CLEANER

CLEAN HEAT AND POWER FROM HYDROGEN

Project ID	101137799
PRR 2024	Pillar 4 – H_2 end uses: stationary application
Call topic	HORIZON-JTI-CLEANH2-2023-04-01: Development and validation of high power and impurity tolerant fuel cell systems ready to run on industrial quality dry hydrogen
Project total cost	EUR 3 949 959.50
Clean H_2 JU max. contribution	EUR 3 949 959.50
Project period	1.1.2024–31.12.2027
Coordinator	SINTEF AS, Norway
Beneficiaries	Albert-Ludwigs-Universität Freiburg, Eurogas, Ferrexpo Services LLC, Fondazione Bruno Kessler, National Gas Transmission plc, PowerCell Sweden AB, Pretexo, Schiphol Nederland BV, Teknologian Tutkimuskeskus VTT Oy, Ukrgasvydobuvannya JSC

http://cleaner-h2project.eu

PROJECT AND GENERAL OBJECTIVES

Hydrogen storage in underground salt cavern structures is very limited; there are three in the United States and one in the United Kingdom. Since the hydrogen mainly originates from steam methane reforming (SMR), the purity is around 95 %. Rock caverns (sealed) are being developed, one of them within the Hybrit project in Sweden, where clean hydrogen from electrolysis will be stored. In most geological storage areas and pipelines, hydrogen will be already, or become, contaminated with substances not suitable for use in all types of fuel cells (e.g. N_2, CO, CO_2, hydrocarbons and sulphur compounds). Hydrogen produced through electrolysis is considered clean; the only impurities are oxygen and water. However, other sources of hydrogen, such as natural gas reforming, have impurities remaining from the production process.

While repurification of this H_2 can and should be done for some applications, for example by pressure swing adsorption, it adds cost and complexity, and is not in all use cases economically feasible. Currently, there is no standard for the quality of H_2 coming from geological storage or pipelines, and knowledge of which contaminants are present in hydrogen from these storage sites is extremely limited.

Large-scale stationary fuel cells in the MW range should be able to operate on such industrial-quality H_2 without repurification. They can offer a low-cost clean alternative both for large-scale (peak) power and heat production and for small, medium and large-scale back-up power units for the critical infrastructure, thereby also improving the resilience of the energy system. The H_2 quality standard under development is expected to become around 98 %, with CO and sulphur compounds the main relevant poisoning impurities, in addition to inert gases such as CO_2 and N_2, so the fuel cell systems must tolerate these.

Cleaner will develop:

- lower-cost and impurity-tolerant catalyst materials, mitigating operating strategies to avoid the impact of potential impurities, and evaluation of new fluorine-free membranes;
- a stationary proton-exchange membrane fuel cell system > 100 kW capable of operating with industrial-quality hydrogen.

NON-QUANTITATIVE OBJECTIVES

Ensure economically and environmentally sustainable development of materials, components and system.

FUTURE STEPS AND PLANS

In the first 7 months of the project, Cleaner will perform a hydrogen impurity survey, mapping the potential impurities expected in the hydrogen value chain. This will serve as a basis for the first material development and testing. Preparations are ongoing on the fuel cell system by PowerCell and at the test facilities of VTT. Tests are planned to start during summer 2025.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?	SOA result achieved (by others)	Year in which SOA result was reported
SRIA (2021–2027)	O & M costs	€ct/kWh	< 1.7	⚙	5	2020
	Electrical efficiency	% LHV	52		50	
	Degradation at CI	%/1 000 h	< 0.2		0.4	
	Non-recoverable CRM as catalyst	mg/Wel	< 0.05 gr/kWe for Pt-based catalysts < 0.025 gr/kWe for IrRu single-site catalysts at the anode. Assumptions: Pt catalysts: anode 0.1 mg(Pt)/cm², cathode 0.4 mg(Pt)/cm², Pt recovery rate > 90 % and nr-PGM in the project < 0.05 mg/cm² (i.e. at 1)		0.1	
	Warm start time	seconds	< 15		60	
	CAPEX	€/kW	< 1 000		1 900	
	Availability	%	> 98		98	

Clean Hydrogen Partnership
Co-funded by the European Union