Producing green hydrogen efficiently: BMBF funds German-Canadian collaborative project at the University of Bayreuth

Increasing the efficiency and reliability of electrolysis plants is the goal of a new international joint project at the Centre for Energy Technology (ZET) at the University of Bayreuth. Together with a German industrial partner and four Canadian partners from industry and academia, novel models as well as hardware and software applications are being developed to reduce costs in the production of green hydrogen. The German Federal Ministry of Education and Research (BMBF) is funding the project for three years, and the University of Bayreuth will receive a total of about 250,000 euros.

In future energy systems, green hydrogen has a key function in decarbonization and the coupling of all sectors. The European Union has therefore set itself the goal of producing ten million tonnes of green hydrogen in its own member countries by 2030 and importing another ten million tonnes. This can only be achieved if efficient, reliable and competitive technologies are available. Particularly suitable for the production of green hydrogen on a large scale are electrolysis plants whose mode of operation is based on the proton exchange membrane (PEM). These PEM electrolysis plants are already being used commercially on a megawatt scale. They offer fast reaction times and can be operated very flexibly. As a result, highly fluctuating power generation from sustainable energy sources such as solar or wind can be directly coupled with PEM electrolysis plants. However, this large dynamic can cause the electrolysis cells, which are combined into stacks, to age prematurely. As a result, the lifetime and the performance of the plant as a whole are also reduced. So far, it is not possible to predict these processes on an industrial scale depending on the mode of operation: the processes involved in electrolysis are complex, and long-term operating experience is limited.

This is precisely where the BMBF-funded German-Canadian joint project "Modeling of electrolysis plant to inform improved electrolyser efficiencies" – in short: "Hyer" – comes in. Together, the research partners want to develop a digital techno-economic model of a PEM electrolysis plant coupled with renewable energy systems and characterized by a dynamic mode of operation. In conjunction with hardware and software applications, this model will enable aging processes and performance degradation to be predicted with high accuracy. As a result, operating strategies can be optimized while taking lifetime into account. To this end, the envisioned model will also include the digital twin of a stack, which will accurately represent the adverse consequences of dynamic operation on the electrolytic cells.

Researchers from the Institute for Integrated Energy Systems at the University of Victoria and the National Research Council Canada (NRC) will work on the development of the digital twin using artificial intelligence and machine learning methods. The experimental data needed for modeling will be provided by the Hydrogen Research Institute at the Université du Québec à Trois-Rivières, which is collaborating with the NRC to manufacture, analyze and characterize novel stacks. These stacks will be tested and accelerated aged in a test bench developed specifically for the "Hyer" project at SEGULA Technologies GmbH in Rüsselsheim, Germany. For the electrochemical characterization of the stacks, the Toronto-based start-up Pulsenics Inc. will provide the necessary technical solutions.

Under the leadership of Prof. Dr.-Ing. Dieter Brüggemann, director of ZET, the Bayreuth-based team will handle the techno-economic simulation and optimization of the PEM electrolysis system. "Our goal is to find a good compromise
between a long lifetime and high flexibility of the electrolysis plant. Project developers and plant operators, for example, will also benefit from the model, as it enables predictable cost-optimized plant operation through data-driven control and operating strategies” says Brüggemann and emphasizes the strong international and interdisciplinary collaboration in the new joint project: “The long-standing German-Canadian partnership in science, technology and innovation has become even more important with the current energy crisis. The two countries complement each other perfectly in their objectives to limit climate change, which is evident not least in the establishment of the German-Canadian Hydrogen Alliance. In the project, the partners contribute their expertise in a wide range of fields – from materials research to the simulation of energy systems using the latest methods. This allows solutions to be developed that would not be possible without this exchange.”

Matthias Welzl, who played a key role in preparing the project at ZET as coordinator for hydrogen research and technologies, is coordinating the German project partners. He adds: “For more than a year, we have been working intensively together on the design of the project. In the process, close contact developed in particular with the two project managers of our industrial partners, Mariam Awara and Dr.-Ing. Stephan Wagner.” Mariam Awara is COO and co-founder of the Canadian start-up Pulsenics Inc. whose electrochemical monitoring and control system is the basis for the implementation of the project. She was recognized for the successful founding of Pulsenics Inc. in the “Manufacturing & Industry” category on the “Forbes 30 Under 30” list in 2022. Stephan Wagner will lead the work at SEGULA Technologies GmbH as a project engineer and expert in hydrogen technologies. Welzl describes the further plans: “Soon we will travel to Canada to meet the other partners in person and officially start the project work with a kickoff workshop.”

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German-Canadian research collaboration: Mariam Awara of Pulsenics Inc, Matthias Welzl of the Centre for Energy Technology at the University of Bayreuth and Dr.-Ing. Stephan Wagner of SEGULA Technologies GmbH (left to right) at f-cell 2022 in Stuttgart.

Photo: SEGULA Technologies GmbH