be used in the pharmaceutical and foodstuff industries.*

Sustainability – the path
and goal of applied research



The 2009 financial crisis, in particular, demonstrated that a company's future survival is not determined by performance indicators alone. Aligning a company with the guiding principle of sustainable development means carrying out a holistic analysis of the work and decision-making processes of all organizational units right down to the level of individual employees.

- Fraunhofer's Sustainability Strategy project team came up with ideas aimed at making Fraunhofer
- a pioneer in implementing sustainability topics in the field of applied research,
 - a change agent that combines research excellence with a policy of sustainability within its own organization,
 - a global contact for sustainable solutions, especially for industry,
 - a trend-setter in sustainability research with a high profile as a sustainable research institution.

In addition, the project and its participants are to function as a think tank for sustainability within the Fraunhofer-Gesellschaft.

- The team's work is divided into three sub-projects:
- Guiding principles, strategy and communication
 - Sustainable research and business processes
 - Research for sustainability

Guiding principles, strategy and communication

The sub-project "Guiding principles, strategy and communication" revolved around drawing up a roadmap for implementing sustainability measures at Fraunhofer.

- Proceeding on the assumption that the existing theoretical approaches constitute a normative framework that is not called into question, the concept of sustainability encompasses
- the guiding principles (including mission statement and vision) along with guidelines and general rules,
 - the areas for action Fraunhofer derives from these, each of which can be viewed from an internal and an external perspective; these answer the question: *Which* areas ought to be addressed (effectiveness)?
 - corresponding strategies for action; these answer the question: *How* should the areas be addressed (efficiency)?
 - a finely tuned raft of measures and projects. This discussion process culminated in three strategic messages for the project:

- 1 *Fraunhofer researchers devised the concept of energy-conserving refurbishment for high-rise buildings that corresponds to today's "passive house" standard.*
- 2 *Plus-energy houses produce more energy than they consume.*
- 3 *Energy from renewable sources can be stored in the form of methane.*



FRAUNHOFER: RESEARCHING WITH RESPONSIBILITY

This means invoking the normative guiding principle of sustainable development and the resulting voluntary commitments.

FRAUNHOFER: FROM INNOVATION PROCESS TO TRANSFORMATION PROCESS

This statement symbolizes Fraunhofer's support for customers and partners as they move from quantitative to qualitative innovation and the anchoring of that innovation in a socio-technical context. Innovation and transformation are not competing concepts, but represent two paths toward more sustainable structures.

FRAUNHOFER: AT THE VERY CENTER OF LIFE

This message signals the opening up of our research to the needs of people – taking into account the humanities and cultural disciplines as well as the interests and opinions of social groups so as to incorporate them in innovation processes.

Key tools in the analysis of external and internal stakeholders were the employee survey and workshops with the involvement of external experts. All Fraunhofer employees had the opportunity to make their personal suggestions and contribute their own views on sustainability via an online questionnaire.

Both the good response rate and the wide variety of ideas contributed by the employees show that the guiding principle of sustainable development is highly topical and of direct relevance to the employees.

Sustainable research and business processes

Aligning the Fraunhofer-Gesellschaft with the guiding principle of sustainable development means including economic, social and ecological aspects in all work and decision-making processes across all organizational units. In the long run, this will give Fraunhofer a competitive edge and simultaneously reduce risks, e.g. by integrating the requirements of stakeholder groups right from the word go. The members of this sub-project analyzed Fraunhofer's own business processes in close cooperation with Head Office. They examined potential obstacles and carried out an in-depth analysis of three business processes – namely human resources, sustainable infrastructure, and business travel and events – determining the current situation and deriving measures for improvement.

Sustainability reports for individual institutes and for Fraunhofer as a whole are planned as a means of communicating these measures to the outside world in future. By way of example, the team members developed methods for drawing up reports for individual institutes (Fraunhofer Institute for Chemical Technology ICT, Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT) and for a particular Group location (Institute Center Stuttgart), as well as outlining ideas for a Fraunhofer sustainability report and associated management system.

Sustainability – the path
and goal of applied research



The goal of the sub-project “Sustainable research and business processes” was to develop a Fraunhofer-specific framework and methodological ground plan that together have the potential to embed sustainability aspects more firmly into early phases of innovation. The intended result is to create system innovations that dovetail with the environmental and social systems in place. As there is scant empirical data for concepts of this kind, any proposal must be understood as being of a provisional nature only. Its further development and verification in practice make it essential that the proposal is subjected to a subsequent test phase within Fraunhofer.

The strategy developed by the members of this sub-project hinges upon the role of the project manager. As the agent who shapes technology, he or she bears ultimate responsibility toward society, sponsors or customers. This responsibility comprises the compatibility of the innovation with consumer preferences and lifestyles that apply at different times and in different parts of the world, the minimization of risks and undesired side effects, and the concern that the innovation does not cause any irreversible damage. In order to support sustainability in the innovation process, information, methods and best practice have to be compiled and rendered utilizable at project and project manager level in four basic areas. These are:

- Premises for action:
Why should I act sustainably and what overriding goals should I strive to achieve?
- Types of action:
How can I plan and carry out a research project so as to maximize its positive contribution to sustainability?
- Options and goals of action:
How do I design the target technology, what specific performance features do I aim for, and how do I deal with conflicting goals if I want to make a positive contribution to sustainability?
- Consequences of action:
What sustainability effects does my innovation have compared with alternative solutions and in respect of consensual social goals?

Research for sustainability

A leadership role in sustainability research calls not only for outstanding expertise, but also for the ability to act strategically. Assigning a particularly high degree of relevance to the inclusion of political and social interests (stakeholders) is one feature specific to research for sustainability. This type of research is also characterized by the higher complexity inherent to determining how solutions should be approached, and by the necessity to systemize solutions for the applications. Research institutions wanting to take on a leading role in research for sustainability must be active at the interface between the various agents of the “sustainability innovation system”.

- 1 *The consumption of resources plays a big part in production, both in economic and ecological terms.*
- 2 *Hollow camshafts are lighter and save fuel. Fraunhofer pioneered the method for producing them.*



Fraunhofer occupies a good starting position when it comes to gaining recognition as Germany's leading scientific institution for research into sustainability. Compared with other research institutions, Fraunhofer can point to its acknowledged role in transferring theoretical knowledge to practical applications and to its broader technological basis in the field of interdisciplinary technologies. Thus far, Fraunhofer has shown as little leadership as other research institutions in initiating strategic dialogs with politicians and with business and non-business stakeholders. In this area, in particular, Fraunhofer must sharpen its profile if it is going to become a leader in research for sustainability.

The sub-project "Research for sustainability" serves as a basis for the strategic further development of the Fraunhofer-Gesellschaft and for rounding off its portfolio of offerings in the field of sustainability. The goal of the sub-project was to cover the topic of sustainability in a customer-oriented manner and to systematically transform Fraunhofer into an opinion and technology leader in this area.

The members of the sub-project therefore identified frontline themes of direct relevance to sustainability – such as renewable energy, water treatment, the exploitation of renewable raw materials, biotechnology, and lifecycle management – and brought them together with existing areas of expertise at the Fraunhofer-Gesellschaft. A clear alignment with sustainability or at least the clear inclusion of this topic in the Fraunhofer-Gesellschaft's future project applications will help the organization secure an early lead over its competitors in terms of securing market shares and thematically focused prominence. Another component of the Sustainability Strategy is closer integration with research policy, enabling Fraunhofer to play an active role in designing public-sector development programs.

Research for a sustainable economy – as put into practice at Fraunhofer

If we want to adhere to the principle of sustainability as defined by the Brundtland Commission, it is necessary to re-design our systems to make them more environmentally and socially compatible. Research and development are key to this process, as they can contribute decisively toward making future growth achievable with a fraction of the resources currently consumed. The focus is on greater efficiency in the use of raw materials, resource and lifecycle management, bio-based raw materials, renewable energy, energy efficiency and energy systems, sustainable mobility and water management.

Lowering consumption of (raw) materials

Production methods that consume fewer resources and thus save raw materials and energy are advantageous not only for the environment, but also for companies. After all, in many industries material and energy costs constitute the main component in the price of the final product. In the processing industry, for instance, materials account for as much as 45 percent of production costs.

In their "Powertrain" project, researchers at the Fraunhofer Institute for Machine Tools and Forming Technology IWU are demonstrating that there are also other options. They want to make automobile drive trains more efficient. The goal of the project is to use new materials to reduce the weight of the drive train and to employ net-shape techniques and closed-loop materials management to lower the amount of materials and energy used. One example is the production of a camshaft using internal high-pressure molding, where the metal is

Sustainability – the path and goal of applied research



1

forced into the mold using hydrostatic pressure. The components manufactured using this technique are hollow and weigh considerably less than conventional camshafts, leading to a rapid reduction in the amount of materials consumed.

But Fraunhofer researchers are already thinking one step further. In future, they want to create production processes that get by without the input of new raw materials. That calls for systematic recycling, not just in private households, but especially in industry. Constantly reusing secondary raw materials in a cascade process and feeding them back into the production process can save enormous amounts of natural resources. In the Molecular Sorting project, various Fraunhofer Institutes are working together to achieve this goal under the leadership of Fraunhofer ICT. Their objective is to close raw material loops, develop new recycling strategies, and assess the latter from an economic and ecological standpoint. The most effective approach is to begin with product design, creating products that reuse raw materials. This is an area in which the Fraunhofer Project Group for Material Cycles and Resource Strategies (IWKS) is heavily involved.

Renewable raw materials

Up till now, oil has served as perhaps the main raw material for many products of the chemical industry. But this fossil-based raw material is becoming ever scarcer and more expensive. With the aid of white biotechnology, biomass can be harnessed as an alternative source of carbon for the production of chemical products. Many of the processes in question already function on laboratory and pilot scale. But in order to make effective and efficient use of renewable raw materials on an industrial scale, new, scalable processes are required that are closely integrated in the existing production structures. The task of the Fraunhofer Center for Chemical-

Biotechnological Processes CBP in the German town of Leuna is to close the gap between laboratory tests and industrial implementation. At the center, a lignocellulosic biorefinery is being constructed, in which all of the main component substances of wood can be processed. Through its research work, Fraunhofer CBP is also the main partner and scientific coordinator in the new “BioEconomy” cluster of excellence.

Algae constitute another natural raw material that has hardly been exploited to date. They use carbon dioxide to produce a variety of chemical substances with high value-added potential for the pharmaceutical and foodstuff industries. Such substances include astaxanthin, a red coloring with antioxidant and health-promoting properties, or the omega-3 fatty acid EPA, which is essential for human beings.

Integrated water systems

Access to clean drinking water and basic sanitation is a fundamental human right. And yet, more than one billion people worldwide still have no access to drinking water, and around 2.6 billion people live without proper sanitation – well over one-third of the Earth’s population. But water is also an important economic factor, with already more than four-fifths of all water being consumed by agriculture and industry. Different studies assume that water will become a more strategically important resource than oil in future. This led eleven Fraunhofer Institutes to join forces in the Fraunhofer Water Systems Alliance (SysWasser) with the aim of developing sustainable technologies for the supply of fresh water and the treatment of wastewater.



Lowering energy consumption

If the transition to a new energy regime is to succeed, much more efficient use will have to be made of energy in private households, for transportation and in industry than has been the case until now. The Fraunhofer study entitled “Energieeffizienz in der Produktion” (Energy efficiency in the production environment) demonstrates the huge potential of this subject for industry. The study comes to the conclusion that, in the medium term, energy consumption in the industrial manufacturing sector can be cut by 30 percent. The “Green Carbody Technologies” innovation alliance, a partnership that is being led by the Fraunhofer Institute for Machine Tools and Forming Technology IWU and brings together automakers, their suppliers, and those equipping the automotive industry, even claims that as much as 50 percent of the energy used to manufacture vehicle bodies can be saved.

Some 40 percent of the total energy consumed in Germany is required to heat, cool, ventilate and light private homes, offices and school buildings. Buildings dating from before 1979 waste a particularly large amount of energy, and account for 95 percent of the energy consumed by real estate. But clever renovation can easily turn such wasteful old buildings into low-energy houses. Even high-rises can be modernized and rendered more energy-efficient. Fraunhofer researchers, for example, succeeded in cutting the heating requirements of a 16-story residential building by 80 percent. Even more can be achieved with new buildings – future structures will in fact be able to produce more energy than they consume.

