

Our task is

to promote the utilization of

SOLAR ENERGY and HYDROGEN TECHNOLOGIES

by means of

- applied research and development in the fields of

Photovoltaics
Solar thermal engineering
Battery technology
Fuel cells

- Systems studies and systems analysis
- Cooperation with industrial and scientific partners
- Consultancy, training and technical assistance
- Information of the public.

Zentrum für
Sonnenenergie- und Wasserstoff-Forschung
Baden-Württemberg (ZSW)



*Solar and Hydrogen Energy
Research Center
Baden-Württemberg (ZSW)*

Main research areas:

Medium and long-term application oriented research and development tasks linking fundamental and industrial research:

Department 1:

- **Photovoltaic plant engineering:**
System components, power conditioning, tracking of solar generators, concentrators, radiation measurement techniques
- **Material science:**
Production and analysis of thin layers (optical-holographic, metallic, semiconducting, insulating), thin film solar cells

Department 2:

- **Systems analysis:**
Evaluation of solar energy technologies, system interconnection (grids, stand-alone systems), marketing strategies
- **Solar thermal energy technology:**
Parabolic dish concentrators, technologies of parabolic troughs (fluid dynamics), of solar radiation receivers and thermal storages, passive and active use of solar energy in buildings
- **Electrochemical and chemical hydrogen technologies:**
Medium and high temperature fuel cells (Phosphoric Acid and Molten Carbonate type), development of electrodes

Directors:

Prof. Dr.-Ing. H. Albrecht
Managing Director
Heßbrühlstr. 61
D-7000 Stuttgart 80
Telephone: +49-711-78 00 954
Telefax: +49-711-78 00 988

Prof. Dr.-Ing. W.H. Bloss
Department 1
Paffenwaldring 47
D-7000 Stuttgart 80
Telephone: +49-711-685-7141
Telefax: +49-711-685-7143

N.N.
Department 2
Paffenwaldring 38-40
D-7000 Stuttgart 80
Telephone: +49-711-6862-357
Telefax: +49-711-6862-349

Prof. Dr. W. Witschel
Department 3
Helmbolzstr. 8
7900 Ulm
Telephone: +49-731-9530-0
Telefax: +49-731-9530-666

Contact for inquiries:

Dr. F. Oster
Heßbrühlstr. 61
D-7000 Stuttgart 80
Telephone: +49-711-78 00 954
Telefax: +49-711-78 00 988

Department 3:

- **Electrochemical storage and converters:**
Conventional (Pb/PbO₂, Ni/Cd-) and advanced batteries (Zn/Br₂-, high-temperature systems), fuel cells (Polymer and Solid Oxide)
- **Applied electrochemistry and material science:**
Electrolysis, electrodeposition, electrochromism, decontamination of pollutants, sensorics
- **Battery testing:**
Real condition tests of batteries in the laboratory and in the system, risk and environmental effect assessment

Facilities:

Photovoltaic outdoor test plant *Widderstall* near Merklingen, test facilities for parabolic dishes, thermal storage and direct evaporation units, portable measuring equipment for the investigation of locations and buildings, sputter deposition and high vacuum coating units, spectroscopy for extreme surface analysis, diffractometry, test facilities for batteries and fuel cells

Target groups:

Industrial companies, research centers, public authorities

S Y S

SYSTEMS ANALYSIS

Contact:

Frithjof Stajß
Tel: +49-711-6862-739

ENERGY ECONOMIC STUDIES

Determination of the technical and economic potential of renewable energy sources (RES)
Technology assessment
Potential of solarthermal power plants in the Mediterranean area
Studies on a hydrogen energy economy

MARKET INTRODUCTION STRATEGIES

Development of strategies for integration and market introduction of renewable energy systems
Integration of RES into large interconnected grids (model calculation)
Integration of RES into local energy supply systems (case studies)

PUBLIC RELATIONS WORK

P V A

PHOTOVOLTAIC SYSTEMS ENGINEERING

Contact:

Dr. Fritz Pfisterer
Tel: +49-711-685-7157
Werner Knaupp
Tel: +49-711-685 7457

MODULE- AND SYSTEMS TECHNOLOGY

Investigations to supporting structures, integration into buildings and optimized interconnection for achieving maximum annual energy gain, combined with high operational security and availability.
Development and testing of soft concentrating systems (V-trough technology) and innovative tracking techniques (e.g. thermohydraulic drive).
Testing and characterization of commercial photovoltaic modules.
Development of stand-alone and grid-connected systems adapted to the needs.

TEST FIELD "WIDDERSTALL"

Operation of a test field on the "Schwäbische Alb" for long-term outdoor tests of various solar energy systems.

