



**Baden-Württemberg**  
Ministry of Economic Affairs

# Fuel Cells

# Baden-Württemberg is at the forefront of the fuel-cell industry – a key emerging technology

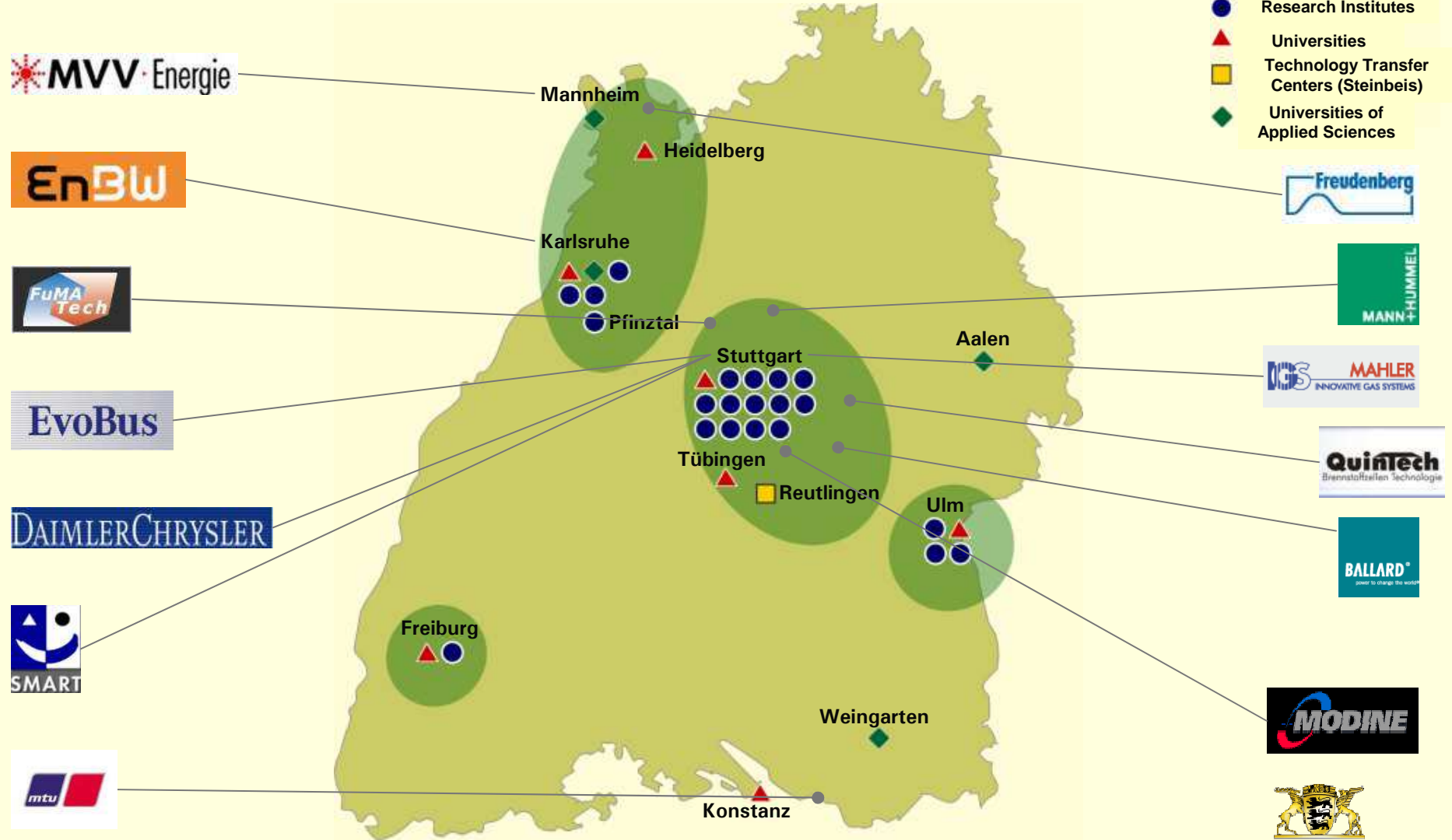
- Fuel-cell technology offers exciting new solutions for the transportation and energy industries, and is fast becoming a major growth market. Fuel cells are deployed in a variety of ways – ranging from major power plants and stationary heaters, to propulsion systems for road vehicles, satellites and ships, to power supply systems for laptops and camcorders. By 2010, they are likely to be established in many portable, stationary and mobile applications.
- Companies in Baden-Württemberg are frontrunners when it comes to developing fuel-cell technology for real-world use:
  - The European offices of Ballard Power Systems, one of the world's leading companies in zero-emission proton exchange membrane (PEM) fuel cells, are located in Baden-Württemberg.
  - Many other leading firms in the region also have a strong focus on fuel-cell technology. These include key automotive component suppliers and manufacturers, such as the Freudenberg Group, Mann + Hummel, and energy utilities, such as EnBW.
- Baden-Württemberg is an ideal location for fuel-cell players: not only does it boast excellent research, innovation and further education networks, it also has a wide range of companies and universities.



