MECHANICAL ENGINEERING

MUR DM 117/Stellantis - Highly integrated battery system design for electric vehicles.

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Context of the research activity	The reduction of carbon emissions is currently one of the main technological challenges in many industrial sectors, in the direction of climate neutrality to be achieved by 2050, as indicated by European programs. The mobility sector accounts for 25% in Europe and 18% globally, forcing the automotive industry to provide short-term solutions. The answer comes with energy optimization at both the component and vehicle system level. The battery-based storage system is one of the major topics under research attention, the aim being the maximization of their energy content to improve autonomy and recharge times. To date, the reference solution for storage is represented by lithium-ion cells, on which intense development activity is concentrated on the optimization of both gravimetric and volumetric energy density. However, in order to take full advantage of these developments, a translation from cell-level into vehicle-level optimization through an integrated design of the entire battery system is required. To this end, the major aspects under study are: a) mechanical integration; b) thermal management of the system; c) electrical connections; d) management of battery system safety and operating conditions. Progetto finanziato nell'ambito del PNRR - DM 117/2023 - CUP E14D23002030004
	The proposed activity captures the current technological needs and aims to develop a solution that integrates the points listed above and leads to the construction of two demonstrator prototypes, one on a reduced scale based on a low voltage system (48V) and one on a full-scale high voltage (800V). The innovative contributions are: 1) development of an immersion cooling system for mass and volume reduction with respect to current state of the art solutions which exploit cold

Objectives	plates with indirect liquid thermal management. 2) study of sealing systems and selection of materials to ensure electrical, structural and thermal safety. A selection of materials will be evaluated, including composites, mica, ABS, fiber reinforced plastics, for the construction of external casing and internal barriers for thermal propagation mitigation. 3) development of a cell-to-pack system to maximize the efficiency of use of the volume occupied by the battery system with respect to majority of current solutions which are based on cell to module approach. 4) integrated thermal, electrical and degradation modeling of latest generation cylindrical cells through experimental characterization. 5) Study of thermal management innovative solutions for pre-heating phase of the battery system in case of low ambient temperature based on immersion cooling solution. In this activity framework, the PhD student will be involved in the following tasks: 1) Computer aided design of the battery system, including structural, electrical, hydraulic and thermal properties and functions. 3D CAD software (Solidworks) will be adopted. 2) CFD numerical modeling at cell and system level. Multi-physics numerical tools (COMSOL) will be adopted. 3) Integrated battery system modeling in Matlab/Simulink environment. 4) Experimental test and performance assessment on the two prototypes. 5) Mobility period of at least 6 months at qualified internationally recognized universities or research centers.

Skills and competencies for the development of the activity	Modelling and simulation in Matlab/Simulink. CAD and CFD numerical modeling capabilities.