ELECTRONICS AND MEASUREMENT TECHNIQUES

Inverters and electronic control devices for grid-connected systems and development of low-power module-integrated inverters.
Test stand for line-commutated inverters.
Development of electronic equipment for security techniques and for automatic monitoring of systems (e.g. power failure, lightning protection).

METEOROLOGICAL MEASUREMENT TECHNIQUES

Continuous measurement of spectral irradiance and correlation with integral irradiation values at various geographical sites.
Irradiation modelling for determination of the specific potentials of various types of solar cells.

M A T

MATERIALS SCIENCE

Contact:

*Dr. Konrad Herz
Tel: +49-711-685-7257*

MATERIALS RESEARCH AND DEVELOPMENT

Investigation of preparation methods and applicability of metal silicides for thin film solar cells.

Investigation of sulfidic ore minerals as promising semiconductors for photovoltaic applications.

DEVELOPMENT OF PREPARATION TECHNIQUES

Development of deposition techniques for the fabrication of large area thin film solar cells and modules on the basis of copper-indium-diselenide with the upscaling to a pilot line.

Development of laser assisted deposition methods (laser ablation) for the preparation of CuInSe₂ thin film solar cells.

Development of holographic optical elements.

ANALYTICAL TECHNIQUES

Characterization of surfaces and thin films with Auger and photoelectron spectroscopy and secondary ion and neutral mass spectrometry.

Phase and texture analysis by x-ray diffraction techniques.

Energy and wavelength dispersive x-ray microanalysis.

S O T

SOLARTHERMAL ENGINEERING

Contact:

*Dr. Jürgen Rheinländer
Tel: +49-711-7804-000*

HIGH-TEMPERATURE APPLICATIONS

Performance measurement of parabolic dish concentrators with heat engine in the focus and development of suitable radiation receivers.

Numerical simulation of heat and fluid flow in solar tower plants.

MEDIUM-TEMPERATURE APPLICATIONS

Experimental and analytical research on direct steam generation in the absorber tubes of solar farm plants.

Experimental and analytical research on thermal energy storage systems for thermal-oil and steam circuits in solar farm plants.

LOW-TEMPERATURE APPLICATIONS

Systems and their components for solar low-temperature applications.

Engineering for the use of passive and active solar systems in buildings.

SOLAR-THERMAL MEASURING

E C W

ELECTROCHEMICAL HYDROGEN TECHNOLOGIES

Contact:

*Dr. Bernd Rohland
Tel: +49-711-6862-734*

G B 3

**DEPARTMENT 3
ELECTROCHEMICAL ENERGY STORAGE
AND CONVERSION**

Contact:

*Dr. Jürgen Garche
Tel: +49-7307-6087
from January 1993 on:
Tel: +49-731-9530-0*

PHOSPHORIC ACID FUEL CELLS (PAFC)

Development of novel electrode materials showing electrochemical corrosion rates lower than those of graphite.

Investigations and materials testing in half cell arrangements.

Operational testing and modelling of 2 kW PAFC units.

MOLTEN CARBONATE FUEL CELLS (MCFC)

Development of an unconventional fabrication technology for high porous electrodes and matrices, innovations to industrial fabrication technology of MCFC stacks.

Development of novel MCFC cathodes for operation under pressures up to 5 bar.

Application of new methods for operational testing of commercial fabricated MCFC, including long term testing.

GENERAL PROCESS TECHNOLOGY FOR FUEL CELL OPERATION

Process technology for fuel preparation (e.g. coal-gas, biogas). Studies of the use of biogas obtained hydrogen for several types of fuel cells.

Development and construction of a test facility for commercial operation of 10 to 100 kW fuel cell power stations.

ELECTROCHEMICAL POWER SOURCES

Research and development on solid and molten salt electrolytes and electrode materials for high energy batteries and solid oxide fuel cells, as well as methods for their preparation.

Further development of electrode materials for conventional batteries (e.g. PbO₂ and NiOOH electrodes).

Investigations related to methanol-consuming fuel cells.

APPLIED ELECTROCHEMISTRY

Development and testing of new inert electrode materials for use in industrial electrochemistry (e.g. electronically conducting ceramics).

Investigations related to improvements in galvanic processes (e.g. chromium electrodeposition).

BATTERY TESTING

Testing of conventional (e.g. Pb/PbO₂) and advanced (e.g. Zn/Br₂, Ni/Metal hydride) battery systems in the laboratory as well as in system operation.

Evaluation of batteries and modelling related to application requirements (e.g. vehicle traction and photovoltaics).

BATTERY-RELATED SAFETY AND ENVIRONMENTAL STUDIES

Investigations of environmental compatibility of new types of batteries (e.g. Zn/Br₂).

Safety studies for vehicle traction batteries (e.g. Pb/PbO₂, Ni/Cd).

