ENERGETICS

MUR DM 117/Vulkan - System-level analysis and energy management strategy design for marine hybrid powertrains

Funded By	VULKAN ITALIA S.R.L. [P.iva/CF:01318430061] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] Politecnico di TORINO [P.iva/CF:00518460019]
Supervisor	MISUL DANIELA ANNA - daniela.misul@polito.it
Contact	
Context of the research activity	The research activity revolves around the development of hybrid powertrains for marine applications, with a specific focus on environmental impact as well as pollutant emission reduction. The research activity will be carried out with Vulkan and will fulfill the target by addressing the system-level energetic analysis and by developing tailored hybrid Energy management Strategies (EMS). The outcome of the research would in fact produce a sound, reliable, and optimized EMS for real-time applications in the waterborne field. Progetto finanziato nell'ambito del PNRR – DM 117/2023 - CUP E14D23001950004
	The introduction of Emission Control Areas and the increasing stringency of pollutant emission regulations for ships is driving the adoption of innovative powertrain technologies for waterborne transport [1]. However, due to the large variety in vessel sizes, ranges, and operational missions, identifying the most effective technological pathway requires ad-hoc engineering practice for each specific application. Hybrid-electric powertrains are a promising technology for short-sea transport of passengers and goods, as a cost-effective solution with a significant potential for emission abatement, particularly in short-sea navigation. Nonetheless, little research has yet been published on the matter. At the same time, hybridization of marine powertrains is a fast-developing field that is attracting the interest of both academia and industry. In particular, the companies are presented with many challenges related to the need to acquire the necessary know-how for robust and cost-effective design of electrified powertrains to meet the demand of the customers for solutions tailored to their applications. As a result, there is a clear research gap that must be filled to foster the adoption of such technology and maximize its impact on air quality and, therefore, on the health and quality of life of

Objectives	European citizens living near coastal areas and inland waterways. Within the broader framework of the research activity, three main objectives can be identified as follows. Analysis of existing rule-based techniques. Rule-based techniques are the most robust types of EMS that can be developed, and they are the current state-of-the-art for control of hybrid powertrains. The student would learn the theoretical groundwork of these techniques at PoliTo and compare it to the behavior of commercially available solutions. The student would also implement such techniques in a high-fidelity simulation environment and apply them to one or more case studies currently under development within the company (Vulkan). Optimization of real-time EMSs using optimization techniques. Online control strategies can be optimized by analyzing the (optimal) design obtained with offline techniques. The student would learn how to implement these offline techniques at PoliTo and would use them to explore improved real-time control strategies, better tailored to the application at hand and specifically aimed at increasing the vessel efficiency, thus reducing energy consumption and emissions. Robustness and safety. The student would analyze the aspects related to the interaction between the EMS and low-level control of individual components to identify and solve potential hazards that may not arise in simulation environments. This would involve both the development of ad-hoc simulation models and field testing, also leveraging facilities from Vulkan and/or its partners. REFERENCES [1] Ni P, Wang X, Li H. “A review on regulations, current status, effects and reduction strategies of emissions for marine diesel engines”. Fuel 2020; 279: 118477.

Skills and competencies for the development of the activity	The candidate should have a background in system-level analysis and simulation of marine hybrid powertrains as well as the development of hybrid energy management strategies for marine applications. The candidate should also have experience in the usage of simulation software for multi-domain systems.