ENERGETICS

Fuel-flexible gas turbines for decarbonization

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Context of the research activity	As far as decarbonization of the power sector is concerned, the use of alternative fuels such as hydrogen or ammonia represents a factual solution to overcome the limits set by renewable sources and to complement the intermittent nature of wind and solar power. Still, CO2 footprint reduction would also require dedicated solutions and manufacturing technologies to allow for lifetime extension of the already existing plants, thus limiting the overall impact in terms of Life Cycle Assessment.
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Objectives	mandatory. Computational Fluid Dynamics methods coupled to tailored optimization strategies will drive the redesign of internal cooling systems aimed at maximizing the positive effect produced by the increased amount of primary air. Starting from the analysis of the state of the art in the fields of fuel-flexible solutions and optimization techniques, the project aims at making significant progresses by developing reliable numerical tools that will be implemented in the power plant design processes. In detail, two main objectives will be pursued. OBJECTIVE 1 - Combustor Detection of the most accurate combustion models for the analysis of the selected fuels. Model validation against experimental data, with reference to different fuel compositions and combustion concepts. Evaluation of the challenges connected to the fuel flexibility: thermal stresses on plant components together with flame stability. Definition and feasibility analysis of combustor redesign (including injectors) required to fulfil emission and safety regulations. OBJECTIVE 2 - Turbine Development of reduced-order models for cycle analysis of industrial gas turbines. Validation of the models against available experimental data. Implementation of combustors performance curves in the developed models. Analysis and optimization of the flow split to maximize the positive outcome at cycle level. Redesign of the high-pressure cooling system to fulfil the thermal requirements and increase gas turbine efficiency using state-of-the-art CFD and optimization methods. Combustor/turbine interaction analysis to validate the final configuration.

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 modeling and numerical simulation will be duly considered.