Main impacts

CO_2 free, low NO_X gas turbine

HyPowerGT will offer an innovative solution for the energy transition: a CO_2 free gas turbine with low NO_X emissions that represents the cleanest possible gas turbine configuration on the market.

Green tech without compromise

The low NO_X target will be obtained working on the DLE combustion technology, neither using diluents, nor catalysts in the gas turbine exhaust or reducing the gas turbine's thermodynamic efficiency by lowering the combustor exit temperature.

Gas turbine fuel flexibility

The project will demonstrate, by means of engine test campaigns, the ability to burn any blend of natural gas and hydrogen up to pure H_2, from start-up and with a switching ability at any load.

Supporting EU climate neutral targets

HyPowerGT will contribute significantly to the Green Deal, proposing through technology development up to TRL 7 a concrete market solution, which will foster energy transition through its retrofittability on existing natural gas and CHP applications.

Consortium

SINTEF, Baker Hughes, zhaw School of Engineering, ETN Global, equinor, TotalEnergies, snam, CERFACS, LUCART

Total Budget	EUR 13,506,110
Funding EU	EUR 6,000,000
Associated parties	*providing additional funding*
ZHAW	EUR 636,015, funded by SERI
Equinor	EUR 300,000
TotalEnergies OneTech	EUR 300,000
Duration	4 years (Jan 24 – Dec 27)
Project Coordinator	SINTEF Energy AS

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HyPowerGT

Hydrogen-Powered Gas-Turbine engine fuelled with up to 100% H_2

The HyPowerGT project is supported by the Clean Hydrogen Partnership and its members (GA 101136656) and the Swiss Federal Department of Economic Affairs, Education and Research, State Secretariat for Education, Research and Innovation (SERI).

Clean Hydrogen Partnership

Co-funded by the European Union

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Schweizerische Eidgenossenschaft
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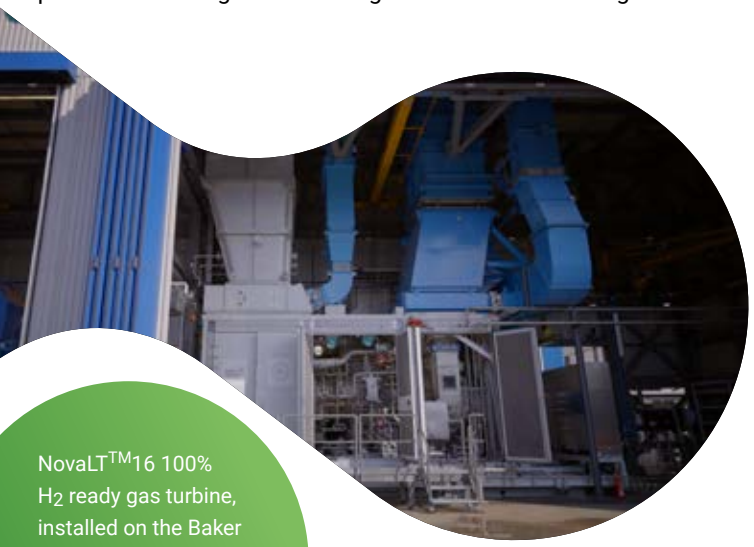
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

HyPowerGT concept

The HyPowerGT project aims at moving technological frontiers to enable gas turbines to operate on hydrogen, ensuring compliance with existing NO_x regulations using neither catalysts, nor diluents or thermodynamic efficiency reduction. The core technology is a novel dry-low emission combustion technology (H_2 DLE) able of handling any blend of natural gas and hydrogen up to pure H_2. Besides ensuring low emissions, the H_2 DLE combustion technology offers fuel flexibility and response ability on par with modern gas turbine engines fired with natural gas.



NovaLT™16 100% H_2 ready gas turbine, installed on the Baker Hughes test bench at Florence site (IT). Image courtesy of Baker Hughes. (*)

The DLE H_2 combustion technology will be fully retrofittable to existing gas turbines, thereby providing opportunities for refurbishing existing assets in industry: in the power sector, including Combine Heat and Power, and in mechanical drives applications. The DLE H_2 technology adheres to the strictest specifications for fuel flexibility, NO_x emissions, ramp-up rate, and safety, stated in the Clean Hydrogen JU Strategic Research and Innovation Agenda 2021-2027.

* NovaLT™ is a trademark of Baker Hughes and its affiliates. All rights reserved

Main project developments

DLE H_2 combustor technology

Since turbulent flame velocity is affected by the hydrogen content in the fuel, the DLE H_2 combustor provides an enhanced gas injection and premixing technology, able to operate with pure hydrogen while guaranteeing a margin against flame flashback and ensuring the most efficient premixing with oxidant to comply with existing NO_x regulations.

The desired fuel flexibility to burn any blend of natural gas and hydrogen requires the combustor to handle different flame stabilization conditions at all engine loads, and the ability to control the possible sources of flame instability and limiting pressure oscillations within the acceptable durability limits.

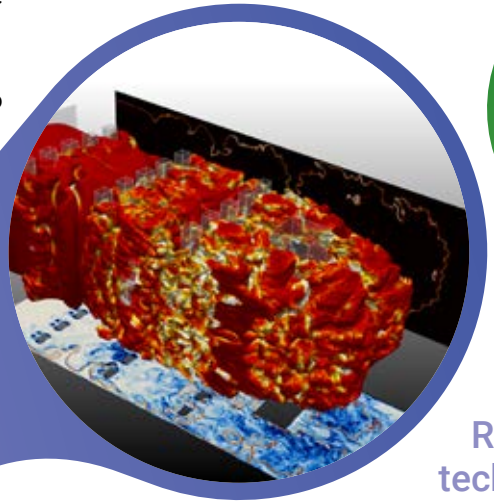
The relevant design enhancements of the gas injectors need to be demonstrated at full pressure and temperature conditions: the capabilities of the DLE H_2 system will be verified at TRL 6 by testing in an instrumented annular combustor rig, operated at engine representative conditions of pressure and temperature.

Baker Hughes NovaLT™16 gas turbine, 100% H_2 ready (*)

To complete the design verification at TRL 7, the DLE H_2 combustor will be introduced in the instrumented prototype engine and tested at all the mission conditions, operating up to rated power (16.9 MWe).

Safety handling

The HyPowerGT project will address several safety aspects related to burning any blend of natural gas and hydrogen. These aspects will be analysed starting from the risk assessment performed on the DLE H_2 gas turbine, supported by detailed numerical simulations of different scenarios involving the presence of hydrogen-air mixtures within the flow path of a fuelled gas turbine during off-design transients. An assessment for retrofitting the DLE H_2 gas turbines and a complementary risk analysis related to health, safety, and environment assessment will be performed. A safety management plan will be ultimately developed, with the aim of enabling operation of retrofitted GTs with up to 100% H_2 and certifying the NovaLT™16 DLE H_2 product.



Advanced numerical simulation of a venting duct deflagration scenario

Retrofitting and techno-economic roadmap

Considering the future expected European hydrogen demand and the relevant infrastructure plans (e.g. European Hydrogen backbone Initiative), the potential market size of the DLE H_2 technology in 2030 and 2050 will be evaluated. Techno-economic analyses will be conducted considering midstream hydrogen turbo-compressor stations, industrial cogeneration stations and energy system solutions. Building on the results of these case studies, an exploitation roadmap will be proposed, considering both the regulatory framework, as well as the research and development required to meet the needs of the potential market segments.