# Regional Centers in Cluster Fuel Cells

(Relevant research institutes, universities and examples of important enterprises)

- Research Institutes
- ▲ Universities
- Technology Transfer Centers (Steinbeis)
- ◆ Universities of Applied Sciences



# Fuel Cells – Selected Companies



**MTU Friedrichshafen GmbH, Friedrichshafen**

<http://www.mtu.de>



**MVV Energie AG, Mannheim**

<http://www.mvv-energie-ag.de>



**Filterwerk Mann + Hummel GmbH, Ludwigsburg**

<http://www.mann-hummel.com>



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# Fuel Cells – Selected Companies



**Ballard Power Systems AG, Kirchheim/Teck**

<http://www.ballard.com>



**QuinTech e.K., Göppingen**

<http://www.quintech.de>



**Modine Europe GmbH, Filderstadt**

<http://www.modine.com>



# Fuel Cells – Selected Companies



**EnBW Energie Baden-Württemberg AG, Karlsruhe**

<http://www.enbw.de>



**EvoBus GmbH, Stuttgart**

<http://www.evobus.com>



**DaimlerChrysler AG, Stuttgart**

<http://www.daimlerchrysler.com>



**Smart Electronic Development GmbH, Stuttgart**

<http://www.smart.com>



# Fuel Cells – Selected Companies



**FuMa-Tech GmbH, Vaihingen an der Enz**

<http://www.fumatech.com>



**Mahler IGS GmbH, Stuttgart**

<http://www.mahler-igs.com>



**Freudenberg Fuel Cell Components Technology oHG, Weinheim**

<http://www.freudenberg.com>



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# Fuel Cells – Regional Centers – Selected Companies

Rhine-Neckar-District:



Mannheim:



Corporate Research

Hohenlohe District:



