One **for all!**

If fuel cells are to have a chance in the race to be the powertrain of the future, all components and sub-systems need further optimisation. So far, however, there has been no universal research platform. This has now moved one step closer with the concept for a generic fuel cell stack developed on behalf of the FVV.

Photos: Dirk Lässig

→ Dr. Joachim Scholta is head of the Fuel Cell Stacks department at the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) in Ulm.

Development of a generic fuel cell stack // 100 kilowatts of power from 304 cells and an active surface of 280 square centimetres on each cell. These figures might sound like the rules of a game, but they are actually the partial results of a fundamental research project that aims to help the fuel cell make the breakthrough in the mobility sector. Commissioned by the FVV, the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) developed the design concept for a generic fuel cell stack. The stack is needed as a research and test platform, as the fuel cell – or, specifically, the low-temperature polymer electrolyte membrane fuel cell used as a vehicle powertrain – needs to be far more cost-efficient in order to succeed in the market. To this end, the performance output per cell needs to be increased further.

»This is not just an issue regarding the cells themselves,« explains Dr. Joachim Scholta, who is responsible for the Fuel Cell Stacks department of the ZSW. »It requires the entire system to be optimised.« After all, combustion engines, too, achieve their high power density not only from optimised combustion in the cylinder, but also through carburation which has been refined over decades, especially regarding turbocharging and injection.

A fuel cell engine comprises similarly complex subsystems, for example to compress or humidify the feed air. Although the often-used collective term of ›peripheral systems‹ makes them sound marginal, they have a decisive impact not only on the performance of the cells, but also on their life cycles. As such, unequal hydrogen distribution across the cell membranes can result in premature ageing. Pollutants in the intake air also cause the catalyst material – usually platinum – to degrade prematurely. Greater knowledge of the relationship between pollutant input, filtration and ageing behaviour could help to reduce the amount of the precious metal needed. The problem when developing filters, compressors and other components is that testing has previously generally only been performed on commercially available fuel cell systems. For competitive reasons, the manufacturers of these systems often do not provide details on the system specifications, for example the materials used in the cells. As a result, individual test results are often not applicable for further research. This is exactly the problem the research project, sponsored by the FVV, aims to solve.

»With a generic stack, fundamental phenomena can be investigated in a reproducible way,« comments Dr. Jan Haußmann from Schaeffler, who led the accompanying working group. As is typical for the work of the FVV, the working group did not simply let the Ulm researchers start developing, but instead incorporated the view of the industry that was to use the technology at a later stage. Accordingly, a basic question had to be answered first – what performance and dimensions are required of a low-temperature fuel cell if it is to cover as many applications as possible later? The researchers initially conducted a survey of the FVV member companies to gauge opinions, which were then discussed intensively in the working group. It quickly became clear that the high level of power density required can only be achieved with metallic bipolar plates. Another advantage of these plates over the graphite plates also investigated at the beginning is that they can be manufactured in a forming process, thus enabling short cycle times in later series production.

After making this fundamental decision, the ZSW developed a design concept that, for example, defines the active surface area per cell. The concept was then successfully validated on the basis of initial simulations – such as the flow in a single cell. »A certain level of robustness was important to us,« explains Scholta, »because the unit needs to withstand a great deal later on in long test series.« The complete design of a generic stack is the subject of a planned follow-up project. If everything goes well, a first prototype could be available as early as the start of 2022.

However, this will need to be tested thoroughly. From 2023, the researcher hopes that a generic stack will be available for all research on the system behaviour of fuel cells. »The stack will then be just as important as the single-cylinder research engine is at the institutes for combustion engines,« adds Scholta. It will be ready just in time to accompany the fuel cell on its journey from small to large series. Dr. Scholta, who has been researching fuel cells for 30 years, is certain that ›cold‹ hydrogen combustion in the low-temperature cell will be an important technology in the future. He regularly drives fuel cell vehicles and refills them at a fuel pump in front of his institute. »It is all completely unspectacular,« praises the physicist. »The technology works, it is just too expensive right now.« But this could change very soon. //

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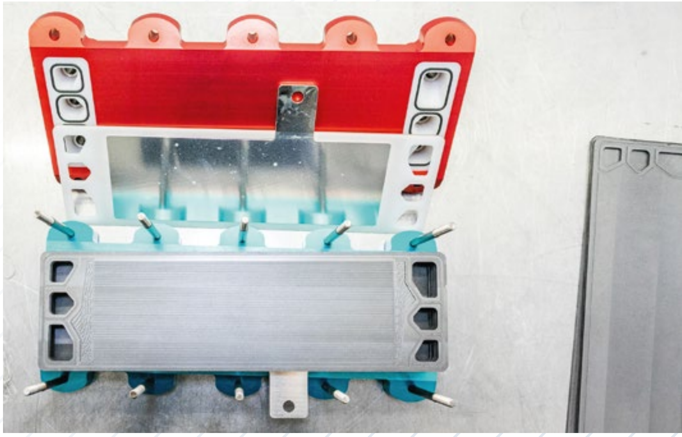
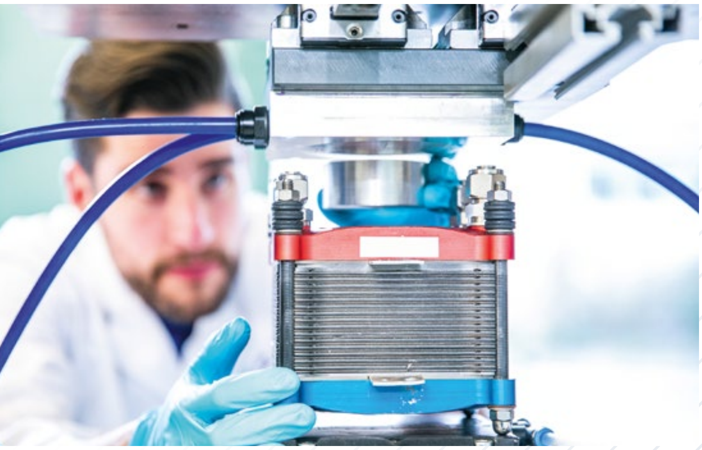
30 years of experience, more than 1,000 stacks – fuel cell research at the ZSW.





Project data

- » Generic Fuel Cell Stack [1366]: Development of a generic fuel cell as a test platform for automotive applications for executing pre-competitive fundamental research on PEM fuel cells in mobile use «
- **PROJECT FUNDING**
  € 100,000 // FVV
- **PLANNING GROUP**
  PG 7 › Fuel Cells‹
- **PROJECT COORDINATOR**
  Dr. Jan Haußmann, Schaeffler Technologies
- **RTD PERFORMER**
  Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW)

VIDEO ABOUT THE PROJECT