FLEX4H2

FLEXIBILITY FOR HYDROGEN

Project ID	101101427
PRR 2024	Pillar 4 – H_2 end uses: stationary application
Call topic	HORIZON-JTI-CLEANH2-2022-04-04: Dry low NOx combustion of hydrogen-enriched fuels at high-pressure conditions for gas turbine applications
Project total cost	EUR 4 872 197.50
Clean H_2 JU max. contribution	EUR 4 178 517.25
Project period	1.1.2023–31.12.2026
Coordinator	Ansaldo Energia SpA, Italy
Beneficiaries	Ansaldo Energia Switzerland AG, Arttic Innovation GmbH, Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique, Deutsches Zentrum für Luft- und Raumfahrt EV, Edison SpA, European Turbine Network, SINTEF Energi AS, Zürcher Hochschule für Angewandte Wissenschaften

https://flex4h2.eu/

PROJECT AND GENERAL OBJECTIVES

FLEX4H2 will design, develop and validate a highly fuel-flexible sequential combustion system capable of operating with any concentration of hydrogen admixed with natural gas up to 100 % at H-class operating temperatures, with the aim of maintaining rated power and efficiency. FLEX4H2 will tackle challenges related to H_2 combustion by developing combustion technology through a combination of design optimisation, analytical research and validation in a relevant environment.

FLEX4H2 will validate scaled and full-size prototypes of the combustor through dedicated atmospheric and high-pressure tests campaigns up to technology readiness level 6. The tests will seek to demonstrate the combustor's ability to operate in the presence of any mixture of hydrogen and natural gas without diluents and while complying with emission limits. In addition, the possibility of starting up an engine with any amount of H_2 in natural gas will be demonstrated.

NON-QUANTITATIVE OBJECTIVES

FLEX4H2 will assess the replicability of the scientific methodologies applied and the transferability of the results to different gas turbine classes.

PROGRESS AND MAIN ACHIEVEMENTS

H2-Optimised Prototypes Design and Testing:

- First generation of H2-optimised prototypes successfully designed and tested.
- Testing activities were completed according to the project plan, demonstrating all target results.
- Further testing with H2 up to 100% was conducted, demonstrating the combustor's fuel and operational flexibility.

Numerical Modelling:

- Platform for exchange of burner geometry/data between CERFACS-ANSALDO has been established.
- First DLR validation case has been selected for 2nd combustion stage, rig geometry has been transferred.
- Initial testing on commercially-relevant CBB configuration has been conducted.

Thermoacoustics:

- Experimental rig geometry has been finalized through network modelling tool.
- Thermoacoustic measurements in Full Can Setup has been carried out.

FUTURE STEPS AND PLANS

Combustion System Development and Testing:

- Focus on second generation H2-optimised prototypes development and validation.
- Utilize data from first development cycle for refinement of burner design.
- Use fullscale atmospheric and high-pressure combustion tests to enhance combustor operation.
- Optimize hardware design considering cooling and mechanical integrity requirements for reproducing full-engine boundary conditions.

Numerical Modelling:

- Perform large eddy simulation on both combustion stages.
- Refine model in first stage (MBFS) to represent burner flashback behaviour and flame stabilisation.
- Enhance modelling activities for thermo-acoustic assessment and modelling.
- Improve second-generation geometry, focusing on aerodynamic improvement of the mixing section.

Thermoacoustics:

- Convert experimental rig geometry to a network modelling tool to reduce model and measurements deviation.
- Expand first-stage-only network model to FCS to prove first-stage-only behavior from experimental data.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
SRIA (2021–2027)	NOx emissions	ppmv at 15 % O_2 (dry)	< 25 by 2024 and < 25 by 2027	
		mg / MJ fuel	< 29 by 2024 and < 24 by 2027	
	Range of H_2 content in gas turbine fuel	%mass	0–100	
		%vol.	0–100	
	Maximum H_2 content of fuel during start-up	%mass	0–100	
		%vol.	0–100	
	Ability to handle H_2 content fluctuations	%mass/min	± 5.11	
		%vol./min	± 15 by 2024 and ± 30 by 2030	
	Minimum ramp rate	%load/min	10 at 100 % H_2	
	Maximum reduction in efficiency of H_2 operation	percentage points	< 2 at 100 % H_2	

Clean Hydrogen Partnership
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