1 *In many big cities clean water is a very limited resource.*

2 *Forests are an essential part of Europe's natural heritage.*

Conventional combustion engines transform only around 20–30 percent of the energy they use into motion. Electric vehicles are better, with efficiency levels of about 40 percent from power generation through to actual driving performance, based on the current electricity mix. If wind energy alone were used to recharge the vehicles' batteries, efficiency levels of 70 percent could even be reached. In the Fraunhofer Electromobility System Research project, researchers are carrying out important groundwork for the transition to electrically powered vehicles.

Safeguarding our cultural heritage

The Earth's cultural heritage is among those resources that cannot be renewed, and which we must manage in a sustainable manner. Without it, we cannot hope to shape the future of Germany and Europe and preserve their unique beauty. What is more, our cultural heritage and the creative industry associated with it are a key economic factor, accounting for around three percent of Europe's GDP.

Climate change and the changes in our energy use resulting from it, but also new materials, must be weighed up in terms of the opportunities and risks they present to our cultural assets. This is possible only through constant research into the materials used for conservation, research that keeps pace with the ongoing changes of our time. Fraunhofer is facing up to this challenge in its Research Alliance Cultural Heritage. The researchers in the alliance are developing approaches to the energy-conserving refurbishment of museums as well as buildings for storing and archiving cultural assets, new processes for the environmentally compatible cleaning of artworks and monuments using plasma technology, and water-based paints to protect items of our industrial heritage. For the first time, the impact of climate change up to the year 2100 is

Sustainability – the path and goal of applied research



being studied using high-resolution climate modeling in combination with building simulation software specially tailored to historical buildings, and researchers are developing corresponding adaptation strategies and options for action.

Renewable energy

Renewable sources of energy such as the sun, wind, water and biomass offer great potential for making Germany more independent of fossil fuels. At above 6 percent, wind power has the largest share in power generation from renewable sources in Germany, and more than 28 gigawatts (GW) of onshore wind power capacity has already been put in place. Gigantic wind farms are now being built at sea. By 2030, these offshore wind parks will be delivering 20–25 GW of power, or around 15 percent of Germany's total energy requirements. "alpha ventus", Germany's first offshore wind farm, was completed in 2010 and doubles as a demonstration facility and a research object. The corresponding research initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) is being coordinated by the Fraunhofer Institute for Wind Energy and Energy System Technology IWES.

Thanks to the German government's Renewable Energy Sources Act (EEG), the feed-in of electricity produced with solar power is a viable option. But in order to make even greater use of solar energy, the price of photovoltaic systems will have to come down. The ambitious goal of the cluster of excellence Solar Valley Central Germany is to make electricity produced with solar energy cheaper than electricity from conventional power stations by 2015. The partners in the cluster, who come from industry and science, want to achieve this through the optimization of processes and products. This will

not only require cost cuts along the entire value chain, but also greater efficiency and longer service lives for the products. The Fraunhofer Center for Silicon Photovoltaics CSP in Halle is acting as scientific coordinator for the project.

Sun and wind cannot be relied on to deliver energy on a regular basis. That is why researchers at the Fraunhofer Institute for Wind Energy and Energy System Technology IWES in Kassel have joined forces with their colleagues from the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) to develop a process for transforming power from renewable sources into methane, thus making it easy to store. This is the first time that this has been accomplished on an industrial scale. The electric current first breaks down water molecules into hydrogen and oxygen. The oxygen is then made to interact with CO₂ to form methane.

Methane can also be produced through the anaerobic fermentation of biomass. In the ETAMAX project, researchers from the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB are cooperating in a consortium with industrial partners to demonstrate how biomethane can be made from the fruit and vegetable waste of the wholesale market in Stuttgart and suitably purified to power commercial vehicles.

Outlook

The Fraunhofer-Gesellschaft has exceptional potential when it comes to tackling the big task – as outlined in the German government's draft progress report 2012 on its sustainability strategy – of helping to steer the right course in an interdisciplinary and transdisciplinary context. The organization's motivated employees are open to all aspects of the subject, it has functioning structures, sound finances, expertise that is both broad and deep, excellent research work that is widely acknowledged and, last but not least, strong ties to industry and the public sector as well as an intensive interaction with



society. Whereas Fraunhofer has excellent credentials for carrying out “research with responsibility”, focusing and steering the forces needed for this task calls for even greater visibility and credibility, and the courage to act in an unconventional manner.

One of Fraunhofer’s particular strengths is initiating innovation processes and bringing them to a successful conclusion. More and more, we are embedding such innovation processes for our customers in larger-scale “conversion processes” engendered by the national sustainability strategy and the goals it has set. It is difficult to imagine economic, technological, scientific, social, political or cultural progress that leaves out the sustainability perspective. We have already begun to reorganize and restructure our economy, the manner in which we handle natural resources, and the way we live together.

That reorganization and restructuring also mean transformation is a fact underscored not only by the federal government’s German Advisory Council on Global Change (WBGU) in its main study released in 2011. Our industrial customers, too, are fully aware of how these are interlinked. Thus, the shift “from an innovation process to an transformation process” does not mean ignoring the one to concentrate on the other. Rather, we need to take a broader view with our innovations, imagining potential sustainability transformations within a larger system, and offer our customers alternative solutions born of unconventional thought processes.

This means supporting customers and partners as they move from quantitative to qualitative innovation and anchoring that innovation in a sociotechnical context. This is what industry expects Fraunhofer to deliver. Fraunhofer is already ideally positioned to help bring about the “big transformation”, namely the transition to a new energy regime. Transferring this systemic approach to other areas will pave the way for future revenue.

Prof. Dr. Thomas Hirth is director of the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB and spokesman of the Fraunhofer Sustainability Network.

Co-authors Ina Andrees, Jürgen Bertling, Markus Hiebel, Johanna Leissner, Anke Nellesen, Hartmut Pflaum and Rainer Walz are members of the Fraunhofer Sustainability Network.

1 Wind energy is to account for a larger share of electricity supplies.

2 The goal of research is to make solar energy economically attractive even without state subsidies.



PROJECTS AND RESULTS 2011

HEALTH

Phylogenetic medicines 1 Human-Centered Technology Prize

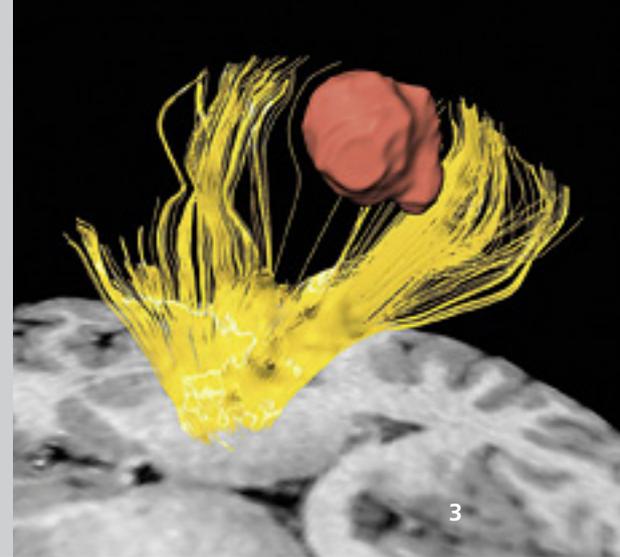
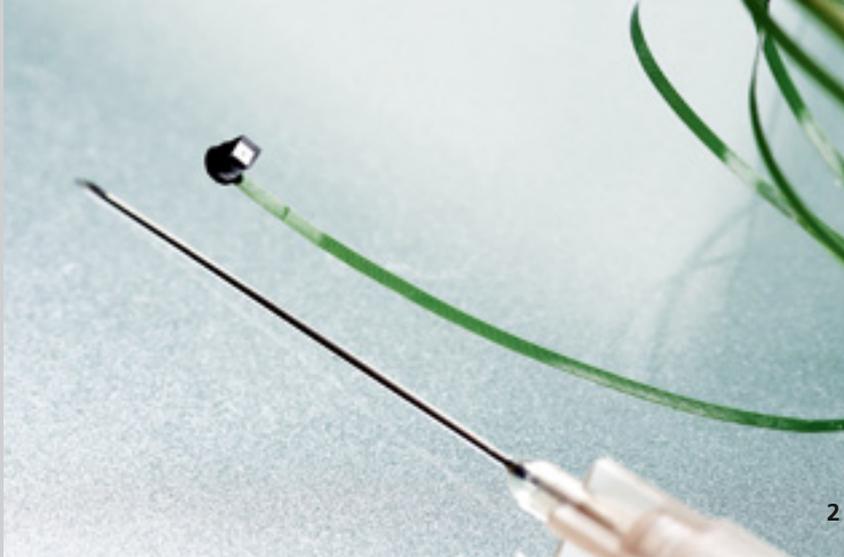
The synthesis of medicines is very costly, and specialized and efficient systems are required for production. That is why plants equipped with the corresponding genetic information are increasingly being used as a production platform for drugs. Dr. Jürgen Drossard, Dr. Thomas Rademacher and Prof. Dr. Stefan Schillberg of the Fraunhofer Institute for Molecular Biology and Applied Ecology IME made a significant contribution toward this development, as did Prof. Dr. Wiltrud Treffenfeldt from Dow AgroSciences and Dr. Uwe Gottschalk from Sartorius Stedim Biotech S.A. The proteins produced by transgenic plants can be delivered on a large scale and at low cost. The drugs produced using this process include vaccines, enzymes and therapeutic antibodies for combating cancer or HIV. For their combined contribution to the development of this production method, the scientists were awarded the Human-Centered Technology Prize 2011.

The fight against metastatic cancer Dr. Josef Steiner Prize

Even after a tumor has been surgically removed and the patient has been through chemotherapy, cancer cells often remain in the body and can form new tumors – metastatic cancer – despite having been inert for decades. Regensburg-based researcher Prof. Dr. Christoph Klein, who is head of the Fraunhofer Project Group for Personalized Tumor Therapy at the Fraunhofer Institute for Toxicology and Experimental Medicine ITEM, is leading the fight against this form of disease. In 2011, he was awarded the Dr. Josef Steiner Prize for his vital research.

Printed tissue

After injuries or the surgical removal of tumors, it is often necessary to regenerate sections of tissue. Together with the company GeSiM mbH, researchers at the Fraunhofer Institute for Material and Beam Technology IWS developed a multi-channel plotter to produce the structures for tissue replacement. Depending on the material used, the structures produced are suitable as a replacement for bones or soft tissue, or as a substrate for tissue cultures and for many other biological and non-biological applications.



Low-price micro-camera 2

Endoscopy has gained a good reputation as a conservative procedure for diagnostic purposes and minimally invasive surgery. Up till now, however, cleaning of the equipment, which is reused many times, was a costly process. Researchers at the Fraunhofer Institute for Reliability and Microintegration IZM teamed up with the company AWAIBA GmbH and colleagues from the Fraunhofer Institute for Applied Optics and Precision Engineering IOF to develop a new, high-performance micro-camera. The camera is so inexpensive to manufacture that it will make single-use endoscopes economically viable. Thanks to its compact dimensions – it is only one cubic millimeter in size – the camera is suitable for a wide variety of other applications, for example as an optical sensor in automobiles.

3D optics for endoscopes

In order to carry out sophisticated minimally invasive procedures, surgeons need to have a good feel for the spatial dimensions inside the human body. Together with other project partners, researchers from the Fraunhofer Institute for Microelectronic Circuits and Systems IMS took part in the EU-funded MiniSurg project to develop 3D optics for integration in endoscopes. The spatial effect it delivers is achieved through micro-optics that project two different perspectives of the image onto two separate rows of pixels on the CMOS sensors. Together, the optics and the chip have a diameter of just 7.5 millimeters and can easily fit into an endoscope.

