Main impacts

Contribution to Net Zero pathway

In line with the EU policies, FLEX4H2 project offers a significant contribution towards the decarbonisation of the electric power sector.

Accelerating the transition phase

Solutions will be offered for full-scale gas turbine combustors retrofittable to other non-OEM gas turbine with can-type combustors.

New combustor technology

The combustion system will handle blends of natural gas with up to 100% of H_2, without use of diluents and power derating.

Efficient grid balancing

Hydrogen-fueled gas turbines carry significant potential to fill in the gaps caused by renewable energy systems (RES) intermittency and unpredictability.

Re-utilisation of existing infrastructure

The absence of strict requirements concerning fuel gas purity makes it possible to reuse the current infrastructure and thus reduce investment costs.

Consortium

ansaldo energia, ETN Global, SINTEF, EDISON, CERFACS, ARTTIC, zhaw School of Engineering, DLR

Project Budget:	Approx. EUR 8.7M
Funding EU:	EUR 4,178,517.25
Funding Switzerland:	CHF 4,012,475.00
Duration:	4 years (Jan 23 – Dec 26)
Project Coordinator:	Ansaldo Energia

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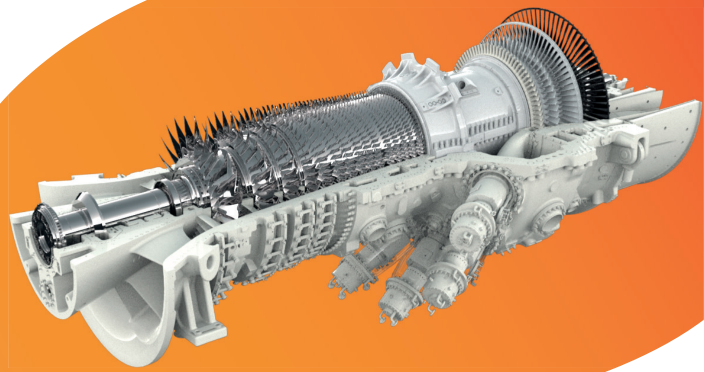
Decarbonised Power



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State Secretariat for Education, Research and Innovation SERI

FLEX4H2 Introduction

Flexibility for Hydrogen (FLEX4H2) is a co-funded project by Clean Hydrogen Partnership, EU and Switzerland. It aims to develop a fuel-flexible combustion system capable of operation with any hydrogen concentration in natural gas, up to 100% H_2.

The design of the combustor is based on the proprietary combustion technology, Constant Pressure Sequential Combustion (CPSC), developed for Ansaldo's GT36 H-Class turbine. The technology will be demonstrated in a stepwise approach, at full gas turbine operation conditions. It will be entirely compliant with NO_x emissions targets without the use of diluents and with minimal impact on thermal efficiency.

The new combustor design will be fully retrofittable to existing gas turbines, thereby providing significant opportunities for refurbishing existing assets.

Key Objectives

H_2 combustion system design and development

FLEX4H2 will develop and validate a safe, efficient and highly fuel-flexible combustion system capable of operating with any hydrogen concentration up to 100% H_2, at H-Class operating temperatures, while still meeting emission targets without any use of diluents.

Validation and demonstration

The combustion system will be validated with up to 100% H_2 at full gas turbine operating conditions. The full-size combustor prototype will undergo dedicated atmospheric and high-pressure testing up to Technology Readiness Level (TRL) 6.

Pathways presentation

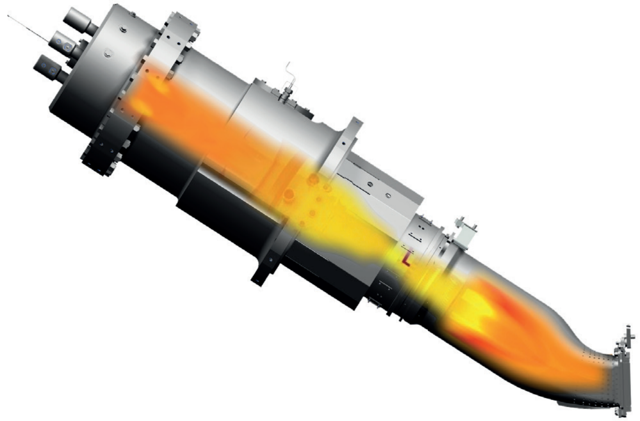
The FLEX4H2 project will provide credible pathways for comprehensive exploitation of the project's results and thereby providing the basis for a firm contribution to the EU Green Deal towards decarbonisation of the electric power sector by 2030 and beyond.

