PhD in Energetics (Fluid Machines)

Research Title: Potential of renewable diesel fuels for a sustainable mobility of advanced CI engines

Future ICEs for a sustainable mobility

Funded by	DENERG/Ateneo fondi CRT
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Context of the research activity	The ‘‘Dieselgate’’ scandal arisen in USA churned up the automobile industry. It became public that some car manufactures manipulated the emissions of diesel engines by illegally installing software that detected emission tests and modulated engine operation and emission control accordingly. Different to other scandals, consumers were hit after a global political debate had emerged, which also involved gasoline engines and more in general world climate changes. Consumers of automobiles were hit twofold. First, they were exposed to the risk of restrictions in combustion vehicles (especially diesel cars) in city centers. Second, they faced a financial disadvantage as the cars’ residual values might decline. Reacting to the ‘dieselgate’, environmental experts and policymakers promptly declared that the regulatory regime of diesel and gasoline vehicle emissions had to be tightened. A previously developed emission laboratory test, namely the WLPT (Worldwide Harmonized Light Vehicle Test Procedure), was introduced in 2017 for gasoline and diesel cars and was coupled with additional real driving emission (RDE) tests conducted on public roads in actual traffic conditions. Furthermore, the European community decided to reduce the CO_2 emissions of passenger cars by at least 37.5% in 2030 compared to levels in 2021, thus posing additional challenges to automotive industry. All this framework has encouraged the development of electrification in vehicles as well the diffusion of cars powered with

	alternative fuels such as renewable diesel, hydrogen, bio-methane and bio-LPG (liquefied petroleum gas). The transition from combustion to fully-electric vehicles is not expected to be rapid and doubts arise about the feasibility of a full substitution of ICEs, at least in the short to mid period. The main weak point of electrical vehicles are batteries: their size, cost, longevity and charging capabilities as well as the scarcity of materials to produce them. Furthermore, concerns about range is still a problem for electric vehicles. Although the technology is evolving and more charging stations are popping up, the "range anxiety", that is, the customers fear to be stranded with nowhere to charge the battery, is still a real issue which OEMs need to solve, especially for heavy vehicles. Therefore, ICEs are still attractive in supporting the demand for a sustainable and reliable mobility. In addition to electric hybridization, one path that could have a long-term perspective refers to the exploitation of some alternative fuels. Among the most promising eco-fuels for the future, there is renewable diesel, that is, diesel fuel obtained from biomass through pyrolysis, hydrodeoxygenation or gasification via e-syngas and Fischer-Tropsch process. Although this fuel have already been investigated in the past, there is today an urgent demand for assessing a definite application to automobiles and trucks at a significant scale level. A reliable response can be obtained by applying state-of-the-art technological and control strategy solutions, which are implemented in modern compression ignition propulsion systems, to engines fueled with this renewable fuel in order to assess their effective potential.

Objectives	The research activity on the compression ignition engine fueled with either renewable diesel or petrol diesel involves both experimental and numerical activities. The engine experimental results measured at a dynamometer cell of the Politecnico di Torino will be used to determine an optimized ECU calibration according to a Design of Experiments (DoE) technique for each of the two fuels. This statistical method has been applied to petrol diesel engines, but there is lack of data in the literature for the application to renewable diesel. State-of-the art injection techniques, such as digital and continuous rate shaping injection schedules and advanced low temperature combustion modes will be implemented in some zones of the engine map to find the best trade-off between fuel consumption, noise and emissions for renewable diesel. Combustion models will also be employed to analyse the differences of combustion evolution between petrol diesel and renewable diesel. Furthermore, comparative tests between petrol diesel and renewable diesel will be performed at the hydraulic rig of the Politecnico di Torino and at a constant volume bomb, equipped	

	with laser Schlieren high-speed photography at Tongji University, in order to investigate the effects of the modified physical properties of renewable diesel on hydraulic performance as well as on fuel spray.	

Skills and competencies for the development of the activity	The PhD candidate should possess a Master of Science degree in Automotive Engineering or in Mechanical Engineering. A background in fluid dynamics, thermodynamics and mechanical structure design would be optimal. Competence in numerical simulation of mechanical or thermo- fluid dynamic systems is also valued. Experience on testing of internal combustion engines, on facilities related to fuel sprays and fuel injection is acknowledged. Awards, patents and papers are valorized in order to evaluate the attitude to research and innovation. Attitude to work independently, based on fixed objectives, and attitude to work in team are required. Attitude to spend periods away from the own country in a context of an international research is necessary.