Fast X-rays in the operating theater

In the case of complicated procedures such as spinal surgery, the surgeon needs to be able to monitor progress of the operation using X-ray images. Previously, the surgeons had to stop operating while these X-rays were taken. Now, thanks

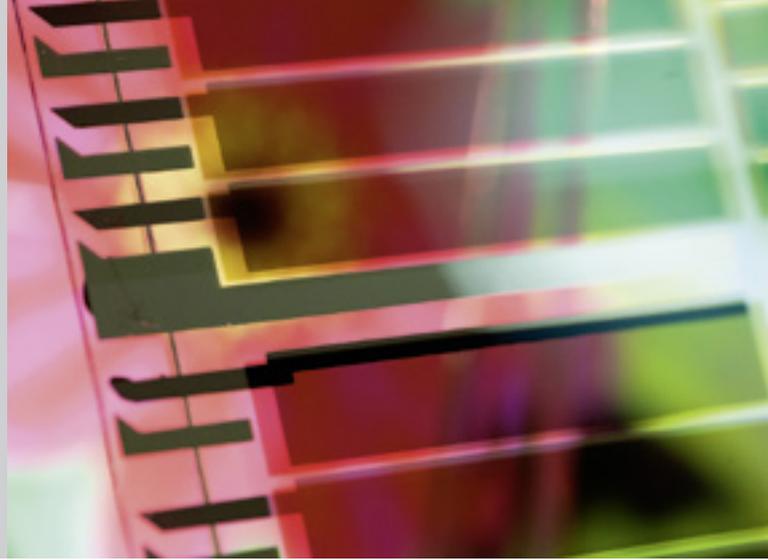
to a technology developed by the Fraunhofer Institute for Production Systems and Design Technology IPK, surgeons no longer need to interrupt their work. In conjunction with Charité – Universitätsmedizin Berlin and the company Ziehm Imaging GmbH, they developed ORBIT, a 3D X-ray scanner that can be seamlessly integrated in the surgical procedure.

Safer brain surgery 3

Brain surgery is precision work of the highest order. If the surgeon has to remove a tumor, for instance, there is a risk that damage could be caused to important parts of the brain. In order to prevent this from happening, researchers at the Fraunhofer Institute for Medical Image Computing MEVIS developed a special imaging process that delivers an exact picture of the brain's individual anatomy and functions. It can help the surgeon to assess the attendant risks and plan the operation carefully and precisely. The system is to be enhanced to the point where it can be used to navigate during the operation.

Surrogate antibiotics

In the fight against bacterial infections, antibiotics are at risk of becoming ineffective weapons. In hospitals especially, bacteria that are resistant to antibiotics are on the rise. Fraunhofer researchers are pinning their hopes on a new group of substances called antimicrobial peptides, which are one day set to replace antibiotics. The tests carried out thus far at the Fraunhofer Institute for Cell Therapy and Immunology IZI have been very promising. The new substances did not damage healthy body cells, but were highly effective in combating bacteria, and even fungi and viruses.



COMMUNICATION

Enhanced flexibility with organic electronics 1 German Future Prize

Carbon-based semiconductors are on the verge of revolutionizing many electronics applications. In particular, they boast greater flexibility and are cheap to manufacture, opening up whole new areas of application. Transparent photovoltaic elements can be fitted to window glazing, while flexible ones can be attached to handbags or items of clothing; highly efficient lamps can be used like wallpaper; displays can be rolled up. For their development work in the field of organic electronics, Prof. Dr. Karl Leo of the Fraunhofer Institute for Photonic Microsystems IPMS, Dr. Jan Blochwitz-Nimoth of Novaled AG and Dr. Martin Pfeiffer of Heliatek GmbH were awarded the German Future Prize 2011 by the Federal President.

Ultra-flat microscope

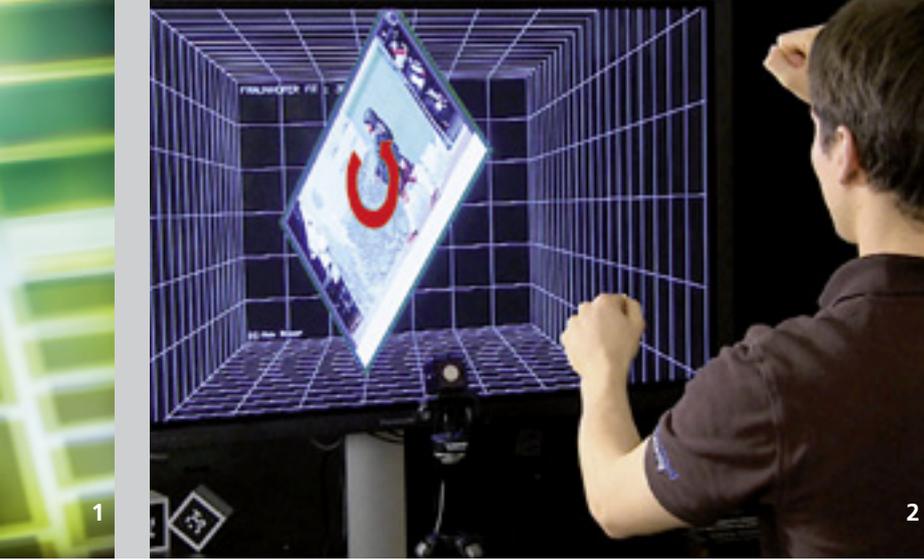
The eyes of insects function according to different principles from those of the human eye. Just like conventional cameras and microscopes, our eye relies on a single large lens, while the compound eyes of insects use many small lenses. The latter technology can lead to extremely flat designs. At the Fraunhofer Institute for Applied Optics and Precision Engineering IOF, researchers have now developed a microscope consisting of miniaturized partial lenses that boasts a depth of just 5.3 millimeters. Potential fields of application include medical technology as well as surface and document technology.

Higher-quality videos Karl Heinz Beckurts Prize

Videos already account for a substantial share of the data streams on the Internet. That makes it all the more important to achieve the desired data quality with the lowest possible volume of data. A key step toward this goal was the development of the H.264/MPEG4-AVC video standard. For the part they played in developing this already international standard and its extensions, Prof. Dr. Thomas Wiegand, Dr. Detlev Marpe and Dr. Heiko Schwarz of the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI were honored with the Karl Heinz Beckurts Prize 2011.

Two worlds on one cell phone

For many employees, mobile phones have not only become an indispensable tool for their work, they also make intensive use of them for private purposes. Now, experts at the Fraunhofer Institute for Secure Information Technology SIT have developed an option for keeping professional and private use separate from each other on Android-based devices. The "BizTrust for Android" security solution prevents hackers from accessing work-related data via privately installed apps. A color symbol on the phone's display allows users to tell at any time whether they are in the smartphone's private or professional mode.



Point to capture 2 **Hugo Geiger Prize**

Simple gesture-recognition systems are already available to the wider public in the shape of computer games. Georg Hackenberg of the Fraunhofer Institute for Applied Information Technology FIT took this type of human-computer interaction one step further: he developed a multi-touch interface that uses a 3D camera system to capture a person's gestures – right down to movements of a single finger – and to process them in real time. As people are trained to execute very precise movements with their fingers and to use them to make signals, this new development constitutes a big advance in gesture recognition technology. The researcher was honored with the Hugo Geiger Prize 2011 for his work.

Top-quality sound over the phone **Joseph von Fraunhofer Prize**

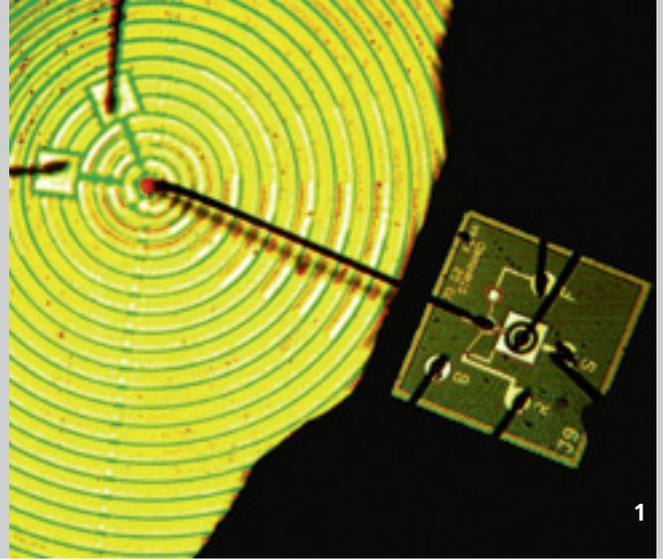
For about a century, the quality of human voice transmissions via the telephone was very restricted. The bandwidth between 300 and 3400 Hertz, which had remained unchanged since the days of analog transmission, made voices difficult to understand and impaired sound quality. Engineers Marc Gayer, Manfred Lutzky and Markus Schnell of the Fraunhofer Institute for Integrated Circuits IIS adapted modern digital audio encoding processes to suit the needs of telephony. They shortened the delay of the audio codecs to such an extent that it is no longer noticeable to users. This paves the way for communication systems with CD-like sound quality which also feature spatial reproduction allowing individual speakers to be localized. The three researchers were awarded the Joseph von Fraunhofer Prize 2011 for their achievements.

LEDs deliver data 3

Light-emitting diodes (LEDs) react so quickly to electrical impulses that they can also be used for data transfer. Researchers at the Fraunhofer Institute for Telecommunications, Heinrich-Hertz-Institut, HHI are making use of this capability to transmit data via the LEDs in ceiling lighting. The luminosity is changed using a frequency undetectable to the human eye. An optical wireless LAN of this kind can be deployed in places where radio waves would cause problems, such as in aircraft, hospitals or factories.

His master's movements

A guitar virtuoso's playing is impressive to watch, though it is usually difficult to discern the details of individual finger movements. Experts at the Fraunhofer Institute for Surface Engineering and Thin Films IST joined forces with M3i Technologies GmbH to develop a sensor technology that registers and digitizes such details. The heart of the system is a tailpiece coated with the piezoresistive material DiaForce®. The tailpiece captures precise data on the pressure exerted on the strings and the playing technique, rendering it amenable to digital editing. This type of recording is set to replace conventional electromagnetic pick-up devices.



SECURITY

My face belongs to me

Data protection is a central concern with biometric applications, and the so-called “template protection” system is an important way of protecting the biometric reference data used. The technique developed at the Fraunhofer Institute for Computer Graphics Research IGD functions without having to save the biometric data. Instead, it generates a digital key via the biometric feature that has nothing in common with the original physical characteristic and is irreversible. The protective function can be further enhanced through password- or PIN-based authentication, which promises additional benefits in terms of security, user-friendliness and accuracy.

X-ray vision plus 1

Since its invention, X-ray technology has undergone enormous development. Researchers at the Fraunhofer Research Institution for Modular Solid State Technologies EMFT are creating systems with highly sensitive detectors that boast an especially high degree of measuring accuracy and speed. A number of quite specific applications are already possible: sorting waste glass on a conveyor belt in order to separate different glass types; analyzing artworks to determine the materials used to make them; or using a mobile X-ray detector to check land for the presence of harmful substances. This new, highly sensitive X-ray technology has the potential for use in many more application areas.

Compact tomograph

Hugo Geiger Prize

In recent years, computer tomography (CT) has made a name for itself in industry as a non-destructive testing procedure. It can be used to create a three-dimensional volumetric model of the exterior and interior structure of an object in no time at all. Until now, the size and price of the devices as well as the complexity of the CT process prevented the further spread of these devices. As part of his Master’s thesis, Stefan Hebele from the Fraunhofer Institute for Integrated Circuits IIS designed a CT system that uses lightweight materials and cutting-edge components to achieve unparalleled compactness and ease of use. Weighing just 19 kilograms and no bigger than a small parcel, the device is portable and easy to use, making it an attractive proposition for researchers, industrial enterprises and service providers alike. Hebele received the Hugo Geiger Prize 2011 for his efforts.



Looking through the walls of containers 2

Starting 2012, all containers bound for the USA must be scanned at their port of departure prior to shipment. The goal of a project being sponsored by the German Federal Ministry of Education and Research (BMBF) is to develop a fast process for scanning the contents of containers and detecting radio-activity that takes into account logistical, data-processing and legal constraints. In collaboration with the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI and other partners, the Fraunhofer Development Center for X-ray Technology (EZRT) – a joint department of the Fraunhofer Institutes for Nondestructive Testing IZFP and for Integrated Circuits IIS – is working on a scanner level for high-energy 3D X-ray imaging that will enable contactless inspection of containers at terminals without infringing on the operating procedures in place.

High-tech cream puffs

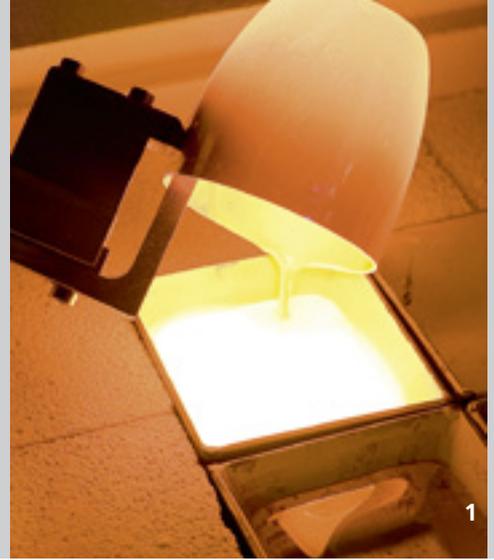
In the food production process, cleanliness is essential for consumer safety, but it can also be crucial for the production process itself. If, for example, a sample of choux pastry contains too many microorganisms, it will not rise during baking. Specialists at the Fraunhofer Institute for Production Systems and Design Technology IPK have developed a dough-making system that automatically cleans itself after every batch. As the finished dough is sterile, it can for the first time be produced in large amounts for bakeries.

