CLEANER

CLEAN HEAT AND POWER FROM HYDROGEN

Project ID	101137799
PRR 2025	Pillar 4 - H_2 End Uses - Stationary Applications
Call Topic	HORIZON-JTI-CLEANH$_2$-2023-04-01
Project Total Costs	3 949 959.50
Clean H_2 JU Max. Contribution	3 949 959.50
Project Period	01-01-2024 - 31-12-2027
Coordinator Beneficiary	SINTEF AS, NO
Beneficiaries	FERREXPO SERVICES LLC, NATIONAL GAS TRANSMISSION PLC, UKRGASVYDOBUVANNYA JOINT STOCK COMPANY, TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, PRETEXO, Powercell Sweden AB, FONDAZIONE BRUNO KESSLER, ALBERT-LUDWIGS-UNIVERSITAET FREIBURG, EUROGAS - EUROPEAN UNION OF THE NATURAL GAS INDUSTRY, SCHIPHOL NEDERLAND BV

http://cleaner-h2project.eu

PROJECT AND GENERAL OBJECTIVES

Hydrogen storage in underground salt caverns structures is very limited; there are three sites in the USA and one in the United Kingdom. Since the hydrogen mainly origins 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 storages and pipelines hydrogen will be already, or become, contaminated with substances not suitable for use in all types of fuel cells (like N_2, CO, CO_2, hydrocarbon 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 re-purification 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 the 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 for both 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 as 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 a stationary 100 kW PEMFC module capable of operating on industrial quality hydrogen.

NON-QUANTITATIVE OBJECTIVES

- Ensure economically and environmentally sustainable development of materials, components and system.
- Exploit project results through dissemination to and dialogue with key stakeholders.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

CLEANER will:

- Develop lower-cost and impurity-tolerant catalyst materials, mitigation operating strategies to avoid the impact of potential impurities.
- Evaluate new fluorine-free membranes.
- Develop a stationary PEM fuel cell system of more than 100 kW capable of operating with industrial-quality hydrogen.

FUTURE STEPS AND PLANS

In the first 12 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 basis for the first material development and testing. Preparations are ongoing on the fuel cell system by PowerCell and at VTT's test facilities.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?	SoA result achieved to date (by others)	Year for reported SoA result
Project's own objectives	O&M cost	€ct/kWh	< 1.7		5	2020
	Electrical Efficiency ηel	% LHV	52		50	
	Degradation @ 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)/cm^2, cathode 0.4 mg (Pt)/cm^2, Pt recovery rate > 90 % à nr-PGM in the project < 0.05 mg/cm^2,		<0.1	
	Warm start time	sec	<15		60	
	CAPEX	€/kW	< 1 000		1 900	
	Availability	%	>98		98	

Clean Hydrogen Partnership
Co-funded by the European Union