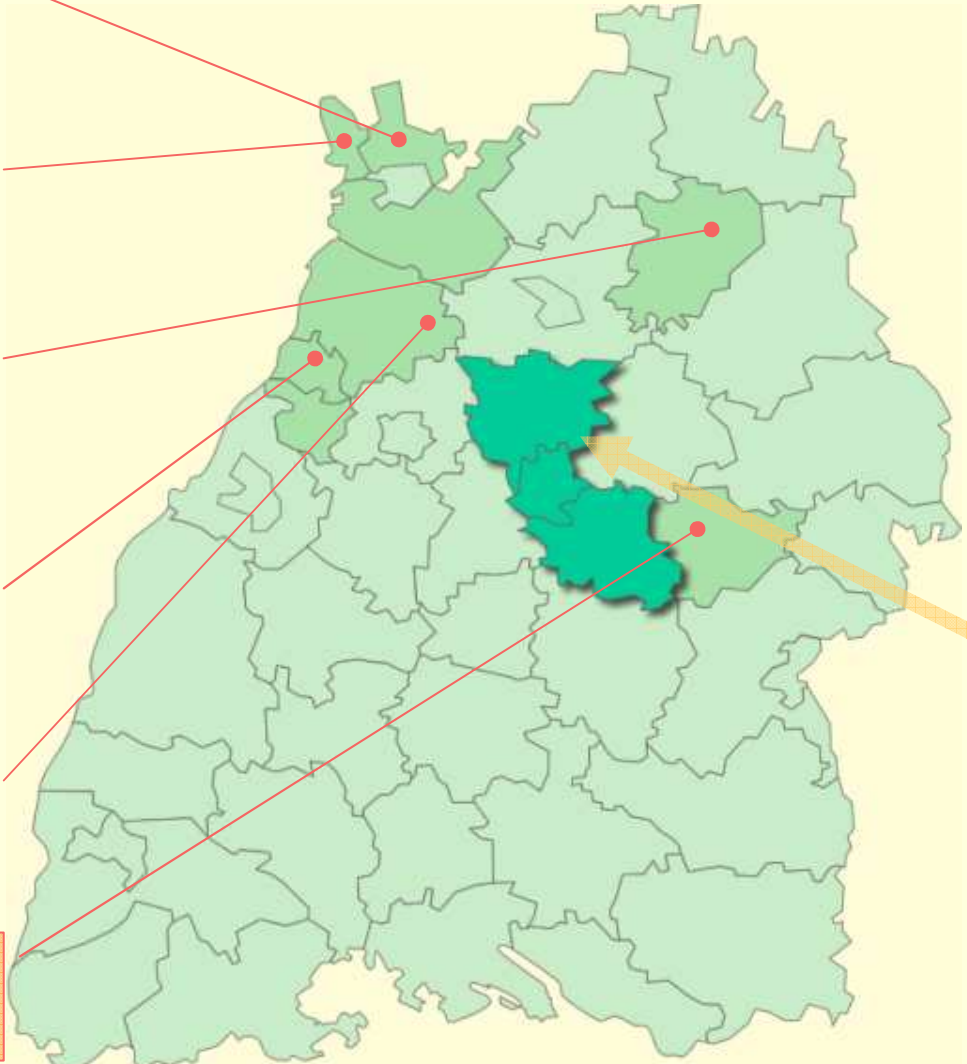
Karlsruhe:



Karlsruhe:



Göppingen:

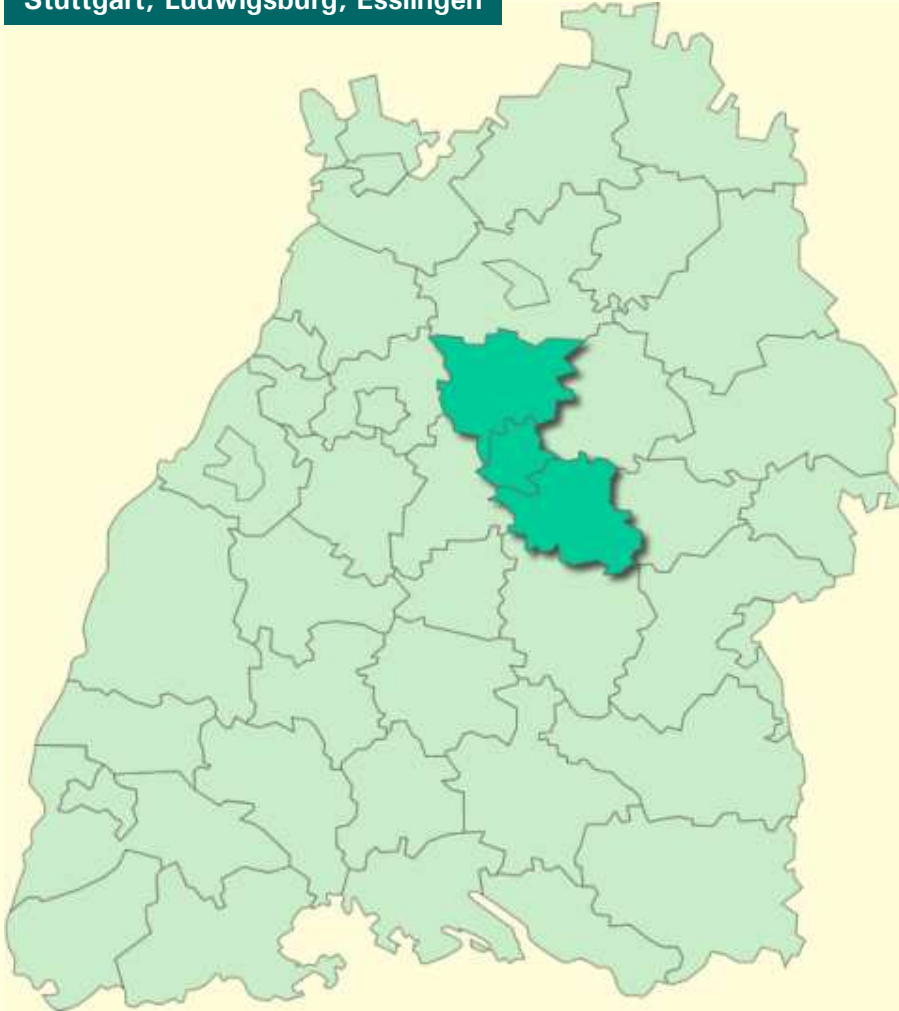


Stuttgart, Ludwigsburg,  
Esslingen:



# Fuel Cells – Regional Centers

## Stuttgart, Ludwigsburg, Esslingen

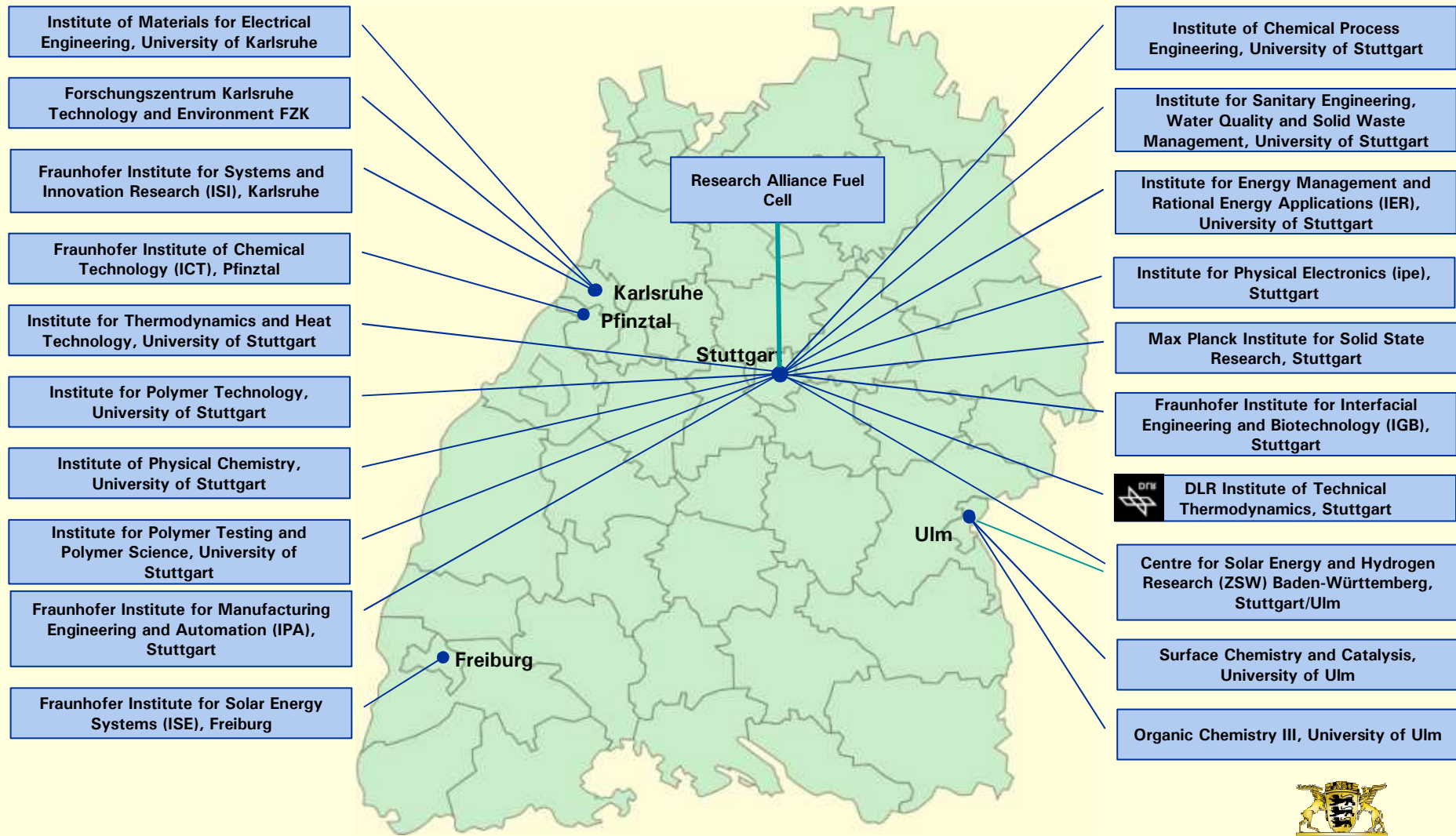


### Stuttgart, Ludwigsburg, Esslingen:

- Modine Europe GmbH (Filderstadt)
- Ballard Power Systems AG (Kirchheim unter Teck)
- Daimler Chrysler AG (Stuttgart)
- EvoBus GmbH (Stuttgart)
- Mahler IGS GmbH (Stuttgart)
- Busak + Shamban GmbH (Stuttgart)
- Franckh-KOSMOS Verlags-GmbH & Co. KG (Stuttgart)
- Ionic Systems GmbH (Stuttgart)
- Escube GmbH Space Sensor Systems (Stuttgart)
- Smart Electronic Development GmbH (Stuttgart)
- Filterwerk Mann + Hummel GmbH (Ludwigsburg)
- FuMa-Tech GmbH (Vaihingen an der Enz)