Child-protection software 3

The Internet is the repository of global knowledge. But it also contains files with criminal content, such as pornographic images of children. Sifting through confiscated databases of this type is a time-consuming and, above all, nerve-racking job for investigators. Working together with the Berlin State Office of Criminal Investigation, researchers at the Fraunhofer Institute for Production Systems and Design Technology IPK developed an automated assistance system for evaluating images and video material that can quickly filter out child pornography even in very large databases. The technology should make the work of criminal prosecutors easier in future.

Effective quality control Hugo Geiger Prize

When it comes to testing materials and components, terahertz technology offers many benefits. But, up till now, it has not been possible to conduct a materials analysis with simultaneous localization in the object being inspected. As part of her Master's thesis, Anika Brahm of the Fraunhofer Institute for Applied Optics and Precision Engineering IOF designed a terahertz measurement system capable of recording transmission and reflection simultaneously. This makes it possible to spatially correlate a complete set of spectral information and create a three-dimensional spectral tomogram, considerably broadening the application potential for terahertz systems in quality control and safety engineering. The researcher was awarded the Hugo Geiger Prize 2011 for her achievement.



MOBILITY

Cashless parking

Anyone who has used a parking garage knows of the physical contortions required to get the parking ticket out of the machine while sitting in the car and to insert it again when leaving, and of the tiresome search for the ticket machine. An invention of the Fraunhofer Institute for Material Flow and Logistics IML will make these problems a thing of the past. With the new VIATAG system, an RFID chip on the front windshield of the vehicle enables cashless payments. This will make procedures in the parking garage more convenient as well as faster and cheaper – a fact that will please parking garage operators, too.

A safe place to land

To ensure that aircraft can take off and land in safety, ground staff constantly check the runways for objects. Automating this time-consuming job required intelligent data fusion algorithms that combine information from different sensor systems. The system needs to be able to detect tiny objects on the runway, even in unfavorable weather conditions. Researchers at the Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE developed a system that learns during operation what a clean runway should look like and also how it changes depending on the weather conditions and time of day.

Robot helpers in glass development 1

Electronic components are playing an ever more important role in motor vehicles. Since these components have to function reliably under extreme conditions, great demands are placed on the materials used in their construction. Certain temperature-resistant types of glass are used as adhesives for the electronic components. At the Fraunhofer Institute for Silicate Research ISC, an automated process has been developed that simplifies and speeds up the development of these sorts of glass. It will enable future electronic components to withstand even more adverse conditions and further enhance vehicle safety.

Warning: slippery road!

Drivers cannot easily tell whether a road is slippery – until it is perhaps too late. An optical procedure developed at the Fraunhofer Institute for Integrated Circuits IIS promises help: a tiny and relatively easy-to-manufacture camera is equipped with a nanostructured CMOS sensor that allows it to capture the polarization of the light. In this way, the system can detect whether the road surface is dry or already covered with a dangerous sheet of ice.



Priority for electric vehicles 2

The way forward is clear: electric vehicles are set to become the dominant mode of transport on tomorrow's roads. In the two-year Electromobility System Research project funded by the German Federal Ministry of Education and Research (BMBF), Fraunhofer researchers played a key role in driving forward development of the relevant technologies. The project focused on the decentralized generation of electricity, transmission of that electricity to the vehicles, energy storage, vehicle technology, system integration and reliability. Other aspects considered were the development of new value chains and, ultimately, public acceptance of electromobility. At the end of the project, the participating Fraunhofer Institutes invited the public to test-drive the experimental vehicles on the ATP test track in Papenburg.

Joining technology for electric motors

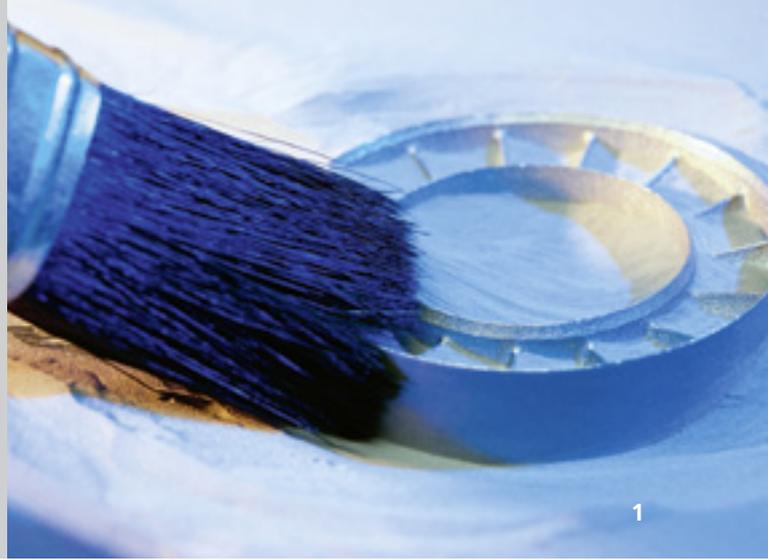
The market breakthrough of a new technology depends on whether it can be offered at an acceptable price, which is why new production techniques are so important for electromobility. Researchers at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM developed an adhesive bonding device for the assembly process which – in defiance of the laws of magnetism – makes it possible to attach permanent magnets to the rotor lamination stacks in exactly the right position. This breakthrough should enable the accurate, safe and low-cost production of compact wheel hub motors on a large scale.

Making better use of free cargo capacity 3

Journeys with empty trucks are the bane of every freight forwarder because they cost time and money – which they can ill afford in their highly competitive market. Researchers at the Fraunhofer Institute for Industrial Mathematics ITWM see one option for avoiding such journeys in the implementation of an order pool shared by cooperating companies. With the aid of an auctioning mechanism, the partners can bid for orders from the pool to augment journeys that are already planned. This would avoid empty trips and make deployment of the trucks more efficient.

Protective cover for batteries

Electromobility places great demands on vehicle developers, also in terms of lightweight construction and battery safety. An innovation by the Fraunhofer Institute for Chemical Technology ICT, which was developed in collaboration with other Fraunhofer Institutes, can help out on both counts. A battery cover made of fiber composite materials is much lighter than conventional steel covers and yet just as safe. What is more, the cover can easily be mass-produced.



ENVIRONMENT

A sensor for dust particles

Dust particles in the air pose a substantial health threat. In addition to traffic emissions, wood-fired furnaces in private homes constitute the main source of these emissions. The German federal government has therefore set emission limits for such domestic heating furnaces. In cooperation with a partner from industry, experts at the Fraunhofer Institute for Toxicology and Experimental Medicine ITEM in Hannover and the Institute of Particle Technology at the Clausthal University of Technology have co-developed a device for measuring the emission of dust particles directly at the wood-burning stoves themselves, thus making it possible to take appropriate countermeasures.

Efficient production of components 1 Innovation Prize of North Rhine-Westphalia

The less often a component is required, the costlier its production and storage. Virtual storage is a particularly practical solution to this problem: all the information on the component is stored in digital form only; the actual components are produced on demand in the exact number required. In this context, selective laser melting – a process by which a component is formed in a short space of time from starting materials in powdered form – is a resource-conserving technique. Today, this technique can be used to manufacture tools and spare parts, but also implants and dental crowns. Prof. Dr. Reinhart Poprawe, director of the Fraunhofer Institute for Laser Technology ILT, was awarded the Innovation Prize of North Rhine-Westphalia 2011 for the research work carried out in this connection by his team of laser experts in Aachen.

High-precision solar measurements

To what extent does solar activity influence the Earth's climate? Questions like this are gaining in relevance in the debate on climate change. In order to provide better answers, researchers at the Fraunhofer Institute for Physical Measurement Techniques IPM developed a high-precision solar spectrometer that can measure the extreme ultraviolet (EUV) radiation emitted by the sun. The device will be deployed on the International Space Station (ISS).



2

Which city is the noisiest? 2

Major cities have different levels of noise. A study carried out by the Fraunhofer Institute for Building Physics IBP on behalf of the GEERS-Stiftung, a German foundation, reveals just how big the differences are. The study was based on the noise maps compiled by the cities themselves. According to the researchers, the noise emitted by road and rail traffic has the strongest effects across large areas. They also identified the neuralgic points at which noise-protection measures are urgently required in the interests of human health.

Purifying wastewater with ultraviolet light

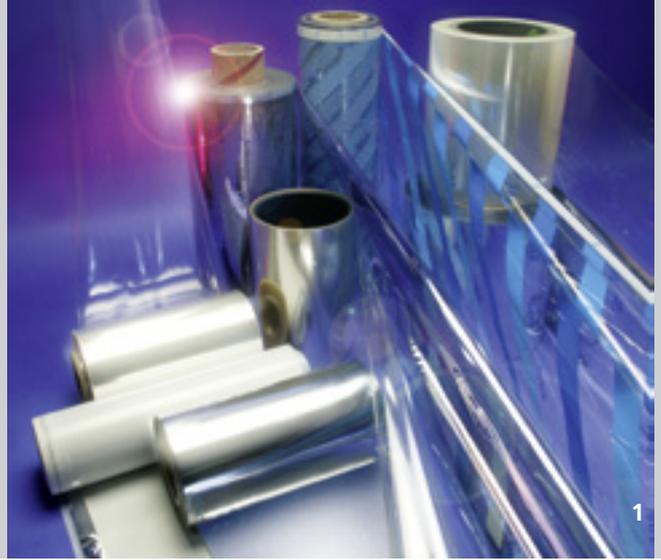
Wastewater from industry may contain organic components that cannot be removed in sewage treatment works. In such cases, the wastewater has to be processed at source before it can be discharged into the public sewerage system. In the EU-funded Light4CleanWater project, researchers from the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB and their partners are developing a process for cleaning this kind of wastewater using UV light. The hydroxyl radicals created in the process oxidize the organic molecules into degradable substances. As a result, the processed water can then be treated by conventional sewage treatment plants.



3

The environmental burden of moving goods 3

The greenhouse gas emissions generated by the transportation sector are rising unabated. In order to get a better idea of the carbon footprint of the logistics of manufactured goods, the Fraunhofer Institute for Material Flow and Logistics IML developed a model for a company that not only encompasses the transportation of goods from the production locations to the end customers, but also includes environmentally relevant expenses at warehouse sites. In this way, the greenhouse gas emissions are calculated annually for each country-specific distribution system and expressed in the form of a CO₂ coefficient. The results reveal possibilities for making distribution systems more environmentally compatible. In a second step, the researchers plan to integrate procurement logistics in the system.



ENERGY

More power from the sun

Joseph von Fraunhofer Prize

Photovoltaics is said to have enormous potential in the medium to long term. But it has to compete with other energy production technologies and must ultimately prove that it is economically viable. Enhancing the efficiency of photovoltaics at all levels is an important step in this direction. Dr.-Ing. Heribert Schmidt of the Fraunhofer Institute for Solar Energy Systems ISE focused on the technology of the converter, which transforms the direct current produced by photovoltaic systems into the alternating current that can be fed into the electricity grid. He invented the HERIC® topology, which can halve the energy lost in transformation – an achievement impressively demonstrated by a new world record in efficiency of over 99 percent. He was awarded the Joseph von Fraunhofer Prize 2011 for his invention.

Film for flexible solar cells 1

Joseph von Fraunhofer Prize

Although the market for displays and photovoltaics is a dynamic one, it is being held back by technical and price constraints in the sphere of flexible, affordable modules. There is great demand for highly efficient, versatile barrier technologies to protect the photoelectric layers. Dr. Sabine Amberg-Schwab of the Fraunhofer Institute for Silicate Research ISC and Dr. Klaus Noller of the Fraunhofer Institute for Process Engineering and Packaging IVV developed a process that unites the desired features. The combination of PVD barrier coatings with ones based on hybrid polymers (ORMOCER®), achieved using a role-to-role method, makes it possible to ecologically produce durable high-barrier films at low cost. The two researchers were awarded the Joseph von Fraunhofer Prize 2011 for their work.

