

Generation and use of chemical energy carriers from renewables

Renewables can also be used to produce chemical energy sources (especially fuels for the transport industry). There needs to be increased development of strategies for the use of renewables in transport, which requires cost-effective and efficient chemical energy sources. However,

before such energy sources can be employed, priority should be given to greatly enhancing the efficiency of the vehicles that are used. The European Union's target is to raise the share of biofuels in petrol and diesel consumption from today's figure of 0.2% to 5.75% by 2010.



Fuels made from biomass



Fuel cells



Hydrogen from renewable sources

Fuels made from biomass

UFOP e. V.



Biofuels can be used both as substitutes for fossil fuels in present-day vehicles and to supply fuel cells in mobile and stationary applications. The extraction of hydrogen-rich energy sources from biomass can thus be seen as one building block in the long-term wider prospects for hydrogen.

When biomass is used as a source of energy, carbon derived liquid fuels can be extracted in conversion processes which are practically carbon-neutral. Biomass as a source of heat, fuel, and electricity has great development potential thanks to its high overall degree of efficiency. The optimized supply of electricity, heat, and fuels – called “polygeneration” – is especially promising because it provides a carbon-neutral energy source for the transport sector. Some 75 % of the energy stored in biomass can be made available as chemical energy – hydrogen – when biomass is gasified into synthesis gas. Compared to the use of biomass as vegetable oils (such as “biodiesel”) or in biochemical processes (such as bio-ethanol), this method is a very efficient way of converting bioenergy into fuels. Biomass is therefore an excellent first step towards a sustainable scenario for the liquid fuel sector.

Research and development requirements

- Production methods for carbon fuels from biomass
- Synthesis gas with the highest possible hydrogen content from biomass
- Gas reformation for the use of synthesis gas and fuel cells
- Optimization of energy efficiency through the cogeneration of electricity, heat, and fuels
- Investigation of suitability for various energy systems such as internal combustion engines, fuel cells, combined heat and power (CHP) plants
- System technology investigations, optimization of process management and heat management
- Better consumer acceptance thanks to lower toxicity of processes and a greater overall safety
- Basic research into the production of hydrogen from bio-resources
- Interface technologies for a future hydrogen economy

Contact:

DLR

Dr. Rainer Tamme

Phone: +49 (0) 711/

6862-440

email: rainer.tamme@dlr.de

ISET

Dr. Bernd Krautkremer

Phone: +49 (0) 6181/

58-2707

email: bkrautkremer@

iset.uni-kassel.de

Fraunhofer ISE

Dr. Thomas Aicher

Phone: +49 (0) 761/

4588-5194

email: thomas.aicher@

ise.fraunhofer.de

ZAE Bayern

Prof. Dr.-Ing.

