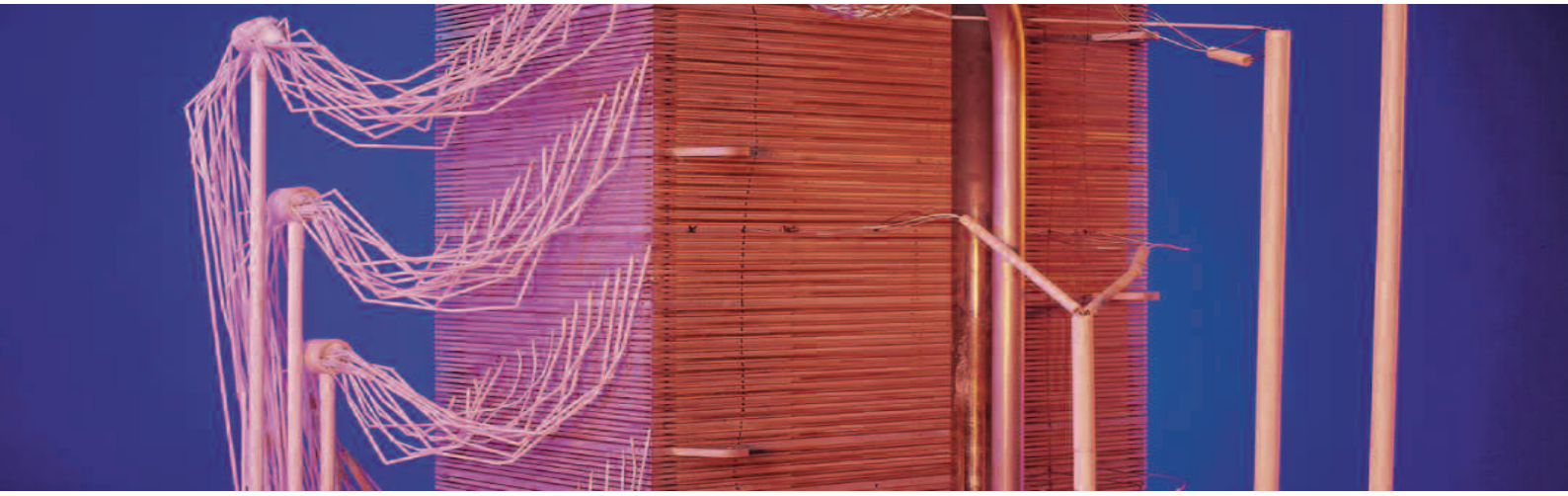
Fuel cells



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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 CO_2 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 SOFC[2] and MCFC[3] 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

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[1] Polymer Elekrolyte Fuel Cell
[2] Solid Oxide Fuel Cell
[3] Molten Carbonate Fuel Cell