ENERGETICS

MUR DM 117/Ethos Energy - Design and optimization of gas turbine components for safe use of hydrogen/methane fuel blends

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Context of the research activity	The research will mainly address the analysis of the hydrogen combustion process in heavy-duty gas turbines and of the combustor-turbine interaction. The study will also focus on the secondary air system, on the re-design of the turbine aerodynamics as well as of the combustor and turbine cooling systems. The main goal is set on the substantial abatement of CO2 emissions and on the enhancement of the system performance, consistently with the actions supported by the PNRR, by Horizon Europe and by the European Clean Hydrogen Alliance. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23001950004
	The recent developments in the energy sector are thrusting the research and industrial efforts towards the net zero CO2 goal and are contributing to the energetic self-sufficiency of the European Community. Such goals should be fulfilled together with a strong boost of the industrial stakeholders on the Italian territory. As a matter of fact, Italy is entitled to a relevant quota of the Next Generation EU funds, mostly devoted by the PNRR guidelines to the energy performance improvement and promoting the joint research of public centres and academy together with the industry. Efforts are hence driven towards the education of professional figures trained to face the decarbonization challenge, thus impacting at an international level. Within such scenario, the study of the combustion process of molecular hydrogen derived from renewable energy sources is of primary importance

Objectives	for heavy-duty gas turbines. The use of hydrogen would in fact pave the road for the deployment of carbon free solutions and systems, and would allow for balancing the electric grid, thus compensating the fluctuations in induced by the renewable energy sources, i.e., solar and wind power. The development of the above-mentioned topics in cooperation with a company, namely EthosEnergy Italia s.p.a., independent service provider leader for the lifetime extension of medium and large size turbogas plants, allows for a considerable boost of the deployed technological solutions thanks to the possibility of the ready-to-market implementation of the optimized components and devices on considerably large fleets. The project will specifically target the systems used to premix the hydrogen-to-air blend, and eventually the hydrogen/methane- to-air blends, to attain consistent NOx reductions, still managing to avoid flashback issues. The impact of the redesigned combustion system on the turbine aerodynamics and thermal behaviour will be thoroughly analysed, with specific attention to the redistribution of the hot spots in the high-pressure stages. The latter would in fact significantly affect the blade load and the effectiveness of the cooling system. A detailed analysis of the secondary air path will hence be carried out. The results produced by such analysis will allow for the redesign of the turbine aerodynamics and of the cooling system architecture, by means of numerical optimization solutions, thus enabling higher temperature operations of the turbine and improved plant efficiencies.

Skills and competencies for the development of the activity	Theoretical background on the combustion process in energy systems, gas-turbine working cycle and secondary circuit, turbine and compressor aero-dynamics. Proven experience in the field of energy systems modelling and numerical simulation will be duly considered.