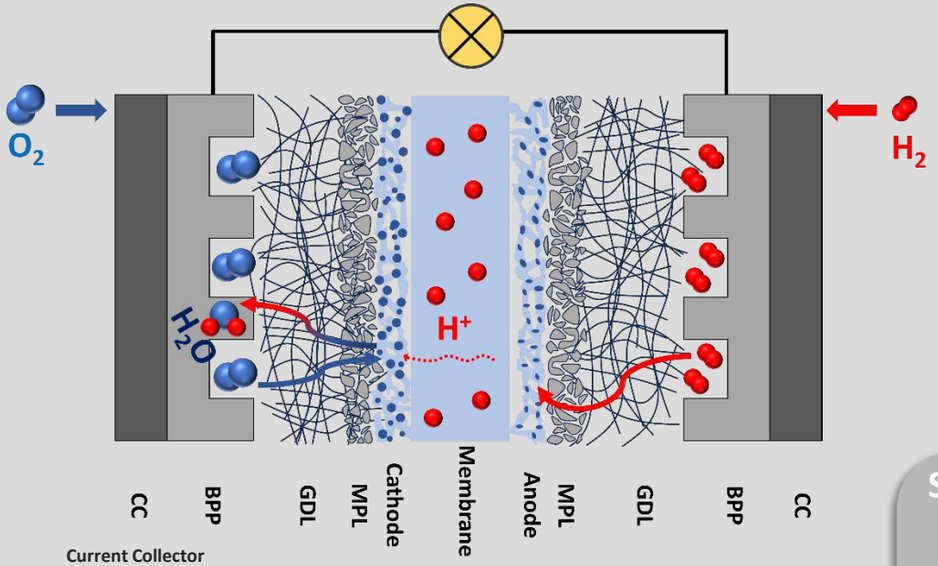
PFAS freie MEA-Entwicklung für Elektrolyse- und Brennstoffzellenanwendungen F-Zero und F-REELY

06.11.2024

Greenerity GmbH

General Overview

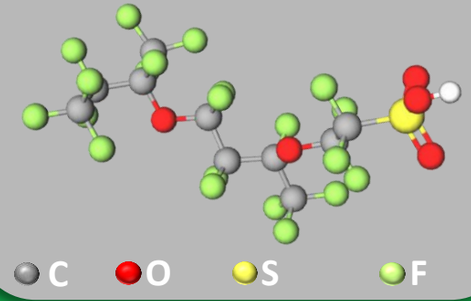
Fuel Cell



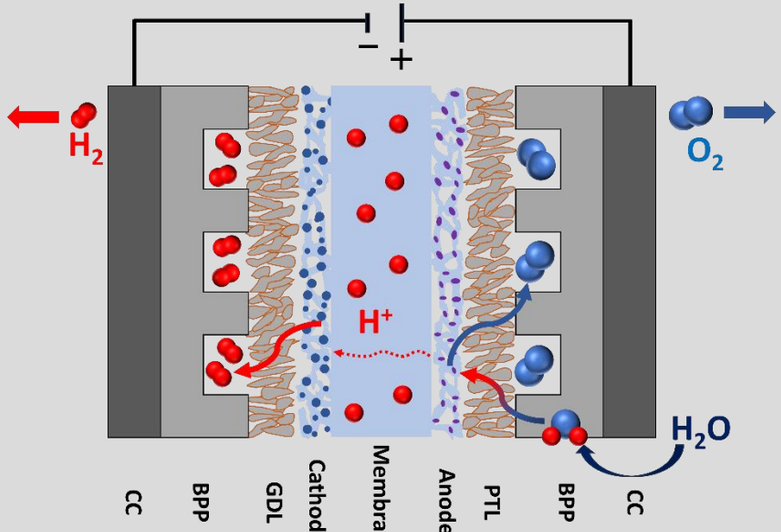
CC	Current Collector
BPP	Bipolar Plate
GDL	Gas Diffusion Layer
MPL	Microporous Layer

1. Use of hydrogen and oxygen gases to generate electricity and water
2. Membrane, binder, microporous layer and gas diffusion layer contain PFAS class materials

