HELIOS

STABLE HIGH HYDROGEN LOW NOX COMBUSTION IN FULL SCALE GAS TURBINE COMBUSTOR AT HIGH FIRING TEMPERATURES

Project ID	101101462
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 3 984 187.50
Clean H_2 JU max. contribution	EUR 3 984 187.00
Project period	1.3.2023–28.2.2027
Coordinator	Technische Universiteit Eindhoven, Netherlands
Beneficiaries	Centro di Combustione Ambiente SpA, Deutsches Zentrum für Luft- und Raumfahrt EV, OPRA Engineering Solutions BV, OPRA Turbines International BV, Technische Universiteit Delft, Thomassen Energy BV

https://www.h2gt-helios.eu/

PROJECT AND GENERAL OBJECTIVES

In addition to its technical advancements, Helios will play a crucial role in fostering a vast innovative ecosystem and facilitating the future adoption and commercialisation of this technology on a cost-effective and scalable basis. As Europe transitions towards renewable energy sources, the repurposing of existing power generation assets to decarbonised alternatives becomes essential. Gas turbines, providing grid inertia and stability along with dispatchable firming capacity, are pivotal in balancing the inherently intermittent renewable energy sources. The Helios project addresses these challenges, contributing significantly to securing, competitively pricing, cleaning, flexibly managing and resiliently shaping Europe's energy system.

The Helios consortium, comprising five partners across three European countries is highly complementary.

Helios aims to achieve the following objectives:

- enable low-NOx combustion of hydrogen-enriched fuels in gas turbines;
- operate the system across a wide range of mixtures, from 100 % natural gas to 100 % hydrogen;
- achieve low NOx emissions (below 9 ppmv);
- modify existing combustors to safely operate at high firing temperatures using 100 % H_2, based on Thomassen Energy's FlameSheet technology;
- provide the combustor as either a newly built option or a retrofit for existing gas turbine systems ranging from 1 MW to 500 MW;
- make the combustor applicable to various industrial and heavy systems, as well as industrial-scale gas turbines.

NON-QUANTITATIVE OBJECTIVES

The Helios project aims to advance the scientific understanding and feasibility of hydrogen-enriched fuels in gas turbines, utilising the FlameSheet combustor framework. Economically, it strengthens European industrial technology by enhancing hydrogen-enriched gas-turbine technology and testing facilities, promoting Europe's leadership position and generating new industrial activities. Financially, it accelerates sustainable energy generation by retrofitting existing gas turbines, minimising social impact and ensuring job security. Environmentally, Helios addresses societal acceptance through socioeconomic evaluation and stakeholder involvement. Overall, Helios improves EU energy security by widening gas turbine operation capabilities, ensuring grid stability and enhancing supply reliability.

PROGRESS AND MAIN ACHIEVEMENTS

Preliminary data from a high-pressure campaign indicated good results. They showed improvements in firing temperatures, particularly with 100 % hydrogen. Preliminary data indicated promising results in terms of flashback resistance. As data are preliminary, it is essential to double-check and verify the findings.

FUTURE STEPS AND PLANS

Helios has been running now for more than 1 year. At the end of the project, we shall deliver a handbook of requirements and recommendations for the implementation of high-hydrogen gas turbines, as one of the key outcomes.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?	SOA result achieved (by others)	Year in which SOA result was reported
Project's own objectives and SRIA (2021–2027)	NOx emissions	ppmv at 15 % O_2 (dry)	< 9		< 25	2020
		mg / MJ fuel	8.7		31	
	Range of H_2 content in gas turbine fuel	%mass	0–100		0–5	
		%vol.	0–100		0–30	
	Ability to handle H_2 content fluctuations	%mass/min	2.21		1.4	
		%vol./min	15		10	
	Reduction in maximum efficiency in H_2 fuel cell operation	percentage points	< 10 at 100 % H_2		10 at 30 % H_2	
	Minimum ramp rate	%load /min	15 at 100 % H_2		10 at 30 % H_2	
	Maximum H_2 content of fuel during start-up	%mass	100		0.7	
		%vol.	100		5	

Clean Hydrogen Partnership
Co-funded by the European Union