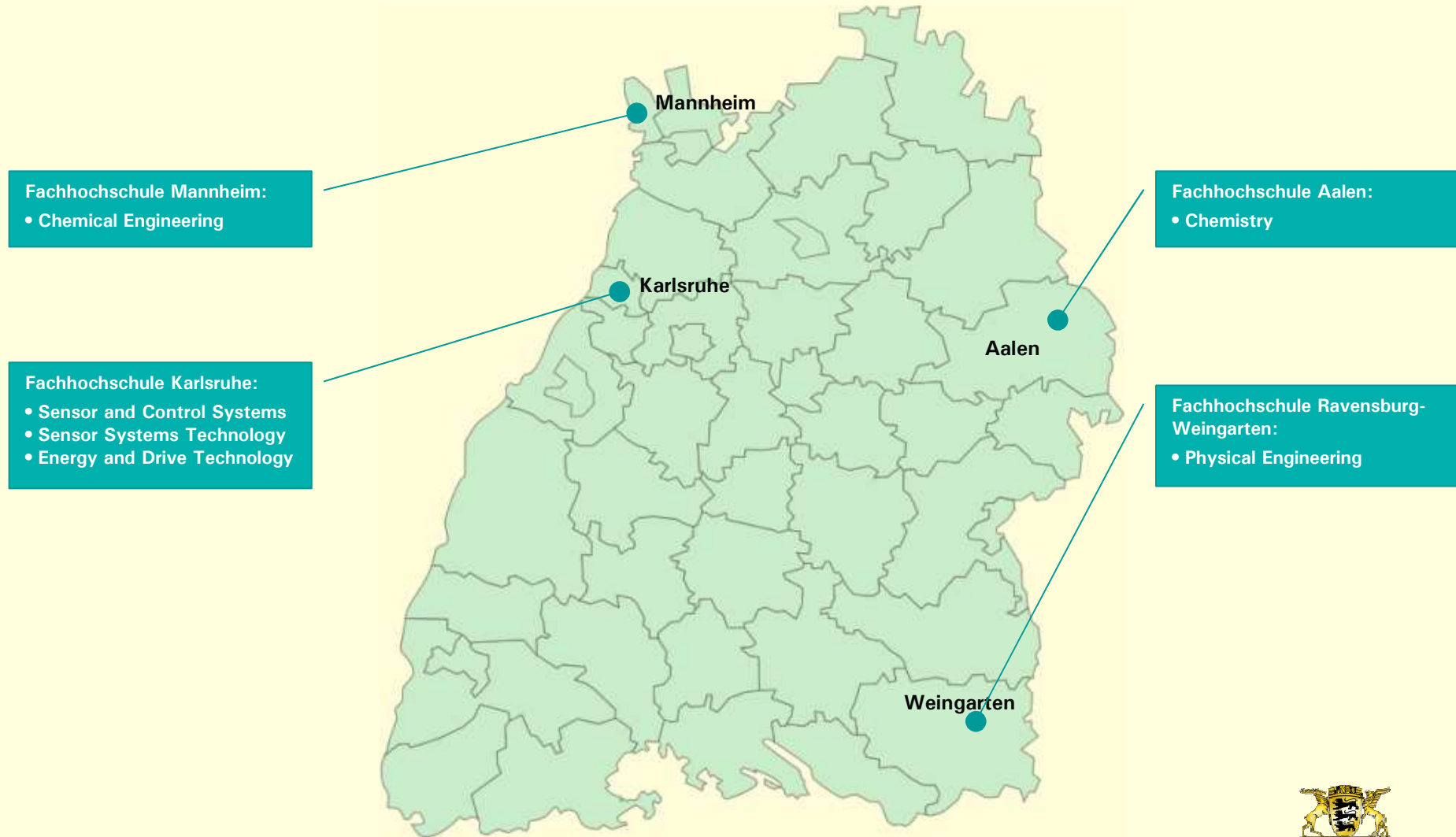
# Fuel Cells – Research Institutes



# Fuel Cells – Relevant Study Courses (Universities)



# Fuel Cells – Relevant Study Courses (Universities of Applied Sciences/Fachhochschulen)



# Fuel Cells – Steinbeis Technology Transfercenters (STZ)



# Fuel Cells – Research



## **Fraunhofer Institute for Solar Energy Systems (ISE), Freiburg**

<http://www.ise.fhg.de>

With its 400 staff, the Fraunhofer ISE is Europe's largest solar research institute, with work ranging from research into the scientific-technical basis of the utilization of solar energy to the development of prototypes and the implementation of demonstration installations. The institute offers planning and consulting services, provides technical know-how and equipment for services.



## **Fraunhofer Institute of Chemical Technology (ICT), Pfinztal**

<http://www.ict.fhg.de>

Fraunhofer ICT in Germany is a unique research and development facility on energetic materials, energetic systems, polymer technology, applied electrochemistry and environmental engineering comprising the entire span from basic research tasks to application investigations and product introduction on behalf of customers' needs.



## **Fraunhofer Institute for Systems and Innovation Research (ISI), Karlsruhe**

<http://www.isi.fhg.de>

With its research and consulting activities, the Fraunhofer-ISI is contributing to solving problems and to the necessary structural changes involved. The preconditions for this are holistic thinking and interdisciplinary and application-oriented research which are traditional strengths of the Institute. The ISI demonstrates the potentials of new technologies, their applications, markets, conditions for diffusion, opportunities and risks. It develops complex and systematic solutions as well as methods and information bases for strategic decision-making processes in industry, science and politics.



# Fuel Cells – Research



## **Fraunhofer Institute for Manufacturing Engineering and Automation (IPA), Stuttgart**

**<http://www.ipa.fhg.de>**

Solutions for organizational and technological functions in the production sector of industrial companies form the main areas of research and development work at the Fraunhofer Institute for Manufacturing Engineering and Automation IPA. The Fraunhofer IPA achieves this objective by developing, testing and piloting methods, components and equipment, through to the implementation of complete manufacturing systems and plant. This majority of this work is carried out under contract to industry. The institute also works on projects funded under public-sector research programs.