Specialty glass cuts cooling costs

Sunlight transmits a great deal of energy. That can be a problem in summer for houses with glass facades, because it takes a lot of energy to cool the interior once it has been heated up by the sun. A better option is to control the amount of energy entering through the windows, and researchers at the Fraunhofer Institute for Applied Polymer Research IAP developed a special kind of glass for precisely this purpose. When the sunshine is strong, the thermotropic glass automatically lowers its light transmittance, thus cutting the amount of energy needed for interior cooling. If the sun disappears, the window panes soon become transparent again.

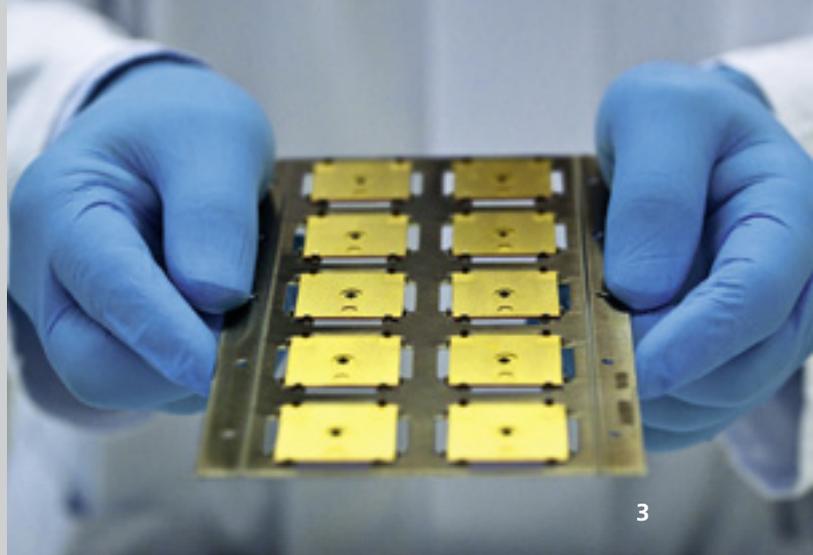


Highly efficient thermal insulation 2

Until now, the claim that thicker thermal insulation was better than thin insulation seemed logical – which was unfortunate for home owners, who often feared the optical and technical consequences for their houses of an all-too-thick layer of insulation. Now, researchers at the Fraunhofer Institutes for Process Engineering and Packaging IVV and for Silicate Research ISC are focusing on developing vacuum insulated panels that are only a few centimeters thick, yet highly efficient. Cheap to produce, and with a potential service life of 30–50 years, these panels could be deployed not only in refrigerators, but also to insulate the outside walls of entire houses.

“Test stress” for rotor blades

In the wind turbine industry, the trend is toward ever larger rotor diameters. In order to test these large wind turbines thoroughly before they enter series production, the Fraunhofer Institute for Wind Energy and Energy System Technology IWES built a new test rig. Even rotor blades with a length of 90 meters can be put through all the necessary load tests using the new test rig. After just a few months of testing, scientists will be able to make reliable forecasts of whether a rotor blade of this size will survive a service life of 20 years unscathed.



Focused sunlight makes its mark 3

Renewable energy is highly popular in Germany, especially since the federal government – with the strong support of the population – resolved to transform the country's energy regime. Researchers based in the German town of Freiburg have taken an important step in the solar energy field by developing concentrator solar cells. These consist of three semiconductor layers of differing spectral sensitivity, on which the sunlight is focused by means of simple optics. Efficiency factors in excess of 40 percent demonstrate this system's potential for generating solar electricity. The prospects for the development are enormous because the higher the efficiency factor, the lower the cost of producing the electricity. Dr. Andreas W. Bett of the Fraunhofer Institute for Solar Energy Systems ISE, Hansjörg Lerchenmüller of Soitec Solar GmbH and Dr. Klaus Dieter Rasch of AZUR SPACE Solar Power GmbH were nominated for the Federal President's Future Prize 2011 for their joint efforts.

Ideas for “Morgenstadt”, the city of tomorrow

Future energy supplies are one of the most important topics of concern to people. Although the problems posed can be solved only through a combination of many specific solutions to particular aspects, it is important not to lose sight of the “big picture”. “Morgenstadt” is a visionary project in which German federal research minister Annette Schavan along with Hans-Jörg Bullinger, President of the Fraunhofer-Gesellschaft, and 19 experts from industry, science and politics, are exploring the idea of a city that is for the most part independent in its energy needs. The vision is not Utopian, but based on a realistic assessment of what could be achieved using technological solutions that are either already available or could be readily developed.



FINANCIAL REPORT

WATER

Water is considered to be the basic prerequisite for organic life. Water molecules (H₂O) are made up of hydrogen and oxygen atoms. Water is not only liquid, but can occur in gaseous (vapor) or solid (ice) form. Many substances, such as salts or gases, dissolve in water. As every known organism needs water for its metabolism, it is assumed that life must have originated in the oceans. Humans can survive only a few days without water. In its many guises – as rain, ice, rivers, lakes and oceans – water is one of the strongest forces shaping the Earth's surface. Two-thirds of our planet is covered by water.



**BALANCE SHEET
AT DECEMBER 31, 2011**

**INCOME STATEMENT FOR THE
FINANCIAL YEAR 2011**

**RECONCILIATION BETWEEN
INCOME STATEMENT AND
PERFORMANCE STATEMENT
(CASH-BASIS ACCOUNTING)**

BALANCE SHEET AT DECEMBER 31, 2011

FRAUNHOFER-GESELLSCHAFT
ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V., MÜNCHEN

ASSETS	€	€	2011 €	2010 € (1000)
Current assets				
Cash and cash equivalents			25,203,303.56	53,171
Marketable securities			236,017,814.63	238,938
Accounts receivable and other current assets				
Trade receivables	169,944,191.98			176,735
Receivables from the federal and <i>Länder</i> governments relating to base funding	23,433,377.91			7,139
relating to project billing including contract research	191,167,942.50			178,511
relating to pension and compensated absence provisions	48,862,800.00			46,381
	<u>263,464,120.41</u>			<u>232,031</u>
Accounts receivable from associated companies	4,507,625.80			3,590
Other current assets	<u>60,131,928.02</u>			<u>57,213</u>
		498,047,866.21		469,569
Inventories		45,462,802.74		25,808
Prepaid expenses and deferred charges		<u>6,324,291.78</u>		<u>6,494</u>
Total current assets			811,056,078.92	793,980
Intangible assets			13,741,003.93	13,277
Property, plant and equipment			1,600,559,517.87	1,466,684
Financial assets			<u>15,104,219.89</u>	<u>13,085</u>
Total assets			<u>2,440,460,820.61</u>	<u>2,287,026</u>
Trust assets			37,680,563.94	41,751

LIABILITIES AND EQUITY	€	€	2011 €	2010 € (1000)
Current liabilities				
Trade payables		81,320,056.05		85,010
Unappropriated grants from the federal and <i>Länder</i> governments				60,871
relating to base funding	42,272,731.24			97,821
relating to project billing	<u>90,948,630.47</u>			<u>158,692</u>
		133,221,361.71		
Accounts payable to associated companies		43,471.25		–
Other current liabilities		<u>4,588,377.98</u>		<u>9,384</u>
Total current liabilities			219,173,266.99	253,086
Deferred income			6,518,174.36	6,123
Provisions for pensions and similar obligations			10,862,800.00	11,433
Other provisions			117,809,266.71	112,390
Special reserves				
License-fee revenue reserve		242,381,406.97		237,981
Grants relating to fixed assets		1,616,106,845.58		1,480,068
Grants used to finance current assets		<u>214,262,427.49</u>		<u>172,928</u>
			2,072,750,680.04	1,890,977
Equity				
Capital of the non-profit organization				
Carried forward	13,001,535.20			12,604
Retained earnings	<u>331,072.31</u>			<u>397</u>
		13,332,607.51		13,001
Restricted reserves		<u>14,025.00</u>		<u>16</u>
Total equity			<u>13,346,632.51</u>	<u>13,017</u>
Total liabilities and equity			<u>2,440,460,820.61</u>	<u>2,287,026</u>
Trust liabilities			37,680,563.94	41,751

INCOME STATEMENT FOR THE FINANCIAL YEAR 2011

FRAUNHOFER-GESELLSCHAFT
ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V., MÜNCHEN

	€	€	2011 €	2010 € (1000)
Revenue from base funding				
Federal government		531,792,350.78		490,547
Länder governments		<u>70,978,532.46</u>		<u>62,961</u>
			602,770,883.24	553,508
Revenue from own activities				
Revenue from research and development activities				
Federal government: Project funding	346,134,370.80			323,233
Contracts	14,457,859.44			10,813
Länder governments: Project funding	221,006,198.30			189,631
Contracts	3,095,279.16			2,945
Business, industry and trade associations	520,411,673.04			453,972
Research funding organizations and other sources	<u>108,083,102.16</u>			<u>111,083</u>
		1,213,188,482.90		1,091,677
Increase in work in progress		31,980,143.36		35,878
Other internally constructed and capitalized assets		8,916,669.56		6,911
Other operating income		33,927,933.43		39,029
Other interest and similar income		<u>277,500.08</u>		<u>75</u>
			1,288,290,729.33	1,173,570
Total base funding and revenue from own activities			1,891,061,612.57	1,727,078
Changes in special reserves				
License-fee revenue reserve		-4,400,132.15		-6,267
Grants relating to fixed assets		-134,351,673.49		-84,075
Grants relating to finance current assets		<u>-41,334,764.20</u>		<u>-69,801</u>
			-180,086,569.84	-160,143
Total income available to cover expenditure			<u>1,710,975,042.73</u>	<u>1,566,935</u>

	€	2011 €	2010 € (1000)
Cost of materials	293,233,650.50		269,834
Personnel expenses	835,344,304.52		785,207
Amortization of intangible assets and depreciation of property, plant and equipment	256,695,602.94		248,090
Other operating expenses	250,776,573.42		213,809
Amortization of financial assets and current marketable securities	4,595,919.04		357
Total expenditure	<u>1,640,646,050.42</u>		<u>1,517,297</u>
Net income on ordinary activities		70,328,992.31	49,638
Extraordinary expenses (allocation to foundation capital)		<u>-70,000,000.00</u>	<u>-49,236</u>
Net income for the year		328,992.31	402
Transfer from reserves		5,000.00	-
Transfer to reserves		<u>-2,920.00</u>	<u>-5</u>
Retained earnings		331,072.31	397
Allocation to capital of the non-profit organization		<u>-331,072.31</u>	<u>-397</u>
		<u>-</u>	<u>-</u>

RECONCILIATION BETWEEN INCOME STATEMENT AND PERFORMANCE STATEMENT (CASH-BASIS ACCOUNTING)

Income/receipts	Performance statement €	Non-profit organization capital €	Reconciling items €	Income statement €
Income/receipts				
from base funding	600,289,433.24		2,481,450.00	602,770,883.24
from research and development activities	1,245,358,233.53		-32,169,750.63	1,213,188,482.90
Increase in work in progress			31,980,143.36	31,980,143.36
Other internally constructed and capitalized assets	8,916,669.56			8,916,669.56
Other income	33,297,701.69	718,124.55	189,607.27	34,205,433.51
Total income/receipts	1,887,862,038.02			
Changes in special reserves				
License-fee revenue reserve			-4,400,132.15	-4,400,132.15
Grants relating to fixed assets				
Allocations to special reserves (capital expenditure)			-390,984,758.55	-390,984,758.55
Reversal of special reserves (depreciation)		43,762.92	256,589,322.14	256,633,085.06
Grants used to finance current assets	-41,334,764.20			-41,334,764.20
Change in grants receivable relating to pension and compensated absence provisions	2,481,450.00		-2,481,450.00	
Total business volume (cash basis)	1,849,008,723.82	<u>761,887.47</u>	<u>-138,795,568.56</u>	<u>1,710,975,042.73</u>

Expenditure / disbursements	Performance statement €	Non-profit organization capital €	Reconciling items €	Income statement €
Expenditure/disbursements				
Cost of materials	295,849,599.04	26,885.07	-2,642,833.61	293,233,650.50
Personnel expenses	844,568,702.33	5,770.00	-9,230,167.81	835,344,304.52
Amortization of intangible assets and depreciation of property, plant and equipment		191,329.68	256,504,273.26	256,659,602.94
Other operating expenses	243,186,001.28	208,910.41	11,977,580.77	255,372,492.46
Expenditure as per the income statement				1,640,646,050.42
Changes in special license-fee revenue reserve	4,400,132.15		-4,400,132.15	
Capital expenditure (current and major infrastructure)	391,004,289.02		-391,004,289.02	
Extraordinary expenses	70,000,000.00			70,000,000.00
Net income for the year		328,992.31		328,992.31
Total business volume (cash basis)	1,849,008,723.82	<u>761,887.47</u>	<u>-138,795,568.56</u>	<u>1,710,975,042.73</u>

The Fraunhofer-Gesellschaft prepares its annual financial statements in accordance with the German Commercial Code (HGB) as applicable to large corporate entities.

