POLITECNICO DI MILANO

PhD in INGEGNERIA MECCANICA / MECHANICAL ENGINEERING - 41st cycle

THEMATIC Research Field: DEMANUFACTURING AND REASSEMBLY SYSTEMS FOR LI-ION BATTERIES SECOND-LIFE APPLICATIONS

Monthly net income of PhDscholarship (max 36 months)
1500.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The continuous growth of electric mobility and energy storage markets has led to an increasing volume of lithium-ion batteries reaching their first end-of-life, though often retaining significant residual capacity. Recovering and reusing these batteries in second-life applications, such as stationary energy storage, offers substantial environmental and economic benefits. The EU Battery Regulation formally recognizes this potential through state-of-health (SoH) thresholds, traceability requirements, and the introduction of the Digital Product Passport (DPP) as a central enabler for transparency and circularity across the battery lifecycle. However, barriers such as variability in degradation patterns, lack of standardized testing and data protocols complicate large-scale adoption. Unlocking the potential for second-life applications requires integrated understanding of technical process feasibility and economic viability, supported by reliable lifecycle data. The objective of this research is to design and develop a decision-support framework integrating process modelling, digital traceability, and business model analysis for second-life Li-ion batteries. The framework will exploit data from the DPP to guide disassembly, testing, reassembly, and certification processes, supporting both technical feasibility and business viability. The final goal is to demonstrate how circular process design and DPP-enabled traceability can create resilient and profitable value chains for the battery sector in Italy and Europe.

Methods and techniques that will be developed and used to carry out the research	The research will be conducted by combining process modelling, experimental analysis, and circular business validation activities, structured in five main phases. In the first phase, a mapping of the battery lifecycle stages will be carried out, from production and first use to collection, diagnosis, and redeployment. Relevant DPP data fields will be identified to represent SoH indicators, provenance data, and material composition, in compliance with EU Battery Regulation requirements.In the second phase, diagnostic and testing procedures will be developed to assess residual performance and safety conditions. These procedures will enable classification of battery modules and cells according to possible second-use applications or recycling routes. DPP data will be used to trace individual unit histories, considering both nominal and real battery conditions, and linking performance trends to end-of-use strategy.In the third phase, a process modelling framework will be established, integrating disassembly, testing, reassembly, and certification steps. Stochastic modelling and simulation will be employed to handle variability in product conditions and to identify optimal reconditioning and redeployment strategies that maximize recovered capacity and retained value.In the fourth phase, the DPP will be integrated as a digital decision-support layer, connecting technical and economic information along the process chain. This will enable real-time lifecycle data exchange between physical testing and business model simulation, ensuring that second-life operations are both traceable and economically justified.In the fifth phase, the combined process and business model will be validated at pilot level, using industrial case studies and real DPP data. Key performance indicators (KPIs) related to lifecycle cost, environmental impact, and second-life market profitability will be defined and assessed, demonstrating scalability and compliance with the new EU regulatory framework.
Educational objectives	Doctoral candidates will acquire competences on circularity-oriented design and management of second-life systems for lithium-ion batteries, with specific emphasis on SoH-based process planning, digital traceability, and

	circular business model design. They will develop knowledge on diagnostic and testing procedures, disassembly and reassembly methods, lifecycle data modelling, and DPP-based information management, as well as on economic and environmental impact assessment.Through modelling, simulation, and pilot validation activities, candidates will gain the ability to integrate technical and economic perspectives in the design of circular battery systems, with specific focus on lifecycle traceability, regulation compliance, and impact assessment, in alignment with European industrial and environmental objectives.
Job opportunities	Employment statistics of PhDs can be found https://cm.careerservice.polimi.it/en/employment-statistics/
Composition of the research group	1 Full Professors 1 Associated Professors 2 Assistant Professors 4 PhD Students
Name of the research directors	Prof. Marcello Colledani

Contacts
For questions about scholarship/support phd-dmec@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Financial aid is available for all PhD candidates (purchase of study books and materials, funding for participation in courses, summer schools, workshops and conferences) for a total amount of € 6.114,50. Our candidates are strongly encouraged to spend a research period abroad, joining high-level research groups in the specific PhD research topic, selected in agreement with the Supervisor.An increase in the scholarship will be applied for periods up to 6 months (approx. 750

euro/month- net amount). Teaching assistantship: availability of funding in recognition of supporting teaching activities by the PhD candidate. There are various forms of financial aid for activities of support to theteaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.