HYPOWERGT

DEMONSTRATING A HYDROGEN-POWERED GAS-TURBINE ENGINE FUELLED WITH UP TO 100 % H_2

HyPowerGT

Project ID	101136656
PRR 2024	Pillar 4 – H_2 end uses: stationary application
Call topic	HORIZON-JTI-CLEANH2-2023-04-03: Retrofitting of existing industrial sector natural gas turbomachinery cogeneration systems for hydrogen combustion
Project total cost	EUR 12 269 095.00
Clean H_2 JU max. contribution	EUR 6 000 000.00
Project period	1.1.2024–31.12.2027
Coordinator	SINTEF Energi AS, Norway
Beneficiaries	Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique, Equinor Energy AS, European Turbine Network, Lucart SpA, Nuovo Pignone Tecnologie SRL, SNAM SpA, TotalEnergies OneTech, Zürcher Hochschule für Angewandte Wissenschaften

http://hypowergt.eu

PROJECT AND GENERAL OBJECTIVES

The HyPowerGT project aims to push technological boundaries to enable gas turbines to operate on hydrogen without diluting it. The core technology is a novel dry low-emission combustion technology (DLE H_2) capable of handling mixtures of natural gas and hydrogen with concentrations up to 100 % H_2. The combustion technology was successfully validated at technology readiness level (TRL) 5 (in early 2021), retrofitted on the combustion system of a 13 MWe industrial gas turbine (NovaLT12). Besides ensuring low emissions and high efficiency, the DLE H_2 combustion technology offers fuel flexibility and response capability on a par with modern gas turbine engines fired with natural gas.

The new technology will be fully retrofittable to existing gas turbines, thereby providing opportunities for refurbishing existing assets in industry (combined heat and power) and offering new capacities in the power sector for load-levelling the grid system (unregulated power) and for mechanical drives. The DLE H_2 technology adheres to the strictest specifications for fuel flexibility, NOx emissions, ramp-up rate and safety, as stated in the strategic research and innovation agenda 2021–2027.

The new DLE H_2 combustion technology will be further refined and developed and, towards the end of the project, demonstrated at TRL 7 on a 16.9 MWe gas turbine engine (NovaLT16) fired with fuel blends mixed with hydrogen from 0 % to 100 % H_2. Within this wide range, emphasis is placed on meeting pre-set targets for (i) fuel flexibility and handling capabilities, (ii) concentration of hydrogen fuel during the start-up phase, (iii) ability to operate at varying hydrogen contents, (iv) minimum ramp speed and (v) safety aspects at any level with regard to related systems and applications targeting industrial gas turbine engines in the 10–20 MWe class.

A digital twin will be developed to simulate performance and durability characteristics, emulating the cyclic operations of a real cogeneration plant in the Italian paper industry.

NON-QUANTITATIVE OBJECTIVES

- **To provide a safe and efficient low-emission H_2 combustion system retrofittable to gas turbine engines in the 10–20 MWe class.** The project will provide a novel dry low-emission hydrogen combustion system retrofittable to gas turbines in the 10–20 MWe class, aimed at offering response power to stabilise and increase the reliability of the electrical energy system. Emphasis is placed on the ability to retrofit the existing heat and power generation systems with gas turbines capable of operating with up to 100 % H_2, while guaranteeing high efficiency, low NOx emissions and operational flexibility in line with typical values obtained under conditions similar to those of natural gas combustion, pursuant to the call.
- **To demonstrate the operating capabilities of a simple-cycle gas turbine in full operating conditions with fuel compositions admixed with hydrogen up to 100 % H_2.** The key enabling technology will first be refined and demonstrated in a relevant environment at TRL 6. Then, a demonstration system will be planned, developed and built into an operational environment, and subsequently demonstrated at TRL 7. This endeavour will require at least 60 aggregated fired hours. The following characteristics of the system will be concluded and documented. Emphasis is placed on (i) gas turbine flexibility, (ii) the content of hydrogen fuel during the start-up phase, (iii) the ability of the system to operate at varying hydrogen contents, (iv) minimum ramp speed and (v) an appropriate safety level with regard to related systems and applications.
- **To present pathways for decarbonised power generation through retrofitting and exploiting the project's results.** The project will present credible ways in which its results can best be utilised, both commercially and economically. The work includes assessing the methods used and the transferability of the results to other gas turbine types and brands, and evaluating the market for retrofitting.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives and SRIA (2021–2027)	Fuel flexibility with full operational (load) capability	%vol. H_2	0–100	
		%mass H_2	0–100	
	NOx emissions for 30–100 %vol. H_2	ppmvd at 15 % O_2	< 25	
Project's own objectives	Variability of the rate of H_2 admixing with natural gas	H_2 volume / minute	±30 %	
	Maximum H_2 content during start-up	%mass	100	
		%vol.	100	
	NOx emissions for 0–30 %vol. H_2	ppmvd at 15 % O_2 (dry)	< 15	
		mgw/MJ of heat	< 26	
	Minimum ramp-up rate	% of load / minute	10	
	Efficiency loss in H_2 operations mode	percentage points	< 2	
	Maximum power reduction in H_2 operations mode	%	< 2	
	NOx emissions for 30–100 %vol. H_2	mgw/MJ of heat	< 43	

Clean Hydrogen Partnership
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