Hartmut Spliethoff

Phone: +49 (0) 89/

329442-10

email: spliethoff@

muc.zae-bayern.de

ZSW

Dr. Michael Specht

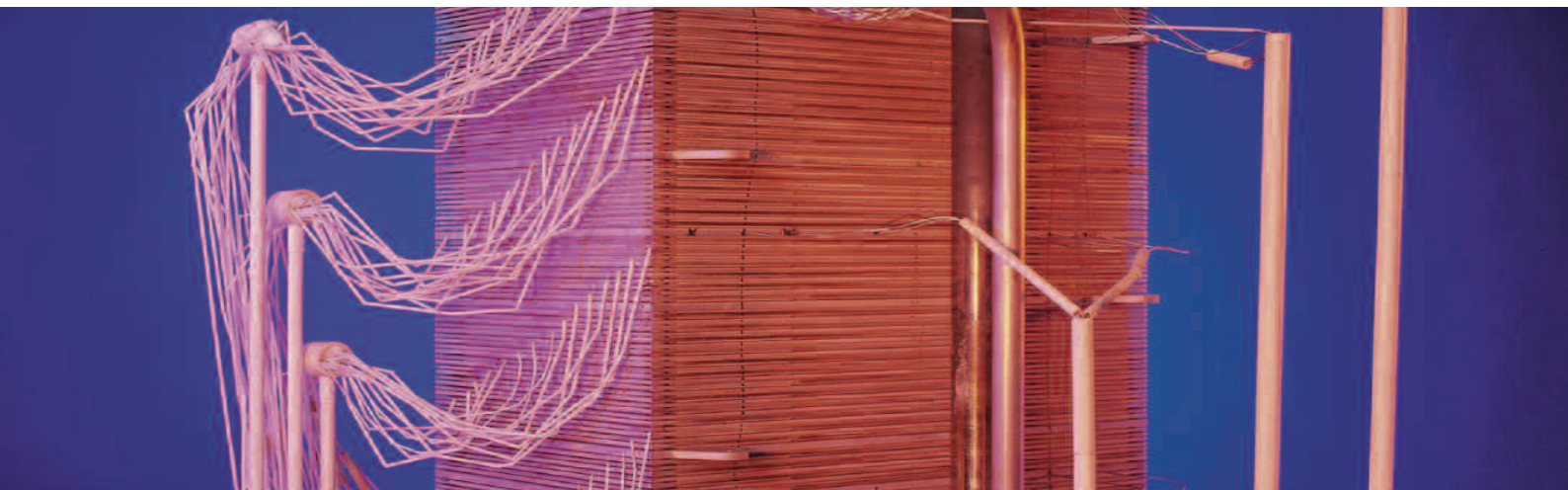
Phone: +49 (0) 711/

7870-218

email: michael.specht@

zsw-bw.de

Fuel cells



Contact:

DLR

Prof. Dr. Hans Müller-Steinhagen

Phone: +49 (0) 711/ 6862-358
email: hans.mueller-steinhausen@dlr.de

Prof. Dr.

Andreas Friedrich

Phone: +49 (0) 711/ 6862-278
email: andreas.friedrich@dlr.de

Fraunhofer ISE

Dr. Christopher Hebling

Phone: +49 (0) 761/ 4588-5195
email: christopher.hebling@ise.fraunhofer.de

Fuel cells are considered to be the energy converters of the future because in principle they achieve particularly high levels of electrical efficiency, a high overall utilisation ratio with simultaneous use of heat, and especially low pollutant emissions. They can operate both with hydrogen and with hydrocarbon fuels (after reformation) and are suitable both for decentralized electricity and heat supplies and for powering electrical vehicles. One highly promising possibility is onboard electricity generation in vehicles and on aeroplanes in place of the units currently used. This will enable considerable fuel savings and performance increases.

However, when the carbon emissions are considered, fuel cell operation based on fossil energy sources still won't bring any great relief to the climate system. For a sustainable improvement in CO₂ emissions, it is therefore essential to replace fossil energy with renewables for providing hydrogen.

The first experiments with car and bus fleets are now taking place worldwide, as well as field trials for supplying energy to buildings, in order to demonstrate their technical feasibility. Japan has begun the first phase of market launch for energy supply in households with 500 units. Germany and other countries are also stepping up product development. Field tests provide a number of insights into daily operation that can then be incorporated into the development of the next generation of products. Furthermore,

inexpensive solutions are being developed both for core components (membrane, catalytic converters, and bipolar plates) and peripheral components (pumps, valves, and sensors).

Considerable R&D efforts are still required to deal with the many open questions that remain, before fuel cells are ready for use, cost-competitive, and ready for market launch. The systems must be made more reliable, efficiency must be maintained over their service life, and service life must be sufficiently long – all of these issues are part of the problems that have to be solved to lower costs.