Schematic PFSA - Membrane



Water Electrolysis



1. Use of electricity and water to generate hydrogen and oxygen
2. Membrane and binder contain PFAS class materials

PFAS components in PEM – FC and PEM – WE

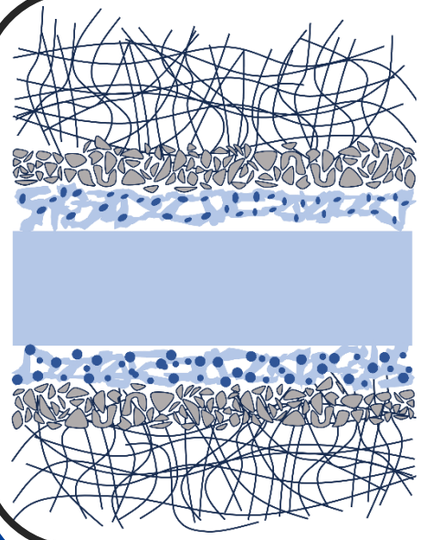
Greenerity®

F-ZERO

Gefördert durch: Bundesministerium für Verkehr und digitale Infrastruktur

Koordiniert durch: NOW-GMBH.DE

Projektträger: Projektträger Jülich Forschungszentrum Jülich

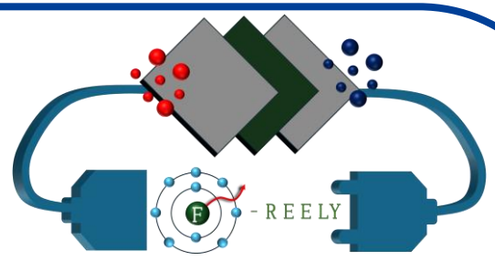


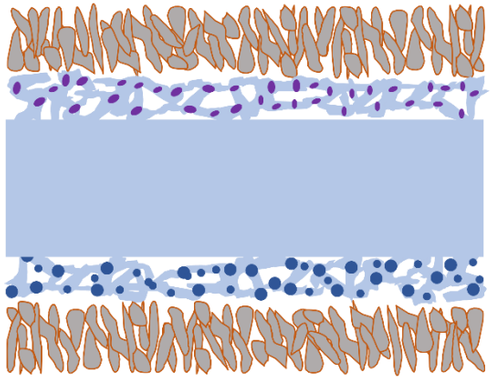
	PFAS	F-Zero
GDL	☑	
MPL	☑	
Anode	☑	●
Membrane	☑	●
Cathode	☑	●
MPL	☑	
GDL	☑	

Gefördert durch: Bundesministerium für Wirtschaft und Klimaschutz

aufgrund eines Beschlusses des Deutschen Bundestages

Projektträger Jülich Forschungszentrum Jülich





	PFAS	F-REELY
PTL		
Anode	☑	●
Membrane	☑	●
Cathode	☑	●
GDL	☑	

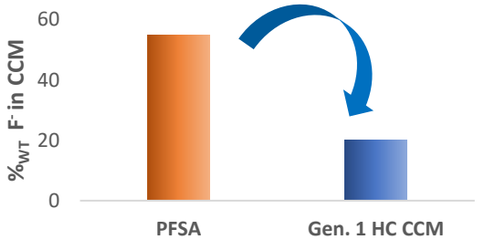
Both projects (F-REELY and F-ZERO) aim for the development of catalyst coated membranes (CCM) where fluorinated materials are substituted by hydrocarbon based technologies

Goals and realization in F-Zero

Greenerity®

Generation 1 HC-CCM with 80% reduction of fluorine content

Percentage F^- content in CCM



① Electrode development → HC membrane = PFSA membrane

② Dry operation comparable to PFSA

③ Mechanical and chemical long term stability

④ Cell reversal tolerance

F-ZERO

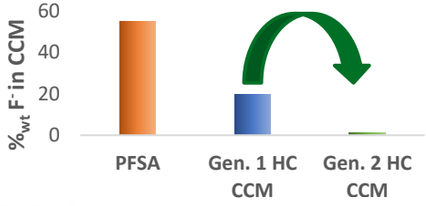
Project time: 12/2023 – 11/2026

Cathode Loading	0.25-0.40 mg_{Pt}/cm^2
Power-specific Loading	0.15-0.31 g_{Pt}/kW
Run Time	30 000 h
Dynamic Stability	25 000 D/W cycles

