ENERGETICS

YANMAR- Real-time predictive combustion models for low and zero-carbon fuelled engines in view of their integration in the engine control architecture

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Supervisor	PIANO ANDREA - andrea.piano@polito.it
Contact	PIANO ANDREA - andrea.piano@polito.it
Context of the research activity	Internal combustion engines will continue to play a key role in the upcoming energy transition, especially in the case of off-road and marine applications, but global warming issues related to the use of conventional fossil fuels need to be faced. To reduce both pollutant and greenhouse gasses emissions from internal combustion engines, transitioning from fossil fuels to low and zero-carbon alternatives is thus essential. In this context, modern engines must maintain optimal performance across all steady-state and transient operating conditions, achieving high efficiency, low emissions, and preventing abnormal combustion, even when operated with low and zero-carbon alternative fuels, such as hydrogen, methanol, ammonia, and e-fuels. Innovative approaches to real-time control of the combustion process will be crucial for ensuring reliable operation of internal combustion engines, especially during transient conditions. To this end, Yanmar aims to explore various techniques for developing control-oriented predictive and real-time combustion models for internal combustion engines operating with alternative fuels: they must be accurate enough and computationally efficient. The prediction of abnormal combustion will also be evaluated. The predictive combustion model will be implemented in a rapid prototyping machine for testing and evaluation to assess its accuracy in predicting combustion events.
Objectives	Innovative approaches to real-time control of the combustion process will be crucial for ensuring reliable operation of internal combustion engines, especially during transient conditions. To this end, Yanmar & PoliTO aim to explore various techniques for developing control-oriented predictive and real-time combustion models for internal combustion engines operating with alternative fuels: they must be accurate enough and computationally efficient. The prediction of abnormal combustion will also be evaluated. The predictive combustion model will be implemented in a rapid prototyping machine for testing and evaluation to assess its accuracy in predicting combustion events. In conclusion the main target of this Doctoral research is to accelerate

	decarbonisation process by: • Investigating innovative combustion system with low carbon footprint and capable of operating with alternative fuels • Developing modelling and simulation methodologies, including XiL applications, for the development of new concepts and retrofit opportunities • Demonstrating the potential to reduce time-to-market of innovative and flexible solutions towards zero CO2 emission.

Skills and competencies for the development of the activity	• Excellent knowledge of fluid-dynamics and engine thermodynamics • Knowledge of 1D/3D CFD simulation codes (such as GT-SUITE, CONVERGE CFD) • Good command of Matlab/Simulink Control Toolbox