

Effizientere Herstellung von SAF über Hochtemperaturelektrolyse (SOEC)

Nachhaltige Flugtreibstoffe für Österreich Nationaler Vernetzungsworkshop 07. September 2022, 10:00 – 17:15 AirportCity Space, Towerstraße 3, 1300 Wien-Flughafen

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AVL List GmbH (Headquarters)

Topics

- **1** SOEC Technology for Hydrogen and eFuel Production
- **2** SOEC Technology for eFuel production
- **3** PtL Demonstration Plant Project

AVL Fuel Cell Global Footprint

- H₂ & fuel cell development since 2002
- H₂ & Fuel Cell Tech-Centers
 - Graz, AT

Public

Vancouver, CA

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- Kecskemet, HU
- Warsaw, POL new
- Remscheid, GER new
- About 600 engineers in engineering, testing & simulation
- More than 170 granted or applied patent families



Hydrogen & Fuel Cell Test & Development Center - Graz / Austria



AVL Fuel Cell Canada - Vancouver / Canada



Large Scale Fuel- and Electrolyzer System Testing - Remscheid / Germany

AVL Solutions for H₂ Ecosystem Implementation



High-performance PEM Systems

- Passenger car
- Truck, Bus & LCV
- Marine
- Rail
- Aviation

PEM...Polymer Electrolyte Membrane SOFC...Solid Oxide Electrolyte Fuel Cell SOEC...Solid Oxide Electrolyzer Cell



SOFC Decentral Power Generation

- Distributed Power
- Marine
- Datacenter & critical infrastructure
- Fast Charging of BEVs
- Combined Heat & Power



Power-to-X Systems

- SOEC Development
- PEM EL system integration
- e-Fuel production
- Reversible electrolyzer/fuel cell systems
- Overall plant & process engineering





SOEC Technology for Hydrogen and eFuel Production

Overview of Electrolysis Technologies

	Alkalino	DEM	SOFC
	Aikainie	PEM	SOLC
Status	Mature		R&D
Market Share	>90%	<10%	0%
Temperature	Amb-120 °C	Amb-90°C	600-800 °C
Pressure	1-200 bar	1-350 bar	1-25 bar
Dynamics	weak	good	medium
Cost and efficiency outlook 2030			
CAPEX	370-800 EUR/kW ¹⁾	250-1270 EUR/kW ²⁾	300 - 800 EUR/kW ³⁾
OPEX	2-5 % ²⁾	2-5 % ²⁾	2 % 2)
Efficiency	48-63 kWh/kgH ₂ ¹⁾	44-53 kWh/kgH ₂ ¹⁾	36-43 kWh/kgH $_{2}^{1)}$
Efficiency	53-69 % ¹⁾	63-76 % ¹⁾	77-92 % ¹⁾
 ¹⁾ Source: FCH-JU ²⁾ Of CAPEX p.a. ³⁾ AVI 	PEMPolymer Electrolyte Membrane SOECSolid Oxide Electrolysis Cell		





PEM-EL



Alkaline



Source: McPhy

SOEC combines low cost potential with highest efficiencies as a basis for economic e-fuel production

SOEC Reference Project: 1MW SOEC Electrolyzer



ceres

NEWS

Ceres and Shell sign agreement for green hydrogen 28 June 2022

Megawatt scale demonstrator to be located in Bangalore, India

• Aim to deliver low-cost green hydrogen for industrial decarbonisation

- 1MW Solid Oxide Electrolysis System
- Size: 40ft Container
- Steam electrolysis
- Target Efficiency:
 - ~80% with water input
 - ~90% with steam input
- Tests start in Sept. 2022
- First field deployments in early 2023

Industrialization of SOEC in Austria



European Commission Hydrogen IPCEI initiative



Establishment of a SOEC Electrolyzer production in Austria



SOEC Technology for eFuel production



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Innovative Process for eFuel Production

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Efficiency Improvement of eFuel Production



e-Fuel Production Cost



SOEC FT Process enables 20-30% lower production cost of e-Fuel



SOEC Power-to-X Routes

SOEC improves the efficiency of all major eFuel production routes significantly

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PtL Demonstration plant in Austria



SOEC Power-to-Liquid Demonstration Plant



- 200kWel SOEC capacity
- ~100.000l production capacity of e-fuels per year
- Focus: SAF (sustainable aviation fuels)
- Demo in 2023
- >30% Efficiency Improvement in e-fuel production





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Project Scope Phase 1 - IFE

- In the first project phase a 200kW plant will be designed and developed.
- The result is a plant ready for order, which will be built and operated in the second project phase.



Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie



Operation Strategy for Demonstration Plant

- Degradation effects on SOEC stack during demonstration
 - e.g., due to an increase of the area specific resistance (ASR) of the stack a higher cell voltage is needed to keep the product yield
 - Higher temperature level at SOEC stack
 more cooling needed
- Keep the PtL efficiency of > 55% and avoid huge cooling demand of the SOEC stack with **part load operation** over lifetime
- Important parameter to keep the efficiency, is the CO₂ conversion rate of the SOEC stack



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Project Scope Phase 2 - HiPoLiq

- Build up of the Power to Liquid Plant at the HQ of AVL in Graz
- 2 years demonstration of the Power to Liquid Plant (mid 2023)





Summary

- SOEC is a key enabler for highly efficient SAF production
 - Decrease the overall system energy demand by $>\!35\%$
- Operation for 200kW PtL demonstration plant at AVL in 2023
- Upscale of SOEC technology within the next years
- Next steps: 3-5MW PtL plant in 2025 and preparation to roll-out PtL industrial plants for SAF production

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