

Energy Research at Fraunhofer

Fraunhofer-Gesellschaft

1. Introduction

The energy supply structure in Germany is undergoing a comprehensive transformation process towards ambitious renewable energy and climate policy goals:

- 2022: Shutdown of the last nuclear power plant
- 2025: 40-45% share of renewable energy on electricity consumption; 2040: 65%
- 2030: 55% reduction of greenhouse-gas emissions compared to 1990; 2040: -70%
- 2038: Shutdown of the last coal-power plant

As the largest research organization for applied research in Europe and a leading international organization for applied energy research, the Fraunhofer-Gesellschaft develops innovative technologies and solutions for the successful transformation of the energy system towards clean energy applications.

Regarding the definition of clean energy, Fraunhofer is orienting itself on the rationale of the German government. “Clean energy” are energy forms that do not harm the environment, especially in regard to greenhouse-gasses and other harmful emissions (e.g. radioactive material).

With our research and development work, we are shaping the transformation towards an economically, environmentally friendly, secure and socially accepted energy supply for electricity, heat and mobility.

2. R&D activities related to clean energy technology

The Fraunhofer-Gesellschaft develops and demonstrates pioneering key technologies for the German and European industry and contributes to Germany and Europe as innovation leaders in the transition towards a sustainable energy system.

Our work covers the entire value-added process — from new ideas and concepts to the development of new technologies, processes and systems, quality assurance and market implementation support. Fraunhofer clean energy related research topics span a wide field, which includes energy generation (esp. solar and wind), hydrogen technologies, material science, R&D for improving the energy grid, intelligent energy management and load balancing, energy storage (incl. batteries and power-to-X), energy efficiency and energy harvesting.

The Fraunhofer-Gesellschaft has an “Energy Alliance” consisting of 18 Fraunhofer institutes, which deal with different topics in the field of energy R&D. Research topics include:

- Renewable energy
- Energy systems
- Energy efficiency
- Energy storage

- Urban energy applications
- Digital energy management

Together with AIST and the National Renewable Energy Laboratory NREL (USA), Fraunhofer is also member of the Global Alliance for Solar Energy Research Institutes GA-SERI. This is an international group of scientific experts, which since 2016 discusses challenges related to the use of photovoltaics to achieve global climate goals.

3. Specific Research activities in hydrogen, CCUS, and related technologies

The German federal strategy focusses primarily on its plans to massively extend the use of renewable energy sources in combination with energy efficiency. Therefore, carbon capture and storage technologies are not regarded necessary and associated with additional risks.

Fraunhofer is active in projects related to CO₂ reduction and recycling, which means to utilize electricity from renewable sources (especially during peak loads) to synthesize important basic chemicals from CO₂ emitted, for example, during the steelmaking process.

Hydrogen technologies are key to a CO₂-neutral economy: they enable sector coupling in the energy system, offer solutions for sustainable mobility, industrial production and recycling, and link electricity, heat and gas networks. Fraunhofer sees itself as a decisive partner when the establishment of a hydrogen economy is heralded in Germany. Since February 2019, 17 institutes with relevant competencies have been working together in the Fraunhofer Hydrogen Network. With the aim of preserving opportunities for value creation and employment in Germany and promoting sustainable solutions, they are developing a joint research agenda.

The Federal Government has decided to develop a National Hydrogen Strategy in response to the customary impulses of the Fraunhofer-Gesellschaft. First results are expected by the end of 2019.

Several Fraunhofer institutes are conducting R&D in areas of carbon recycling/carbon utilization and hydrogen technologies. Project examples include:

- **Carbon2Chem**
Brings together the energy, steel and chemical industries to form a cross-industry production network. The hydrogen synthesis process plays a key role, as hydrogen is required for almost all subsequent synthesis routes.
- **HYPOS - Hydrogen Power Storage & Solutions East Germany**
One of the ten innovation projects of the "2020 - Partnership for Innovation" funding initiative launched by the German Federal Ministry of Education and Research (BMBF). The objective of the project is the production, storage, distribution and broad application of green hydrogen in the chemical and refining industry, mobility and energy sectors.
- **SALCOS**
SALCOS® focuses on the primary avoidance of CO₂ formation in the steel production process through research innovative process technologies. Specialists from a large German steel producer are working together with Fraunhofer Institutes and other partners on integrated the new technologies into smelting plants.

4. International collaboration

- AtaMoS-TeC: photovoltaic technologies for the exceptional conditions of the Atacama Desert (Fraunhofer and Solar Energy Research Center (Chile))
- CPV-India: Concentrator Photovoltaics Targeted for highly efficient power production in India (Fraunhofer and NTCP NETRA (India))
- AFLOAT: Demonstration of high survivability cost competitive floating offshore wind (FOW) technology (Fraunhofer together with companies and research institutions from Ireland, France, Netherlands)
- REstable: Improvement of regenerative-based power grid systems and services (Fraunhofer together with companies and research institutions from France and Germany)
- Solid State Battery (ICON Project: Fraunhofer and EMPA (Switzerland))
- DEKADE: novel catalyst systems, electrodes and membranes are developed for automotive fuel cell applications (Fraunhofer and National Research Council, University of British Columbia and Simon Fraser University, Vancouver (Canada))

5. Future perspectives and challenges in clean energy technologies

In order to reach Germany's ambitions renewable energy and climate goals, technological innovations are necessary, that also include new technologies for electricity grids, load management, energy storage and carbon recycling.