Research and development requirements

- Development of cost-effective materials (catalysts, membranes etc.)
- Modelling and characterisation of fuel cells to increase their power density and operational reliability
- Development of technical-mathematical models for thermodynamic, electrochemical and mass transport phenomena (material and heat transport/electricity transfer) in fuel cells with the goal of optimizing the design of cells and stacks
- Research into mechanisms of degradation in various incinerator gas compounds
- Development of innovative diagnosis and investigation methods for fuel cells
- R&D into compact, cost-effective reformation technologies (e.g. natural gas and diesel) to take advantage of current energy source infrastructure as a transition technology
- Development of fuel cells suitable for synthesis gas ($H_2 + CO$)
- Development of “reversible” fuel cells/ electrolyser systems
- Improvement of low temperature fuel cells (PEFC)¹ for direct feeding and efficient transformation of methanol and related alcohols
- Further development of SOFC² and MCFC³ fuel cells for higher power densities and various fuels
- Development of control strategies for fuel cells in hybrid systems
- Development of serial production methods for all fuel cell components in order to lower costs
- Fuel cell system technology, particularly power converter technology, remote status diagnosis and error forecasting, and optimised grid integration

FZ Jülich

Prof. Dr. Detlef Stolten

Phone: +49 (0) 2461/

61-3076

email: d.stolten@

fz-juelich.de

Dr. Robert

Steinberger-Wilckens

Phone: +49 (0) 2461/

61-2052

email: r.steinberger@

fz-juelich.de

HMI

Prof. Dr.

Helmut Tributsch

Phone: +49 (0) 30/

8062-2247

email: tributsch@hmi.de

ISET

Peter Caselitz

Phone: +49 (0) 561/

7294-332

email: pcaselitz@

iset.uni-kassel.de

ZAE Bayern

Prof. Dr. Ulrich

Stimming

Phone: +49 (0) 89/

329442-10

email: stimming@

muc.zae-bayern.de

ZSW

Dr. Ludwig Jörissen

Phone: +49 (0) 731/

9530-609

email: ludwig.joerissen@

zsw-bw.de

¹ Polymer Elektrolyte Fuel Cell

² Solid Oxide Fuel Cell

³ Molten Carbonate Fuel Cell

Hydrogen from renewable sources



Contact:

DLR

Prof. Dr. Hans Müller-Steinhagen

Phone: +49 (0) 711/ 6862-358
email: hans.mueller-steinhagen@dlr.de

Dr. Christian Sattler

Phone: +49 (0) 2203/ 601-2868
email: christian.sattler@dlr.de

ZSW

Dr. Michael Specht

Phone: +49 (0) 711/ 7870-218
email: michael.specht@zsw-bw.de

Fraunhofer ISE

Dr. Tom Smolinka

Phone: +49 (0) 761/ 4588-52124
email: tom.smolinka@ise.fraunhofer.de

Renewable energy sources have the greatest potential for the sustainable production of hydrogen. Usually, hydrogen is made from biomass or generated by means of electrolysis, with electricity and heat produced from renewable sources. If the electricity market is developed extensively for renewables (share >50%), the availability of low-cost electricity could mean that the use of electrolysis for the energy industry will become economically viable. Then, electrolysis could be inexpensive and solar-compatible.

Concentrator solar power systems are also increasingly becoming interesting. They directly convert sunlight thermochemically into combustible fuels with very high conversion efficiencies. The reformation of methane from synthesis gas is the most advanced concept of such solar chemical processes.

Today, hydrogen is mainly made from natural gas, with large quantities of hydrogen also being created in the chemicals industry. The generation technologies used to serve as intrigue technologies towards a hydrogen energy system based on renewable sources. Advanced synthesis gas methods that already provide a very high level of hydrogen content at little process temperatures in a single gasification stage represent a new entry point for the

production of hydrogen from biomass, and hence decentralized production for mid-size power generators.

Research and development requirements

- Development of synthesis gas production with high hydrogen content
- Solar-chemical procedures to reform methane in concentrator solar power units
- Direct water-splitting by means of thermochemical circulation processes for the production of solar hydrogen
- Solar heat to support high-temperature electrolysis for the production of hydrogen
- Highly efficient pressure electrolysis with small-scale units
- Development of inexpensive materials, such as catalysers' electrolysis units, membranes, gas distribution layers