	TRL (Project start)	TRL (Project end)
Gen 1.	2	5
Gen 2.	2	4

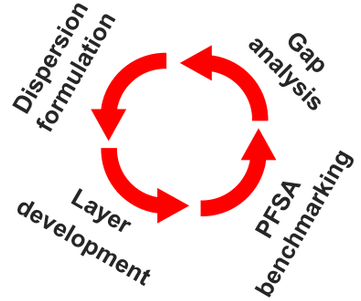
Generation 2 HC-CCM with completete elimination of fluorine

Percentage F^- content in CCM



PFAS - free Cathode layer

PFAS - free Anode layer



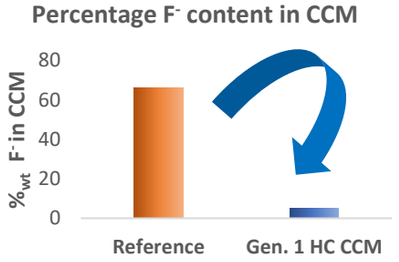
PFAS free CCM

3 Years

Goals and realization in F-REELY

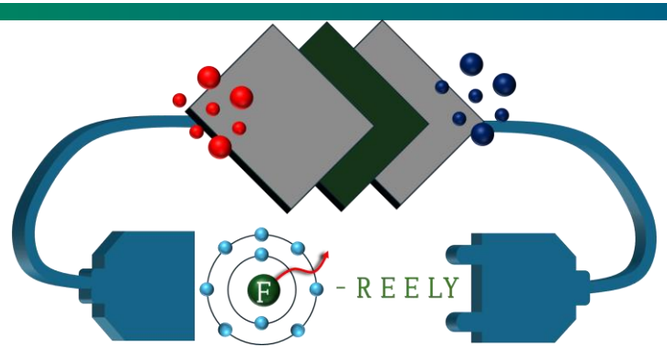
Greenerity®

Generation 1 HC-CCM with 90% reduction of fluorine content



Processing → Failure Analysis → Solution

- Lamination + Assembly → HC-CCM
- Electrochemistry, Mechanical Stability → Screening
- Oxidative Stability, Gas crossover → Mitigation Concepts

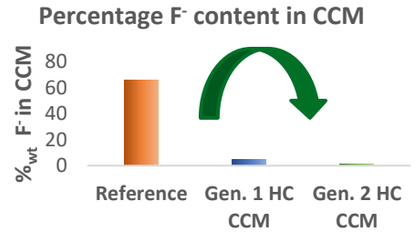


Project time: 10/2024 – 09/2027

Current Density (@1.75 V)	2.8 A/cm²
Run Time	80 000 h
Degradation Rate	≤5 µV/h
Efficiency	≥ 69.5%