The annual financial statements for the year ending December 31, 2011, have been audited and fully certified by the auditing firm Rödl & Partner GmbH, Nuremberg.

The income statement is reconciled to the format required by the relevant public funding authorities.

SERVICE

EARTH

The planet on which we live is called the Earth. In a narrower sense, the same word is used to describe the planet's firm surface, especially when plants can grow on it. In that case, "earth" stands for a mixture of decomposed organic matter and eroded rock. Plants can take root in this substrate, drawing minerals and water from it to create their biomass. If the organic components of the earth decompose very slowly over long periods of time and under the influence of geological changes, they can be transformed into combustible resources such as peat, coal and crude oil.



THE GROUPS OF THE
FRAUNHOFER-GESELLSCHAFT

THE ALLIANCES OF THE
FRAUNHOFER-GESELLSCHAFT

ADDRESSES

EDITORIAL NOTES



THE GROUPS OF THE FRAUNHOFER-GESELLSCHAFT

The institutes of the Fraunhofer-Gesellschaft are organized into seven research groups, each focusing on a particular area. The idea behind these groups is to strengthen cooperation within the organization and enable Fraunhofer's customers to benefit from joint, coordinated research services.

- Fraunhofer ICT Group
- Fraunhofer Group for Defense and Security VVS
- Fraunhofer Group for Life Sciences
- Fraunhofer Group for Light & Surfaces
- Fraunhofer Group for Materials and Components – MATERIALS
- Fraunhofer Group for Microelectronics
- Fraunhofer Group for Production

Fraunhofer ICT Group

The Group comprises the Fraunhofer Institutes and Research Institutions for

- Algorithms and Scientific Computing SCAI
- Applied and Integrated Security AISEC
- Applied Information Technology FIT
- Communication, Information Processing and Ergonomics FKIE
- Communication Systems ESK (associated member)
- Computer Architecture and Software Technology FIRST
- Computer Graphics Research IGD
- Digital Media Technology IDMT
- Experimental Software Engineering IESE
- Industrial Engineering IAO
- Industrial Mathematics ITWM
- Integrated Circuits IIS (associated member)
- Intelligent Analysis and Information Systems IAIS
- Medical Image Computing MEVIS
- Open Communication Systems FOKUS

- Optronics, System Technologies and Image Exploitation IOSB
- Secure Information Technology SIT
- Software and Systems Engineering ISST
- Telecommunications, Heinrich-Hertz-Institut, HHI (associated member)

Group Chairman:

Prof. Dr. Matthias Jarke

Phone +49 2241 14-2925

matthias.jarke@fit.fraunhofer.de

Fraunhofer Institute for Applied Information Technology FIT

Schloss Birlinghoven

53757 Sankt Augustin

Deputy chairman:

Prof. Dr. Heinz-Otto Peitgen

Phone +49 421 218-3552

heinz-otto.peitgen@mevis.fraunhofer.de

Fraunhofer Institute for Medical Image Computing MEVIS

Universitätsallee 29

28359 Bremen

Managing director:

Dipl.-Inform. Thomas Bendig

Phone +49 30 7261566-0

Fax +49 30 7261566-19

thomas.bendig@iuk.fraunhofer.de

Fraunhofer ICT Group

Anna-Louisa-Karsch-Strasse 2

10178 Berlin

Press and public relations:

Phone +49 30 7261566-0

Fax +49 30 7261566-19

presse@iuk.fraunhofer.de

www.iuk.fraunhofer.de

Fraunhofer Group for Defense and Security VVS

The Group comprises the Fraunhofer Institutes for

- Applied Solid State Physics IAF
- Chemical Technology ICT
- Communication, Information Processing and Ergonomics FKIE
- High Frequency Physics and Radar Techniques FHR
- High-Speed Dynamics, Ernst-Mach-Institut, EMI
- Integrated Circuits IIS (associated member)
- Optronics, System Technologies and Image Exploitation IOSB
- Systems and Innovation Research ISI (associated member)
- Technological Trend Analysis INT
- Telecommunications, Heinrich-Hertz-Institut, HHI (associated member)

Group Chairman:

Prof. Dr. Klaus Thoma
Phone +49 761 2714-351
Fax +49 761 2714-400
klaus.thoma@emi.fraunhofer.de

Fraunhofer Institute for
High-Speed Dynamics, Ernst-Mach-Institut, EMI
Eckerstrasse 4
79104 Freiburg

Deputy chairman:

Prof. Dr.-Ing. Jürgen Beyerer
Phone +49 721 6091-210
Fax +49 721 6091-413
juergen.beyerer@iosb.fraunhofer.de
Fraunhofer Institute for
Optronics, System Technologies and Image Exploitation IOSB
Fraunhoferstrasse 1
76131 Karlsruhe

Central office:

Dr. Tobias Leismann
Phone +49 761 2714-402
Fax +49 761 2714-316
tobias.leismann@emi.fraunhofer.de
Fraunhofer Institute for
High-Speed Dynamics, Ernst-Mach-Institut, EMI
Eckerstrasse 4
79104 Freiburg

www.vvs.fraunhofer.de

Fraunhofer Group for Life Sciences

The Group comprises the Fraunhofer Institutes for

- Biomedical Engineering IBMT
- Cell Therapy and Immunology IZI
- Interfacial Engineering and Biotechnology IGB
- Molecular Biology and Applied Ecology IME
- Process Engineering and Packaging IVV
- Toxicology and Experimental Medicine ITEM

Group Chairman:

Prof. Dr. rer. nat. Thomas Hirth
Phone +49 711 970-4400
Fraunhofer Institute for
Interfacial Engineering and Biotechnology IGB
Nobelstrasse 12
70569 Stuttgart

Head of central office:

Dr. Claus-Dieter Kroggel
Phone +49 511 5350-103
Fax +49 511 5350-155
claus.kroggel@vls.fraunhofer.de

The groups of the Fraunhofer-Gesellschaft

Fraunhofer Group for Life Sciences
Nikolai-Fuchs-Strasse 1
30625 Hannover

www.lifesciences.fraunhofer.de

Fraunhofer Group for Light & Surfaces

The Group comprises the Fraunhofer Institutes for

- Applied Optics and Precision Engineering IOF
- Electron Beam and Plasma Technology FEP
- Laser Technology ILT
- Material and Beam Technology IWS
- Physical Measurement Techniques IPM
- Surface Engineering and Thin Films IST

Group Chairman:

Prof. Dr. rer. nat. habil. Andreas Tünnermann

Phone +49 3641 807-201

Fax +49 3641 807-600

andreas.tuennermann@iof.fraunhofer.de

Fraunhofer Institute for

Applied Optics and Precision Engineering IOF

Albert-Einstein-Strasse 7

07745 Jena

Central office:

Dipl.-Betriebswirt (FH) Susan Oxfart

Phone +49 3641 807-207

Fax +49 3641 807-600

Fraunhofer Institute for

Applied Optics and Precision Engineering IOF

Albert-Einstein-Strasse 7

07745 Jena

www.light-and-surfaces.fraunhofer.de

Fraunhofer Group for
Materials and Components – MATERIALS

The Group comprises the Fraunhofer Institutes for

- Applied Polymer Research IAP
- Building Physics IBP
- Ceramic Technologies and Systems IKTS
- Chemical Technology ICT
- High-Speed Dynamics, Ernst-Mach-Institut, EMI
- Industrial Mathematics ITWM (associated member)
- Integrated Circuits IIS (associated member)
- Interfacial Engineering and Biotechnology IGB (associated member)
- Manufacturing Technology and Advanced Materials IFAM
- Mechanics of Materials IWM
- Nondestructive Testing IZFP
- Silicate Research ISC
- Solar Energy Systems ISE
- Structural Durability and System Reliability LBF
- Systems and Innovation Research ISI
- Wood Research, Wilhelm-Klauditz-Institut, WKI

Group Chairman:

Prof. Dr.-Ing. Holger Hanselka

Phone +49 6151 705-222

Fax +49 6151 705-305

Fraunhofer Institute for

Structural Durability and System Reliability LBF

Bartningstrasse 47

64289 Darmstadt

Deputy chairman:

Prof. Dr.-Ing. Peter Elsner

Phone +49 721 4640-401

Fax +49 721 4640-111

Fraunhofer Institute for Chemical Technology ICT

Joseph-von-Fraunhofer-Strasse 27

76327 Pfinztal (Berghausen)

Central office:

Dr. phil. nat. Ursula Eul

Phone +49 6151 705-262

Fax +49 6151 705-214

ursula.eul@lbf.fraunhofer.de

Fraunhofer Institute for

Structural Durability and System Reliability LBF

Bartningstrasse 47

64289 Darmstadt

www.materials.fraunhofer.de

Fraunhofer Group for Microelectronics

The Group comprises the Fraunhofer Institutes and Research Institutions for

- Applied Solid State Physics IAF
- Communication Systems ESK
- Digital Media Technology IDMT (associated member)
- Electronic Nano Systems ENAS
- High Frequency Physics and Radar Techniques FHR
- Integrated Circuits IIS
- Integrated Systems and Device Technology IISB
- Microelectronic Circuits and Systems IMS
- Modular Solid State Technologies EMFT
- Nondestructive Testing IZFP, Dresden (associated member)
- Open Communication Systems FOKUS (associated member)
- Photonic Microsystems IPMS
- Reliability and Microintegration IZM
- Silicon Technology ISIT
- Telecommunications, Heinrich-Hertz-Institut, HHI, and the
- Fraunhofer Center Nanoelectronic Technologies CNT

Group Chairman:

Prof. Dr.-Ing. Dipl.-Phys. Hubert Lakner

Phone +49 351 8823-110

hubert.lakner@ipms.fraunhofer.de

Fraunhofer Institute for Photonic Microsystems IPMS

Maria-Reiche-Strasse 2

01109 Dresden

Deputy chairman:

Prof. Dr. rer. nat. Anton Grabmaier

Phone +49 203 3783-105

anton.grabmaier@ims.fraunhofer.de

Fraunhofer Institute for

Microelectronic Circuits and Systems IMS

Finkenstrasse 61

47057 Duisburg

The groups of the Fraunhofer-Gesellschaft

Head of central office:

Dr.-Ing. Joachim Pelka

Phone +49 30 6883759-6100

Fax +49 30 6883759-6199

joachim.pelka@mikroelektronik.fraunhofer.de

Fraunhofer Group for Microelectronics

Anna-Louisa-Karsch-Strasse 2

10178 Berlin

Project management and research coordination:

Jörg Stephan

Phone +49 30 6883759-6102

Fax +49 30 6883759-6199

joerg.stephan@mikroelektronik.fraunhofer.de

Press and public relations:

Christian Lüdemann

Phone +49 30 6883759-6103

christian.luedemann@mikroelektronik.fraunhofer.de

www.mikroelektronik.fraunhofer.de

Fraunhofer Group for Production

The Group comprises the Fraunhofer Institutes for

- Environmental, Safety and Energy Technology UMSICHT
- Factory Operation and Automation IFF
- Machine Tools and Forming Technology IWU
- Manufacturing Engineering and Automation IPA
- Material Flow and Logistics IML
- Production Systems and Design Technology IPK
- Production Technology IPT

Group Chairman:

Prof. Dr.-Ing. Dr.-Ing. E. h. Dr. h. c. Dr. h. c. Fritz Klocke

Fraunhofer Institute for Production Technology IPT

Steinbachstrasse 17

52074 Aachen

Deputy chairman:

Prof. Dr.-Ing. habil. Prof. e. h. Dr. h. c. mult. Michael Schenk

Fraunhofer Institute for Factory Operation and Automation IFF

Sandtorstrasse 22

39106 Magdeburg

Head of central office:

Dipl.-Ing. Axel Demmer

Phone +49 241 8904-130

Fax +49 241 8904-6130

axel.demmer@ipt.fraunhofer.de

Fraunhofer Institute for Production Technology IPT

Steinbachstrasse 17

52074 Aachen

THE ALLIANCES OF THE FRAUNHOFER-GESELLSCHAFT

Fraunhofer Adaptronics Alliance

Spokesman: Prof. Dr.-Ing. Holger Hanselka

Phone +49 6151 705-222

Fax +49 6151 705-214

holger.hanselka@lbf.fraunhofer.de

www.adaptronik.fraunhofer.de

Fraunhofer Institute for Structural Durability
and System Reliability LBF

Bartningstrasse 47

64289 Darmstadt

Managing director: Prof. Dr.-Ing. Tobias Melz

Phone +49 6151 705-236

Fax +49 6151 705-214

tobias.melz@lbf.fraunhofer.de

Fraunhofer Institute for Structural Durability
and System Reliability LBF

Bartningstrasse 47

64289 Darmstadt

Fraunhofer Adaptronics Alliance

Postfach 10 05 61

64205 Darmstadt

Fraunhofer Additive Manufacturing Alliance

Spokesman, head of central office:

Dipl.-Ing. Axel Demmer

Phone +49 241 8904-130

axel.demmer@ipt.fraunhofer.de

www.generativ.fraunhofer.de

Fraunhofer Institute for

Production Technology IPT

Steinbachstrasse 17

52074 Aachen

Fraunhofer AdvanCer Alliance

Spokesman: Dr.-Ing. Michael Zins

Phone +49 351 2553-7522

Fax +49 351 2554-171

michael.zins@ikts.fraunhofer.de

www.advancer.fraunhofer.de

Fraunhofer Institute for

Ceramic Technologies and Systems IKTS

Winterbergstrasse 28

01277 Dresden

Head of central office: Susanne Freund

Phone +49 351 2553-7504

Fax +49 351 2554-334

susanne.freund@ikts.fraunhofer.de

Fraunhofer Institute for

Ceramic Technologies and Systems IKTS

Winterbergstrasse 28

01277 Dresden

Fraunhofer Ambient Assisted Living Alliance AAL

Spokesman: Dr. Reiner Wichert

Phone +49 6151 155-574

reiner.wichert@igd.fraunhofer.de

www.aal.fraunhofer.de

Fraunhofer Institute for

Computer Graphics Research IGD

Fraunhoferstrasse 5

64283 Darmstadt

Deputy spokesman: Thomas Norgall

Phone +49 9131 776-7305

thomas.norgall@iis.fraunhofer.de

Fraunhofer Institute for

Integrated Circuits IIS

Am Wolfsmantel 33

91058 Erlangen

The alliances of the Fraunhofer-Gesellschaft

Fraunhofer Automobile Production Alliance

Spokesman: Prof. Dr.-Ing. habil. Prof. e. h.
Dr.-Ing. E. h. Dr. h. c. Reimund Neugebauer
Phone +49 371 5397-1400
Fax +49 371 5397-1404
reimund.neugebauer@iwu.fraunhofer.de
www.automobil.fraunhofer.de
Fraunhofer Institute for Machine Tools
and Forming Technology IWU
Reichenhainer Strasse 88
09126 Chemnitz

Deputy spokesman: Prof. Dr.-Ing.
Dr.-Ing. E. h. Dr. h. c. Dr. h. c. Fritz Klocke
Phone +49 241 8904-101
Fax +49 241 8904-6106
fritz.klocke@ipt.fraunhofer.de
Fraunhofer Institute for
Production Technology IPT
Steinbachstrasse 17
52074 Aachen

Head of central office:
Dr.-Ing. Hans Bräunlich
Phone +49 371 5397-1210
Fax +49 371 5397-1123
hans.braeunlich@iwu.fraunhofer.de
Fraunhofer Institute for Machine Tools
and Forming Technology IWU
Reichenhainer Strasse 88
09126 Chemnitz

Fraunhofer Battery Alliance

Spokesman: Dr. Jens Tübke
Phone +49 721 4640-343
Fax +49 721 4640-800343
jens.tuebke@ict.fraunhofer.de
www.batterien.fraunhofer.de
Fraunhofer Institute for
Chemical Technology ICT
Joseph-von-Fraunhofer-Strasse 27
76327 Pfinztal (Berghausen)

Fraunhofer Building Innovation Alliance

Spokesman: Prof. Dr.-Ing. Klaus Sedlbauer
Phone +49 8024 643-243
Fax +49 8024 643-366
klaus.sedlbauer@ibp.fraunhofer.de
Fraunhofer Institute for
Building Physics IBP
Fraunhoferstrasse 10
83626 Valley/Oberlindern

Deputy spokesman: Prof. Dr.-Ing. Peter Elsner
Phone +49 721 4640-401
peter.elsner@ict.fraunhofer.de
Fraunhofer Institute for
Chemical Technology ICT
Joseph-von-Fraunhofer-Strasse 27
76327 Pfinztal (Berghausen)

Managing director: Andreas Kaufmann
Phone +49 8024 643-240
Fax +49 8024 643-366
andreas.kaufmann@ibp.fraunhofer.de
Fraunhofer Institute for Building Physics IBP
Fraunhoferstrasse 10
83626 Valley/Oberlindern

Fraunhofer Cleaning Technology Alliance

Spokesman, head of central office:
Dipl.-Ing. (FH) Martin Bilz M.Sc.
Phone +49 30 39006-147
Fax +49 30 3911037
martin.bilz@ipk.fraunhofer.de
www.allianz-reinigungstechnik.de
Fraunhofer Institute for Production
Systems and Design Technology IPK
Pascalstrasse 8–9
10587 Berlin

Fraunhofer Cloud Computing Alliance

Spokesman: Dipl.-Phys. Jürgen Falkner
Phone +49 711 970-2414
Fax +49 711 970-2401
juergen.falkner@iao.fraunhofer.de
www.cloud.fraunhofer.de
Fraunhofer Institute for
Industrial Engineering IAO
Nobelstrasse 12
70569 Stuttgart

Deputy spokesman:
Dipl.-Wirt.-Ing. Mathias Dalheimer
Phone +49 631 31600-4484
Fax +49 631 31600-5484
mathias.dalheimer@itwm.fraunhofer.de
Fraunhofer Institute for
Industrial Mathematics ITWM
Fraunhofer-Platz 1
67663 Kaiserslautern

Fraunhofer Digital Cinema Alliance

Spokesman: Dr. Siegfried Foessel
Phone +49 9131 776-5140
Fax +49 9131 776-5108
siegfried.foessel@iis.fraunhofer.de
Press and marketing: Angela Raguse M. A.
Phone +49 9131 776-5105
Fax +49 9131 776-5108
angela.raguse@iis.fraunhofer.de
www.dcinema.fraunhofer.de
Fraunhofer Institute for
Integrated Circuits IIS
Am Wolfsmantel 33
91058 Erlangen

Fraunhofer E-Government Alliance

Spokesman: Dr. Michael Tschichholz
Phone +49 30 3463-7215
Fax +49 30 3463-8215
michael.tschichholz@fokus.fraunhofer.de
www.egov-zentrum.fraunhofer.de
Fraunhofer E-Government Alliance
Kaiserin-Augusta-Allee 31
10589 Berlin

Fraunhofer Embedded Systems Alliance

Spokesman: Prof. Dr.-Ing. Peter Liggesmeyer
Phone +49 631 6800-1101
Fax +49 631 6800-1099
peter.liggesmeyer@iese.fraunhofer.de
www.embedded.fraunhofer.de
Fraunhofer Institute for
Experimental Software Engineering IESE
Fraunhofer-Platz 1
67663 Kaiserslautern

Deputy spokesman: Prof. Dr.-Ing. Rudi Knorr
Phone +49 89 547088-0
rudi.knorr@esk.fraunhofer.de
Fraunhofer Research Institution for
Communication Systems ESK
Hansastraße 32
80686 München

Fraunhofer Energy Alliance

Spokesman: Prof. Dr. Eicke R. Weber
Phone +49 761 4588-5121
Fax +49 761 4588-9121
eicke.weber@ise.fraunhofer.de
www.energie.fraunhofer.de
Fraunhofer Institute for
Solar Energy Systems ISE
Heidenhofstraße 2
79110 Freiburg

Deputy spokesman: Prof. Dr.-Ing. Gerd Hauser
Phone +49 711 970-3000
gerd.hauser@ibp.fraunhofer.de
Fraunhofer Institute for Building Physics IBP
Nobelstraße 12
70569 Stuttgart

Managing director: Dr. Thomas Schlegl
Phone +49 761 4588-5473
Fax +49 761 4588-9473
thomas.schlegl@energie.fraunhofer.de
Fraunhofer Institute for
Solar Energy Systems ISE
Heidenhofstraße 2
79110 Freiburg

The alliances of the Fraunhofer-Gesellschaft

Fraunhofer Food Chain Management Alliance

Spokesman: Dr. Mark Bücking
 Phone +49 2972 302-304
 Fax +49 2972 302-319
 mark.buecking@fcm.fraunhofer.de
 www.fcm.fraunhofer.de
 Fraunhofer Institute for Molecular Biology and Applied Ecology IME
 Auf dem Aberg 1
 57392 Schmallenberg

Deputy spokesman: Dr.-Ing. Andreas Hengse
 Phone +49 30 5306-2177
 Mobile +49 162 7440296
 andreas.hengse@fcm.fraunhofer.de
 Fraunhofer Food Chain Management Alliance
 Auf dem Aberg 1
 57392 Schmallenberg

Fraunhofer Lightweight Structures Alliance

Spokesman: Prof. Dr.-Ing. Holger Hanselka
 Phone +49 6151 705-222
 Fax +49 6151 705-214
 holger.hanselka@lbf.fraunhofer.de
 www.leichtbau.fraunhofer.de
 Fraunhofer Institute for Structural Durability and System Reliability LBF
 Bartningstrasse 47
 64289 Darmstadt

Fraunhofer Nanotechnology Alliance

Spokesman, head of central office:
 Dr. Karl-Heinz Haas
 Phone +49 931 4100-500
 Fax +49 931 4100-559
 karl-heinz.haas@isc.fraunhofer.de
 www.nano.fraunhofer.de
 Fraunhofer Institute for Silicate Research ISC
 Neunerplatz 2
 97082 Würzburg

Deputy spokesman: Dr. habil. Günter Tovar
 Phone +49 711 970-4109
 Fax +49 711 970-4200
 guenter.tovar@igb.fraunhofer.de
 Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB
 Nobelstrasse 12
 70569 Stuttgart

Fraunhofer Optic Surfaces Alliance

Spokesman: Dr. Benedikt Bläsi
 Phone +49 761 4588-5995
 Fax +49 761 4588-9995
 benedikt.blaesi@ise.fraunhofer.de
 www.funktionale-oberflaechen.de
 Fraunhofer Institute for Solar Energy Systems ISE
 Heidenhofstrasse 2
 79110 Freiburg

Fraunhofer Photocatalysis Alliance

Spokesman: Dr. Michael Vergöhl
 Phone +49 531 2155-640
 Fax +49 531 2155-900
 michael.vergoehl@ist.fraunhofer.de
 www.photokatalyse.fraunhofer.de
 Fraunhofer Institute for Surface Engineering and Thin Films IST
 Bienroder Weg 54 E
 38108 Braunschweig

Marketing and communication:
 Dr. Simone Kondruweit-Reinema
 Phone +49 531 2155-535
 Fax +49 531 2155-900
 info@photokatalyse.fraunhofer.de
 Fraunhofer Institute for Surface Engineering and Thin Films IST
 Bienroder Weg 54 E
 38108 Braunschweig

Fraunhofer Polymer Surfaces Alliance POLO

Spokeswoman, head of central office:
 Dr. Sabine Amberg-Schwab
 Phone +49 931 4100-620
 Fax +49 931 4100-698
 sabine.amberg-schwab@isc.fraunhofer.de
 www.polo.fraunhofer.de
 Fraunhofer Institute for Silicate Research ISC
 Neunerplatz 2
 97082 Würzburg

Fraunhofer Simulation Alliance

Spokesman, head of central office:

Andreas Burbliès

Phone +49 421 2246-183

Fax +49 421 2246-77-183

andreas.burbliès@ifam.fraunhofer.de

www.simulation.fraunhofer.de

Fraunhofer Institute for

Manufacturing Technology and

Advanced Materials IFAM

Wiener Strasse 12

28359 Bremen

Fraunhofer Traffic and Transportation Alliance

Spokesman: Prof. Dr.-Ing. Uwe Clausen

Phone +49 231 9743-400

Fax +49 231 9743-402

uwe.clausen@iml.fraunhofer.de

www.verkehr.fraunhofer.de

Fraunhofer Institute for

Material Flow and Logistics IML

Joseph-von-Fraunhofer-Strasse 2–4

44227 Dortmund

Head of central office:

Christiane Kollosche

Phone +49 231 9743-371

Fax +49 231 9743-372

info@verkehr.fraunhofer.de

Fraunhofer Traffic and Transportation Alliance

Joseph-von-Fraunhofer-Strasse 2–4

44227 Dortmund

Fraunhofer Vision Alliance

Spokesman, head of central office:

Dipl.-Ing. Michael Sackewitz

Phone +49 9131 776-5800

Fax +49 9131 776-5899

vision@fraunhofer.de

www.vision.fraunhofer.de

Fraunhofer Vision Alliance

Am Wolfsmantel 33

91058 Erlangen

Press and public relations, marketing:

Regina Fischer M. A.