## **Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB), Stuttgart**

**<http://www.igb.fhg.de>**

Close cooperation between physicists and chemists, molecular-, micro- and cell biologists and engineers guarantees client-oriented, efficient and innovative answers to biotechnical R&D challenges from test tube to pilot plant.

The successful establishment of new technologies and processes requires the interdisciplinary and constructive cooperation of biological sciences and engineering. The Fraunhofer Institute for Interfacial Engineering and Biotechnology faces these demands with its long-standing experiences in industrial research and its motivated and specifically experienced staff.



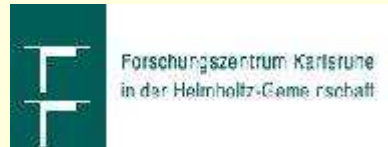
# Fuel Cells – Research



## **DLR Institute for Technical Thermodynamics, Stuttgart**

<http://www.dlr.de/tt>

The Institute of Technical Thermodynamics at the German Aerospace Centre in Stuttgart has additional sites in Köln-Porz and Almeria/Spain. The institute works on the exploitation of highly efficient energy conversion technologies and on the accelerated introduction of renewable energy sources. The work ranges from theoretical studies and basic laboratory work to the operation of pilot plants.



## **Forschungszentrum Karlsruhe**

<http://www.fzk.de>

Forschungszentrum Karlsruhe is one of the biggest science and engineering research institutions in Europe and funded jointly by the Federal Republic of Germany and the State of Baden-Wuerttemberg. Its research and development programs are of public interest and serve peaceful purposes exclusively. They concentrate on the five research areas of Structure of Matter, Earth and Environment, Health, Energy, and Key Technologies. In pursuing these research activities, the Forschungszentrum Karlsruhe cooperates with partners in science and industry. Furthermore, it operates large-scale facilities also for external users.



## **Max Planck Institute for Solid State Research (MPI FKF), Stuttgart**

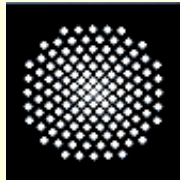
<http://www.fkf.mpg.de>

The institute's research focuses on solid-state physics and chemistry. In particular, it conducts experiments and theoretical research into the physical properties (electrical, magnetic, optical) and the chemical properties (bonding, reactivity) of solid states. Through improved experimental procedures/techniques, new production/manufacturing processes, and sophisticated theoretical concepts, this research aims to establish a better understanding of the relationship between physical properties and structures.



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# Fuel Cells – Research



## **Institute for Energy Management and Rational Energy Applications (IER) University of Stuttgart**

<http://www.ier.uni-stuttgart.de>

The Institute for Energy Management and Rational Energy Applications (IER) focuses on research into: (1) the analysis and assessment of new energy technologies and energy systems, (2) technology assessment and environmental analysis, (3) development of models and decision support systems for energy economics and energy policy, (4) energy system analysis, (5) rational use of energy.



## **Institute for Physical Electronics (ipe), University of Stuttgart**

<http://www.ipe.uni-stuttgart.de>

The Institute for Physical Electronics (ipe) conducts research and offers courses in micro and optoelectronics, thin-film technology and semiconductor physics. Currently, the center is developing new concepts and identifying new applications for photovoltaics and large-area electronics (macro electronics).

**Institut für Werkstoffe  
der Elektrotechnik**

## **Institute of Materials for Electrical Engineering, University of Karlsruhe**

Materials play a central role for the technical and economic progress. Their employment determines the innovation degree of modern technologies such as information -, energy -, traffic -, manufacturing -, environmental and medical technology. So many innovations in electro-technology could be realized only on the basis of new materials and finishing techniques. The materials development and its use in systems become therefore one of the key fields of the industrial technology of the 21. Century with a high strategic meaning outstandingly.



