HYPOWERGT

DEMONSTRATING A HYDROGEN-POWERED GAS-TURBINE ENGINE FUELLED WITH UP TO 100% H_2 – (HYPOWERGT)

Project ID	101136656
PRR 2025	Pillar 4 - H_2 End Uses - Stationary Applications
Call Topic	HORIZON-JTI-CLEANH$_2$-2023-04-03
Project Total Costs	12 269 095.00
Clean H_2 JU Max. Contribution	6 000 000.00
Project Period	01-01-2024 - 31-12-2027
Coordinator Beneficiary	SINTEF ENERGI AS, NO
Beneficiaries	EUROPEAN TURBINE NETWORK, LUCART SPA, TOTALENERGIES ONETECH, NUOVO PIGNONE TECNOLOGIE SRL, SNAM S.P.A., EQUINOR ENERGY AS, ENERGY AND TURBOMACHINERY NETWORK, ZURCHER HOCHSCHULE FUR ANGEWANDTE WISSENSCHAFTEN, CENTRE EUROPEEN DE RECHERCHE ET DEFORMATION AVANCEE EN CALCUL SCIENTIFIQUE

http://hypowergt.eu

PROJECT AND GENERAL OBJECTIVES

HyPowerGT aims at to push technological boundaries to enable gas turbines to operate on hydrogen without dilution. 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 het 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, NO_x 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 HyPowerGT, demonstrated at TRL7 on a 16.9 MWe gas-turbine engine (NovaLT16) fired with fuel blends mixed with hydrogen from 0-100% 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 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. HyPowerGT 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% hydrogen, while guaranteeing high efficiency, low NO_x emissions, and operational flexibility at the level of typical values obtained under conditions similar to those of natural gas combustion, pursuant to the call.
- To demonstrate operating capabilities of a simple-cycle gas turbine at 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 relevant environment at TRL6. Then a system demonstrator will be planned, developed, and built into an operational environment, and subsequently demonstrated at TRL7. This endeavour will require at least 60 aggregated fired hours, and the following characteristics of the system will be concluded and documented. Emphasis is placed on (i) gas turbine flexibility, (ii) content of hydrogen fuel during the start-up phase, (iii) ability to operate at varying hydrogen content, (iv) minimum ramp speed, and (v) proper safety level with regard to related systems and applications.
- To present pathways for decarbonised power generation through retrofits and uptake of project's results. HyPowerGT will present credible ways in which its results can best be utilised, both commercially and economically. The work includes assessing the methods used, transferability of the results to other gas turbine types and brands, and evaluating the market for retrofitting.

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PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Project execution tools in place to facilitate the project implementation and internal financial and technical reporting.
- Performance of direct numerical simulations performed, increasing robustness of burning-rate scaling and improving flashback model predictions.
- Finalisation of designs for experimental setup, and development of purchase order.
- TRL 6 test campaign instrumentation and rig refurbishment on track for demonstration tests at the end of 2025.
- Establishment of health, safety and environment procedures and safety plan.
- Performance of preliminary de-risking simulations of H_2 operated GT and FMECA workshop.
- Start of road mapping work for positioning H_2 gas turbines towards the European energy transition initiated.
- Preparation of dissemination material including website, social media profile and presentation of the project at international conferences and other meetings.

FUTURE STEPS AND PLANS

- TRL 6 Demonstration tests at the end of 2025.
- Monitoring the safety engineering of the test campaigns.
- Application of available models and tools for risk assessment.
- Strengthen cooperation with sister projects.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives	Maximum H_2 content during start up	%vol H_2	100	
	Variability of H_2 admixing rate with natural gas	%H_2 volume/minute	±30	
	Maximum H_2 content during start up	%mass H_2	100	
	Minimum ramp up rate	% of load/minute	10	
	Efficiency loss in H_2 operations mode	% points	<2	
	Maximum power reduction in H_2 operations mode	%	<2	
	Fuel flexibility with full operational (load) capability - H_2 volume fraction	%vol H_2	0-100	
	Fuel flexibility with full operational (load) capability - H_2 mass fraction	%mass H_2	0-100	
	NO_x emission 0-30% vol H_2	mgw/MJth	< 26	
	NO_x emission 30-100% vol H_2	mgw/MJth	<43	

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