



**Deutsches Zentrum
für Luft- und Raumfahrt**
German Aerospace Center

Institute of Engineering
Thermodynamics

Germany

The operational behaviour of the core technology

Via experiments and simulations the operational behaviour of the core technology of SWITCH was analysed. The full operational envelope for SWITCH was demonstrated. The capability of switching between modes has been shown.

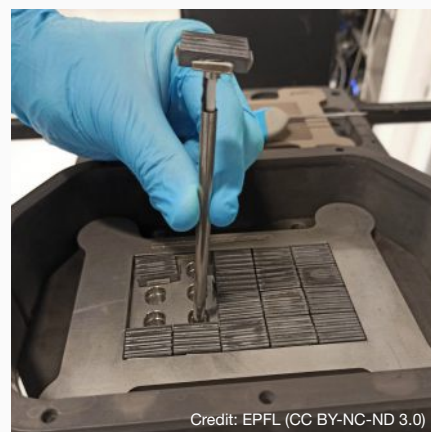
Experiments in steady state and transient operation were performed on different levels from cell to module level during electrolysis and fuel cell mode.

The latter mode can also be defined as polygeneration mode as not only electricity is produced but also hydrogen and heat.

A segmented cell-test characterization was performed by EPFL:

- Gaining insights to local thermal and electrochemical behaviour.
- For investigating local long-term degradation in real operating conditions with daily switches between electrolysis and fuel cell mode and advanced electrochemical characterization in a **durability test of more than 1000 hours**.
- Post-test examinations via SEM and EDX **confirmed the safety of the switching procedure** and no severe damage.

Durability test
1000_h



Credit: EPFL (CC BY-NC-ND 3.0)

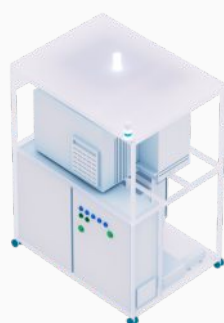
Segmented test rig



A 70 cell-stack was successfully investigated by FBK:

- Investigating the thermal behaviour and **mapping the performance up to 8 kW_{el} power input**.
- Investigating and successfully demonstrating possible switching control and thermal control strategies.
- Studying the effect of temperature and the steam utilization factor, and thermoneutral operation on the performance of the Solid Oxide Electrolyzer (SOE).

8 kW_{el}
power input



Credit: FBK (CC BY-NC-ND 3.0)

Stack tested
in FBK Laboratories



A large stack module with 25 kW_{FC} and about 77 kW_{EC} was tested at DLR:

- Successful demonstration of the targeted operational range and production capacity of 24 kg/day to 54 kg/day of hydrogen in electrolysis mode and mapping of the operational range with reactant conversion ratios between 35% to 90% with core temperatures between 680°C and 760°C.
- Demonstration of 11-22 kW_{FC} of power output with about 12 kg/day to 30 kg/day of hydrogen production within polygeneration mode.
- Testing of switching procedures and development of a transient model for further simulative investigations.



Credit: DLR (CC BY-NC-ND 3.0)

Large test rig GALACTICA at DLR laboratories



77 kW_{EC}
power input

54 kg/day
of hydrogen
production

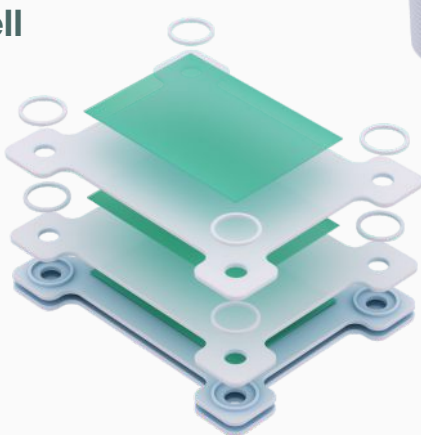
Module



Stack



Cell



Graphical presentation of the experimentally tested scales of SOC technology