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# Fuel Cells – Research



## **Institute for Polymer Technology (IKT), University of Stuttgart**

**<http://www.ikt.uni-stuttgart.de>**

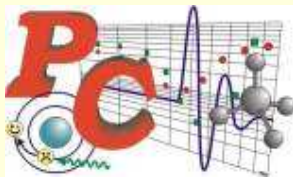
IKT's teaching and research focuses on the production and processing of polymers, the design of plant and equipment for manufacturing/processing polymers, fluid mechanics, rheology and rheometry. The recycling of polymers also plays an important role.



## **Institute of Chemical Process Engineering, University of Stuttgart**

**<http://www.icvt.uni-stuttgart.de>**

Main fields of research and teaching are: Chemical Reaction Engineering, Physico-chemical operations including Membrane Technology, Apparatus and Plant Design and Technology. Special emphasis is laid upon mathematical modelling and numerical simulation of the considered processes in direct combination with a detailed experimental analysis. Research activities in Chemical Reaction Engineering cover fixed-bed and monolithic reactors for catalyzed gas-phase reactions under steady state and dynamic operating conditions, especially for high temperatures.



## **Institute of Physical Chemistry, University of Stuttgart**

**<http://www.ipc.uni-stuttgart.de>**

The Institute of Physical Chemistry comprises two chairs, one research group for "Photochemistry" and one research group for "Chemistry of the lower atmosphere". The institute investigates amorphous systems, e.g. molten salts, molecular liquids, sols/gels and super-critical systems at high pressure, and deals with structure and kinetics of organic radicals in the solid, liquid and gaseous state and with the dynamics of organic adsorbates on surfaces, thereby using the methods of electron- and muon-spin-resonance. The physical chemistry on liquid crystalline systems and the kinetics of gas-phase reactions are further research subjects.



# Fuel Cells – Research



## **Institute for Sanitary Engineering, Water Quality and Solid Waste Management, University of Stuttgart**

<http://www.iswa.uni-stuttgart.de>

The Institute for Sanitary Engineering, Water Quality and Solid Waste Management was already dealing in the Fifties with problems of water quality, water supply, wastewater disposal and solid waste disposal, long before the investigation of environmental problems was common. The main objectives of the institute are teaching, research and the assistance of federal and state ministries and agencies, and of communities and industries in solving practical problems, for example by means of pilot plant experiments or by working out the basic data and concepts for the planning and design of plants.



## **Institute for Thermodynamics and Heat Technology (ITW), University of Stuttgart**

<http://www.itw.uni-stuttgart.de>

ITW's research activities concentrate on heat transfer during changes in the aggregate state of matter, on determining the properties of materials, and on developing integrated energy concepts – with a particular emphasis on solar heating systems.



## **Institute for Polymer Testing and Polymer Science (IKP), University of Stuttgart**

<http://www.ikp.uni-stuttgart.de>

The institute focuses on all key aspects of polymers, including strength, aging, and the relationship between manufacturing, morphology, properties (mechanical, dynamic, thermal, emission, permeation) and design. IKP's research concentrates on the fundamentals of polymer engineering and real-world challenges. Not only is it a leading institute when it comes to ensuring that products and processes are environmentally, technically and economically sound, it is also a front runner in rapid prototyping/tooling.



# Fuel Cells – Research



## Department Organic Chemistry III, University of Ulm

Research subjects are: (1) Miniemulsions, (2) Supramolecular aggregats, (3) Monolayers of anchored polymers.



## Department Surface Chemistry and Catalysis, University of Ulm

Research subjects are: (1) surface chemistry / metals (metal epitaxy, adsorption processes), (2) heterogeneous catalysis (model catalysts, fuel cell catalysis), (3) electrochemistry (metal electrodeposition, corrosion), (4) electrocatalysis (reactions in PEM fuel cells).



## Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW), Stuttgart

<http://www.zsw.de>

The Centre for Solar Energy and Hydrogen Research works on the research and development of technologies for the environmentally friendly provision of power, heat and fuel, their realization in marketable products together with industry partners, as well as consulting for producers, users, political decision-makers and associations.

Research focus is photovoltaic materials, batteries and fuel cells.