Phone +49 9131 776-5830

Dipl.-Pol. Ulrike Persch

Phone +49 9131 776-5853

Fax +49 9131 776-5899

vision@fraunhofer.de

Fraunhofer Vision Alliance

Am Wolfsmantel 33

91058 Erlangen

Fraunhofer Water Systems Alliance (SysWasser)

Spokesman: Prof. Dr. Walter Trösch

Phone +49 711 970-4220

Fax +49 711 970-4200

walter.troesch@igb.fraunhofer.de

www.syswasser.de

Fraunhofer Institute for

Interfacial Engineering and Biotechnology IGB

Nobelstrasse 12

70569 Stuttgart

Managing director:

Prof. Dr. Dieter Bryniok

Phone +49 711 970-4211

Fax +49 711 970-4200

dieter.bryniok@igb.fraunhofer.de

Fraunhofer Institute for

Interfacial Engineering and Biotechnology IGB

Nobelstrasse 12

70569 Stuttgart

ADDRESSES

The Fraunhofer-Gesellschaft

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

Hansastraße 27c

80686 München

Germany

Phone +49 89 1205-0

Fax +49 89 1205-7531

info@fraunhofer.de

www.fraunhofer.de

Press and public relations:

Franz Miller

Phone +49 89 1205-1301

Fax +49 89 1205-7513

presse@zv.fraunhofer.de

Historic Fraunhofer

Glassworks

Fraunhoferstraße 1

83671 Benediktbeuern

Executive Board:

Prof. Dr.-Ing. habil.

Prof. e.h. mult. Dr. h.c. mult.

Hans-Jörg Bullinger

(Corporate Management,

President of the

Fraunhofer-Gesellschaft)

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(Senior Vice President Research
Planning)

Prof. (Univ. Stellenbosch)

Dr. rer. pol. Alfred Gossner

(Senior Vice President Finance,
Controlling, IT)

Dr. rer. publ. Ass. jur.

Alexander Kurz

(Senior Vice President Human
Resources and Legal Affairs)

Contact for businesses:

Dipl.-Biol. Andrea Vidal MBA

Phone +49 89 1205-1221

Fax +49 89 1205-77-1221

projektanfragen@fraunhofer.de

SERVICE

International addresses



Fraunhofer International

Contact in Germany

Fraunhofer-Gesellschaft
International Business
Development
Dr. Raoul Klingner
Phone +49 89 1205-4700
Fax +49 89 1205-77-4700
raoul.klingner@zv.fraunhofer.de
Hansastrasse 27c
80686 München, Germany

Contact in Brussels

Fraunhofer Brussels Office
Dr. Patrick Bressler
Phone +32 2 50642-42
Fax +32 2 50642-49
patrick.bressler@zv.fraunhofer.de
Rue du Commerce 31
1000 Brussels/Bruxelles, Belgium

Fraunhofer in Austria

**Fraunhofer Austria
Research GmbH****Production Management
and Logistics Unit**

Daniel Palm
Phone +43 1 504 6906
Fax +43 1 504 691091
daniel.palm@fraunhofer.at
www.fraunhofer.at/pl/
Theresianumgasse 7
1040 Vienna, Austria

Visual Computing Unit

Dr. Eva Eggeling
Phone +43 316 873 5417
Fax +43 316 873 105417
eva.eggeling@fraunhofer.at
www.fraunhofer.at/vc/
Inffeldgasse 16c
8010 Graz, Austria

Fraunhofer in Chile

**Fraunhofer Center for
Systems Biotechnology CSB**

Dr. Wolfgang Schuch
Phone +56 2 378 1652
wolfgang.schuch@
fraunhoferchile.cl
www.fraunhofer.cl
Avenida M. Sánchez Fontecilla
310, Piso 14
Las Condes 7550296
Santiago, Chile

Fraunhofer in China

**Fraunhofer Representative
Office Beijing**

HAN Xiaoding
Phone +86 10 6590 6135
Fax +86 10 6590 0052
hanxd@fraunhofer.cn
www.fraunhofer.cn
Unit 0606, Landmark Tower II
8 North Dongsanhuan Road
Chaoyang District
100004 Beijing, China

Fraunhofer in India

**Fraunhofer Representative
and Senior Advisor India**

Anandi Iyer
Phone +91 80 40965008
anandi.iyer@fraunhofer.in
901-902 Prestige Meridian II
Towers
No. 30, M G Road
Bangalore 560001, India

Fraunhofer in Indonesia

**Fraunhofer Representative
Office Indonesia**

Dr.-Ing. Ida-Bagus Kesawa
Narayana
Phone +62 21 315 4795
Fax +62 21 315 4195
narayana@fraunhofer.or.id
www.fraunhofer.or.id
Menara Thamrin Suite 3A07
Jl. M. H. Thamrin Kav. 3
Jakarta 10250, Indonesia

Fraunhofer in Italy

**Fraunhofer Innovation
Engineering Center IEC**

Prof. Dr. Dominik Matt
Phone +39 0471 1966901
Fax +39 0471 1966949
info@fraunhofer.it
www.fraunhofer.it
Schlachthofstrasse 57
39100 Bolzano, Italy

International addresses

Fraunhofer in Japan**Fraunhofer Representative
Office Japan**

Dr. Lorenz Granrath
 Phone +81 3 3586 7104
 Fax +81 3 3586 7187
 granrath@fraunhofer.jp
 www.fraunhofer.jp
 German Cultural Center 1F
 Akasaka 7-5-56, Minato-ku
 Tokyo 107-0052, Japan

**Fraunhofer Office for Process
Engineering of Functional
Materials and Robotics OPER**

Ivica Kolaric
 Phone +81 66133 5844
 Fax +81 66133 5858
 oper@fraunhofer.jp
 http://oper.fraunhofer.jp
 Coffret Umeda 8F,
 2-12-4 Sonezaki, Kita-ku
 Osaka, 530-0057, Japan

Fraunhofer in Malaysia**Fraunhofer Senior Advisor
Malaysia**

Dr. Ahmad b. Ibrahim
 Phone +603 4292 3460
 Fax +603 4295 8219
 ibrahim.ahmad@fraunhofer.de
 34, Jalan IS 5, Lembah Jaya
 Ampang 68000
 Selangor D. E., Malaysia

Fraunhofer in the Middle East**Fraunhofer Representative
Office Middle East**

Dr. Dieter R. Fuchs
 Phone +971 4 2099 189
 Mobile +971 506536211
 Fax +971 4 2977742
 dieter.fuchs@zv.fraunhofer.de
 c/o SS Lootah BCGas
 P.O. Box 41033
 Dubai, UAE

**Fraunhofer Senior Advisor
Middle East**

(from January 2012)
 Heinz Krier
 Phone +971 55 8841440
 heinz.krier@gmail.com
 P.O. Box 102990
 Dubai, UAE

**Fraunhofer Senior Advisor
Egypt**

Dr. Mona El Tobgui
 Phone +20 2 2735 7046
 Mobile +20 10 660 2437
 mona.el.tobgui@fraunhofer.de
 c/o DAAD Cairo Office
 11 Street El Saleh Ayoub,
 Zamalek
 Cairo, Egypt

Fraunhofer in Portugal**Fraunhofer Center for
Assistive Information and
Communication Solutions
AICOS**

Prof. Dr.-Ing. Dirk Elias
 Phone +351 220 408 300
 Fax +351 226 005 029
 dirk.elias@fraunhofer.pt
 www.fraunhofer.pt
 Rua Alfredo Allen 455
 4200-135 Porto, Portugal

Fraunhofer in South Korea**Fraunhofer Representative
Office Korea**

JooHwan Kim
 Phone +82 2 3785 3026
 Fax +82 2 6008 6246
 jooHwan.kim@fraunhofer.kr
 www.fraunhofer.kr
 138-794, Sincheon-ro 6-gil 10,
 A-202 (Sincheon-dong,
 Jamsil Deosyap Star Park)
 Seoul, South Korea

Fraunhofer in the USA**Fraunhofer USA, Inc.
Headquarters**

Dr. William F. Hartman
 Phone +1 734 354 9700
 Fax +1 734 354 9711
 whartman@fraunhofer.org
 www.fraunhofer.org
 44792 Helm Street
 Plymouth, MI 48170, USA

**Fraunhofer Center for
Coatings and
Laser Applications CCL**

Prof. Dr. Jes Asmussen
 Phone +1 517 355 4620
 Fax +1 517 432 8168
 asmussen@egr.msu.edu
 www.ccl.fraunhofer.org
 B100 Engineering
 Research Complex
 Michigan State University
 East Lansing, MI 48824-1226
 USA

**Fraunhofer Center for
Experimental Software
Engineering CESE**

Prof. Dr. Rance Cleaveland
 Frank Herman
 rcleaveland@fc-md.umd.edu
 Phone +1 240 487 2905
 Fax +1 240 487 2960
 http://fc-md.umd.edu
 5825 University Research Court,
 Suite 1300
 College Park, MD 20740-3823
 USA

**Fraunhofer Center for
Laser Technology CLT**

Dr.-Ing. Stefan Heinemann
Phone +1 734 738 0500
Fax +1 734 354 3335
sheinemann@clt.fraunhofer.com
www.clt.fraunhofer.com
46025 Port Street
Plymouth, MI 48170-6080, USA

**Fraunhofer Center for
Manufacturing Innovation
CMI**

Prof. Dr.-Ing. Andre Sharon
Phone +1 617 353 1888
Fax +1 617 353 1896
asharon@fraunhofer.org
www.fhcmi.org
15 St. Mary's Street
Brookline, MA 02446-8200, USA

**Fraunhofer Center for
Molecular Biotechnology CMB**

Dr. Vidadi M. Yusibov
Phone +1 302 369 1708
Fax +1 302 369 8952
vyusibov@fraunhofer-cmb.org
www.fraunhofer-cmb.org
9 Innovation Way, Suite 200
Newark, DE 19711, USA

**Fraunhofer Center for
Sustainable Energy Systems**

CSE
Mr. Nolan Browne
Dr. Christian Hoepfner
Phone +1 617 575 7250
http://cse.fraunhofer.org/
25 First Street, 1st Floor,
Suite 101
Cambridge, MA 02141, USA

**Fraunhofer Heinrich Hertz
Institute USA**

Mr. Frank Menzler
Phone +1 617 714 6529
fmenzler@fraunhofer.org
www.hhi.fraunhofer.org
25 First Street, Suite 101
Cambridge, MA 02141, USA

**Fraunhofer USA Digital Media
Technologies DMT**

Mr. Robert Bleidt
Phone +1 408 573 9900
robert.bleidt@dmf.fraunhofer.org
www.dmf.fraunhofer.org
100 Century Center Court,
Suite 504
San Jose, CA 95112, USA



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Editorial notes

Editorial team

Dr. Martin Thum (editor in chief)
Christa Schraivogel (picture editor)

Production

Marie-Luise Keller-Winterstein

Design concept

Zone für Gestaltung

Layout

Büro für Typografie:
Dieter Bottling

English edition

Burton, Van Iersel & Whitney
GmbH, Munich

You can call up the addresses,
focal fields of research, and
contacts for all Fraunhofer Insti-
tutes and Groups in English
or German on the Internet:
www.fraunhofer.de

Editorial address

Fraunhofer-Gesellschaft
Press and Public Relations
Dr. Martin Thum
Hansastraße 27c
80686 München
Germany
Phone +49 89 1205-1367
martin.thum@zv.fraunhofer.de

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