Technology

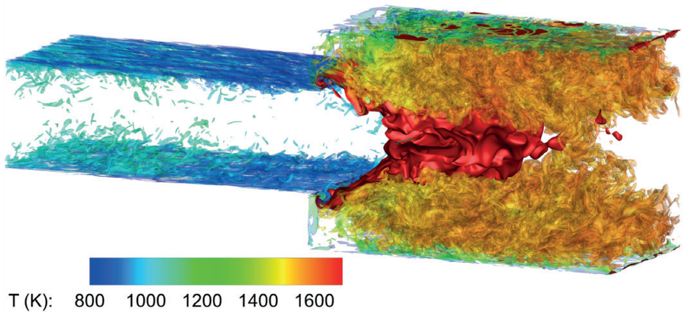
Hydrogen Combustion

To maximise cycle efficiency, while keeping emissions at very low levels, modern gas turbines must strike a balance between ultra-high firing temperatures, robust flame stabilisation and the widest flexibility both in respect to engine operation and fuel type. Sequential combustion has demonstrated its advantages towards such extremely ambitious targets.

The use of two combustion systems, one utilising aerodynamic flame stabilisation and the other stabilised by autoignition, provides outstanding performance in terms of both NO_x and CO emissions, turn-down capability as well as enhanced flexibility in optimising the combustor for different fuel types. The intrinsic flexibility of sequential combustion has already been shown to enable clean and efficient operation on a wide variety of fuels with very high hydrogen contents.



Constant Pressure Sequential Combustion (CPSC) technology



Numerical simulation of hydrogen sequential combustion

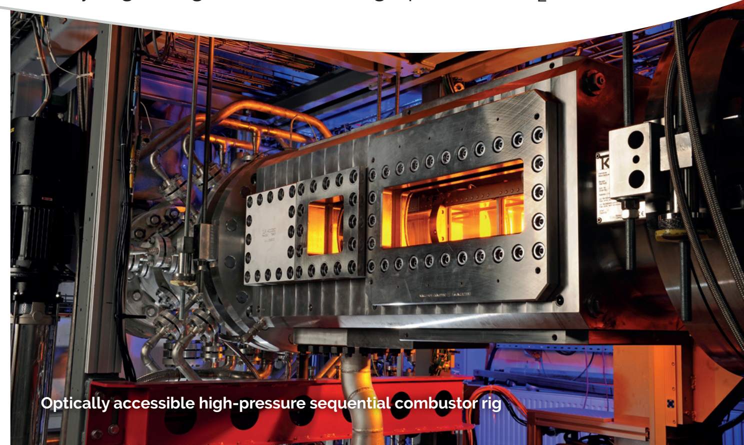
Test Rigs & Validation

The numerical simulations during the sequential combustion system development will be crucially complemented by dedicated tests of a simplified sequential combustor geometry at GT relevant operating conditions in an optically accessible rig, providing experimental data for both numerical modelling validation and optimisation of the engine operation concept.

Full-scale single-can combustor prototypes will be manufactured and tested both at atmospheric conditions for validation of ignition procedures and at full engine operating conditions (including temperature, pressure, fuel and air mass-flows) to ultimately validate the combustor operation at all natural gas-hydrogen blends, up to 100% H_2, thus successfully achieving TRL6.

Numerical Modelling

The development of the sequential combustion system to achieve 100% hydrogen operation at H-class conditions will be supported by advanced numerical modelling and simulations. These activities will combine state-of-the-art modelling tools for the simulation of turbulent reactive flows and the computational power of modern high-performance computers. High-resolution calculations of both combustor stages will reveal detailed insights and trends about flame stabilisation and emission formation in each stage. Additionally, a reduced-order model of both stages will be constructed to investigate their interaction and map the boundaries of their stability. The numerical results will be used to design the combustion system, with the aim of reducing combustion testing costs and improving the operational window, specifically regarding fuels containing up to 100% H_2.



Optically accessible high-pressure sequential combustor rig