GIORNATA NAZIONALE BANDO CLEAN HYDROGEN AWP23 8 Febbraio 2023

Recenti sviluppi per l'elettrolisi a bassa temperatura: Progetti FCHJU2 HPEM2GAS, FCH JU2 ANIONE e CLEAN HYDROGEN ADVANCEPEM

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Water Electrolysis: Dissociation of water molecules into hydrogen and oxygen gases









HORIZON 2020 PROGRAMME FUEL CELLS AND HYDROGEN JOINT UNDERTAKING (FCH 2 JU) TOPIC H2020-JTI-FCH-2015-1 Improved electrolysis for distributed hydrogen production

High Performance PEM Electrolyser for Costeffective Grid Balancing Applications

Coordinator Antonino S. Aricò (CNR-ITAE)



http://www.hpem2gas.eu



PROJET CONTEXT



- As more renewables are being integrated to the grid, there is a need to develop high performance electrolysers to provide superior grid-balancing services and to produce "green" hydrogen for fuel cell vehicles and other applications.
- Hydrogen appears the most appropriate choice for at-scale decarbonization of selected segments in transport, industry, and buildings.
- HPEM2GAS is addressing these aspects to contribute in making hydrogen the future energy carrier.





H2020 HPEM₂GAS Water electrolysis for Distributed Hydrogen Production

The concept and approach were targeted to improve stack performance (180 kW; 75 cells, <u>3 A cm⁻² @ 1.8 V/cell</u>), energy efficiency (82% or 48 kWh/kg H₂), stack lifetime (degradation rate <5 µV/h during 1000 hrs) and reduce system costs (CAPEX < € 1,000/kW for systems of >1 MW) while meeting the technical requirements of electrolysers for the interaction with the grid and renewable energy sources (100% of nominal load per second; minimum load range 5-10%).

integrated system Improved stack design TRL6 HPEM2GAS HPEM2GAS **SSC** Aquivion[®] membranes IRD TRL4 NR Det WD | 500 ser Spot Magn (D 60x Nanostructured * - CF_-CF_-CF_-CF-m* electro-catalysts Enhanced MEAs HPEM2 GAS 5 nm

http://hpem2gas.eu/

Advanced BoP and safety

Extruded vs. Recast Aquivion membranes







Parameter	HPEM2GAS
Stack efficiency /%	81
Current density A cm ⁻² @ 1.8 V	3
PGM loading mg/W	0.3
Temperature °C	75

HPEM₂GAS

() ITM POWER



TAE

Efficiency: 81% at 3 A cm⁻² and 75 °C







HPEM2GAS: Field testing at Emden (Germany)

Emden's ambition is to use 100% renewable energy (electricity and gas) by 2030.

- □ Stadtwerke Emden (SWE) is the local supplier for electricity water and gas.
- Two wind farms have been built in the city of Emden which provides 117% (240 MWh/y) of the electric energy for homes
- □ Photovoltaic panels have been installed on a noise barrier along the motorway.

Current technical limitations of the local grid at the city of Emden are:

- ✓ Need for utilizing excess wind power in specific periods of the year;
- Need to address the congestion of transmission;
- Need to stabilize the electricity grid from frequent fluctuations;
- Need to implement storage technologies for load shifting, peak shaving and to enhance power quality.



Predicted generated wind electricity for Emden region, Germany for a typical week in January 2020.

Reproduced courtesy of the University of Emden.





Planning Field testing at Emden (Germany)





http://hpem2gas.eu/





Setting-up field testing site

Emden, Germany





Location for the installation of the electrolyzer: → Pfälzer Straße, 26725 Emden





Control station



The pressure is reduced to 10 bar at the electrolysis system before the outlet



 ✓ After the check, the hydrogen leaves the control station and enters the gas transfer station
✓ Above-ground pipeline with a DN12 pipe

Hydrogen is fed into the natural gas grid

Mixer has built-in lamellas, so the gas mixture flow is turbulent The gas grid is operated at 8.5 bar, the hydrogen is fed in with a slight overpressure of 10 bar



HPEM2GAS system development and field-testing in Emden (DE)

Energy consumption: 54.2 kWh/kg H_2 at 3 A cm⁻² and 55 °C



Parameter	HPEM2GAS	HPEM2GAS	
	High current	Low current	
	density	density	
System energy consumption kWh/kg H ₂	54	47	
Current density A cm ⁻² @ 1.8 V	3	1	
Temperature	54-56 °C	54-56 °C	









ANION EXCHANGE MEMBRANE ELECTROLYSIS (AEMWE)



H2020 FCH JUANIONE: Anion Exchange Membrane Electrolysis for Renewable Hydrogen Production

Call: H2020-JTI-FCH-2019-1; Topic: FCH-02-4-2019





Cell Potential / V

ANION EXCHANGE MEMBRANE ELECTROLYSIS (AEMWE)





FCH



https://anione.eu/

Electrochimica Acta 413 (2022) 140078



Comparison of PEMWE and AEMWE performance



Z' / ohm·cm²







Call: HORIZON-JTI-CLEANH2-2022-1

Topic: HORIZON-JTI-CLEANH2-2022-01-03

Advanced High Pressure and Cost-Effective PEM Water Electrolysis Technology

PROJECT

Grant Preparation (General Information screen) — Enter the info.

Project number:	101101318				
Project name:	Advanced High Pressure and Co Technology	ost-Effective PEM Water Electrolysi			
Project acronym:	ADVANCEPEM	ADVANCEPEM			
Call:	HORIZON-JTI-CLEANH2-2022-1	HORIZON-JTI-CLEANH2-2022-1			
Торіс:	HORIZON-JTI-CLEANH2-2022-01	HORIZON-JTI-CLEANH2-2022-01-03			
Type of action:	HORIZON-JU-RIA	HORIZON-JU-RIA			
Service:	CLEANH2	ARTICIPANTS			
Project starting date:	fixed date: 1 February 2023	Grant Preparation (Beneficiaries screen) –			
Project duration:	36 months				





Enter the info.

Number	Role	Short name	Legal name	Country	PIC
1	COO	CNR	CONSIGLIO NAZIONALE DELLE RICERCHE	IT	999979500
2	BEN	SLV	SOLVAY SPECIALTY POLYMERS ITALY SPA	IT	999932455
2.1	AE	RHODIA-O	RHODIA OPERATIONS	FR	998153863
2.2	AE	RHODIA-L	Rhodia Laboratoire du Futur	FR	998394811
3	BEN	IRD	IRD FUEL CELLS A/S	DK	998129225
4	BEN	RWE-POWER	RWE POWER AKTIENGESELLSCHAFT	DE	999936529
4.1	AE	RWE-G	RWE GENERATION SE	DE	915069483
5	AP	OORT	OORT ENERGY LTD	UK	887220589
6	AP	HSSMI	HSSMI TRADING LIMITED	UK	886279786

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Thank you for your kind attention !





Institute CNR-ITAE – Messina (Italy)