	TRL (Project start)	TRL (Project end)
Gen 1.	4	6
Gen 2.	3	5

Generation 2 HC-CCM with completete elimination of fluorine



PFAS–free Cathode layer

Processing → Failure Analysis → Solution

PFAS-free Anode layer

Processing → Failure Analysis → Solution

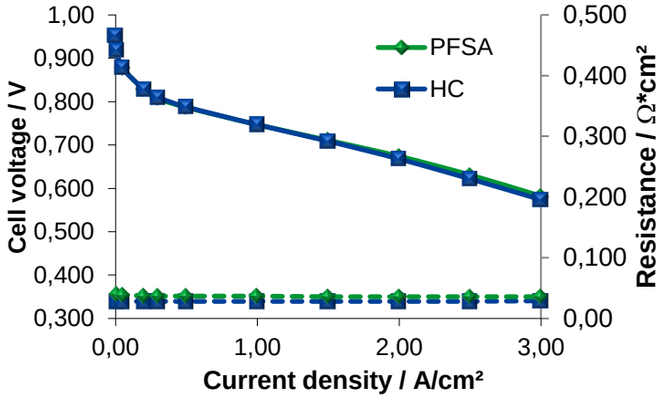
PFAS free CCM

3 Years

F-Zero results

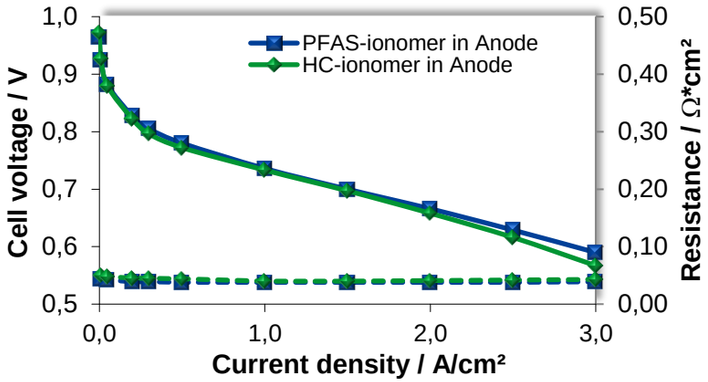
Greenerity®

Performance comparison



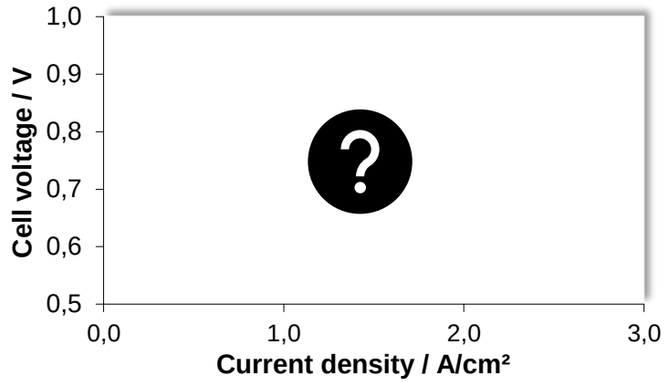
HC and PFSA membrane performance comparable

Anode integration



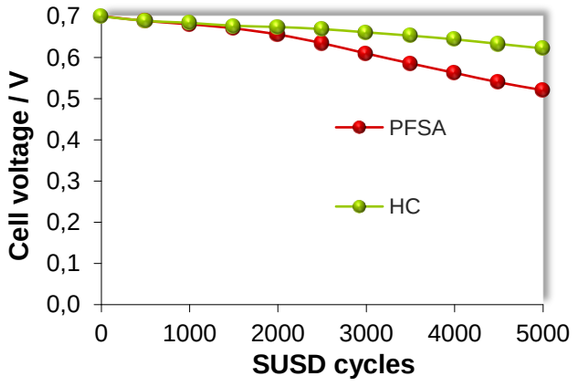
Similar performance achieved with HC ionomer in anode

Cathode integration



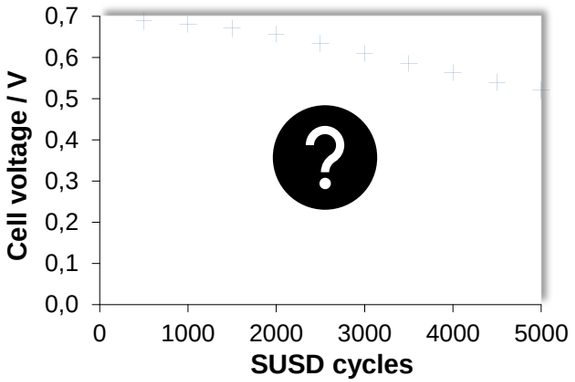
HC ionomer in cathode open for future work in F-Zero

SUSD comparison



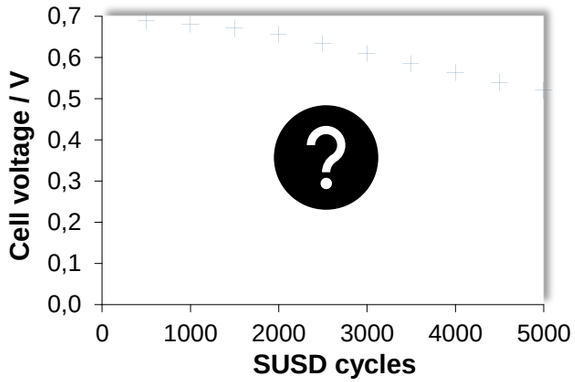
HC membrane voltage degradation less pronounced compared to PFSA membrane

SUSD comparison



Stability with developed anode open for future work in F-Zero

SUSD comparison



Stability with developed cathode open for future work in F-Zero

Greenerity®

Thank you for your attention