A meta-analysis of several German energy-related studies has identified the following major challenges for a successful energy transition in Germany, which also include societal and economic issues:

- Renewable energy technologies need to be developed and implemented faster
- Energy Consumption and power plant management need to get more flexible in order to ensure supply
- A new technology mix in transportation/mobility is necessary
- A comprehensive, energy-efficient and faster renovation of buildings must take effect
- Further reduction and avoidance of industrial emissions with more energy efficiency, renewable energies use and new processes is required
- A holistic control of the energy transition to facilitate investments is important
- Positive economic and societal conditions and incentives need to be conveyed

PROF. DR.-ING. REIMUND NEUGEBAUER

President of the Fraunhofer-Gesellschaft

BIOGRAPHY

Born June 27, 1953 in the municipality of Esperstedt in Thuringia, Germany

- Since 2012 President of the Fraunhofer-Gesellschaft e.V.
- 2010 – 2011 President of the German Academic Society for Production Engineering (WGP)
- 2010 Initiator and spokesperson of the Fraunhofer AutoMOBILE Production Alliance
- 2003 – 2006 Dean of the Faculty of Mechanical Engineering at Chemnitz University of Technology (TU Chemnitz)
- 2000 Founding President of Industrieverein Sachsen 1828 e. V., an association of approximately 120 companies (representing 20 billion euros in sales; 30,000 employees); Founder and Managing Director of the Institute for Machine Tools and Production Processes (IWP), TU Chemnitz
- 1998 Initiator and Dean of Studies, Microtechnology/ Mechatronics program, TU Chemnitz
- 1995 Full Professor and Department Chair of Machine Tools and Forming Technology, TU Chemnitz, while also serving as Director of the Fraunhofer Institute for Machine Tools and Forming Technology IWU
- 1994 – 2012 Executive Director of Fraunhofer IWU



- 1992 Director of Machine Tools and Automation Technology at the Fraunhofer Institution for Forming Technology and Machine Tools, the predecessor of Fraunhofer IWU
- 1991 Award of the academic degree of Doktor-Ingenieur habilitatus; commissioned by the Fraunhofer Executive Board to establish the Fraunhofer Research Institution for Forming Technology and Machine Tools
- 1990 Executive Director at the Institute of Machine Tools, Technische Universität Dresden (TUD)
- 1989 University Lecturer, Machine Tools and Tool Design, TUD
- 1989 Doctorate in technical sciences (Dr. sc. techn.), TUD: “Development of flexible sheet metal molding systems“
- 1985 Employed in the field of design and development by the company Kombinat Umformtechnik, Erfurt, rising to a senior position
- 1984 Doctorate in engineering (Dr.-Ing.), TUD: “Computer-assisted preparation of finite element calculation models for machine tool structures“
- 1975 Degree in mechanical engineering (Dipl.-Ing.), TUD; focus on machine tool design

AWARDS / HONORS (SELECTION)

- 2019 Honorary doctorate awarded by Michigan State University (MSU), USA
- 2018 Honorary doctorate awarded by Budapest University of Technology and Economics (BME), Hungary
- 2016 Honorary doctorate awarded by KU Leuven, Belgium
- 2015 Honorary doctorate awarded by the Wrocław University of Science and Technology, Poland
- 2015 Honorary doctorate awarded by the University of Naples Federico II, Italy
- 2014 Erich Siebel Medal, bestowed by the European Research Association for Sheet Metal Working (EFB)
- 2014 Honorary doctorate awarded by the Czech Technical University in Prague (CTU), Czechia
- 2013 Honorary doctorate awarded by Stellenbosch University, South Africa
- 2012 Honorary doctorate awarded by the Technical University of Munich (TUM), Germany
- 2012 Order of Merit of the German State of Saxony (Sächsischer Verdienstorden)
- 2012 Prize of Honor awarded by Initiative Südwestsachsen e. V., in the Science, Art and Culture category
- 2011 Medal of honor presented by Chemnitz University of Technology (TU Chemnitz), Germany
- 2007 Honorary doctorate awarded by Brno University of Technology, Czechia
- 2005 Officer's Cross of the Order of Merit of the Federal Republic of Germany
- 2003 Professor Hýbl Medal bestowed by CTU in Prague, Czechia
- 2003 Honorary doctorate awarded by Moscow State University of Technology "Stankin" (MSTU), Russia
- 2001 Honorary professorship at Kuzbass State Technical University named after T.F. Gorbachev (KuzSTU), Russia
- 2000 Education and Innovation Award bestowed by the German research association for automation and microelectronics DFAM

MEMBERSHIPS (SELECTION)

- Since 2019 Co-chair of the German federal government's High-Tech Forum (together with State Secretary Christian Luft)
- Since 2017 Member of the Steering Committee of the Plattform Lernende Systeme – a platform for AI and machine learning
- Since 2016 Member of the Executive Board of Plattform Industrie 4.0
- Since 2015 Member of the European Defence Agency's High-level Group of Personalities on Defence Research
- Since 2015 Co-chair of the German federal government's High-Tech Forum
- Since 2014 Member of the Steering Committee of the Innovation Dialogue between the German federal government, science, industry and society, initiated by Chancellor Angela Merkel
- 2014 Elected to the German National Academy of Sciences Leopoldina
- Since 2005 Fellow of the International Academy for Production Engineering (CIRP)
- Since 1998 Member of acatech – National Academy of Science and Engineering in Germany
- Since 1998 Member of the German Academic Society for Production Engineering (WGP)