



# PhD in INGEGNERIA DEI MATERIALI / MATERIALS ENGINEERING - 39th cycle

**THEMATIC Research Field: RECYCLING STRATEGIES FOR THERMOPLASTIC AND THERMOSETTING COMPOSITE MATERIALS USED IN THE ELECTRICAL SECTOR**

**Monthly net income of PhDscholarship (max 36 months)**

**€ 1400.0**

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

In the context of the European Union's commitment to a circular economy, the electrical sector faces a critical challenge in meeting the ambitious recycling targets set by the WEEE Directive (2012/19/EU).

Plastics, constituting 20 to 30% in weight of WEEE (Waste from Electrical and Electronical Equipment), are integral to this challenge.

As of 2021, the EU's collection rate for WEEE stands at 46.2%, notably below the 65% target mandated by the directive. Additionally, numerous European countries struggle to meet the ambitious recovery and recycling targets mandated by the WEEE directive - set at 85% and 80%, respectively.

This challenge is arguably attributed to the complexity associated with recovering low-value waste, such as plastics. This research aims to bridge the gap by comprehensively evaluating recycling strategies for thermoplastic and thermosetting composite materials in the electrical sector. With the current collection rate falling short, an enhanced understanding of recycling processes, especially for hard-to-recycle materials, becomes imperative. Successful implementation of improved technologies and knowledge can significantly contribute to achieving the recycling targets, fostering a more sustainable and efficient management of this vital waste stream.



<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>This research takes a comprehensive approach, focusing on a thorough review and assessment of a wide range of recycling technologies for composite materials used in the electrical sector. Specifically, the target materials are those mainly used in ABB products, such as:</p> <ul style="list-style-type: none"> <li>•Polyamide and Polycarbonate composites (thermoplastics)</li> <li>•Bulk / Sheet Molding Compounds (thermosets)</li> </ul> <p>The emphasis lies in a comparative analysis across three key indicators: Techno-economic, Environmental (Life Cycle Assessment - LCA), and Social (Social Life Cycle Assessment, S-LCA). Rather than heavily relying on experimental methodologies, this study will leverage a systematic review of the literature to identify and evaluate a broad spectrum of recycling technologies, assessing their efficacy across different scales (lab, pilot, and commercial). The research will critically examine both innovative and established technologies, assessing their scalability and practical implementation. Selective experimental tests and data collection campaigns will be conducted when necessary for unexplored recycling techniques.</p> <p>This structured framework aims to provide a concise yet comprehensive comparison of all known technologies, shedding light on their strengths and weaknesses based on the defined indicators. The ultimate goal is to contribute valuable insights that inform sustainable design strategies and support decision-making within the electrical sector.</p> <p>The research is funded by ABB; it will be developed at the department of Chemistry, Materials, and Chemical Engineering (DCMC) of Politecnico di Milano, with the support of ABB laboratories located in Bergamo.</p>
<p><b>Educational objectives</b></p>	<p>The project offers the candidate the chance to prepare recycled materials while gaining proficiency in a variety of experimental characterization techniques. A primary</p>



	<p>emphasis will be on mastering the life cycle sustainability methodology, specifically applying it to real case studies derived from experimental activities.</p> <p>Additionally, the candidate will collaborate with industry experts and technicians, gaining valuable experience in an industrial environment, with a particular focus on techno-economic assessments and life cycle sustainability considerations.</p>
<b>Job opportunities</b>	<p>The project delves into a pivotal area aligned with upcoming European policies, making it a focal point for industries shaping their economic and strategic decisions in the next decade. Consequently, there will be a heightened demand for experts in waste valorization, recycling technologies, and Life Cycle Sustainability Assessment (LCSA) methodologies, offering promising career prospects for individuals equipped with the knowledge and skills gained from this research.</p>
<b>Composition of the research group</b>	<p>1 Full Professors 2 Associated Professors 3 Assistant Professors 9 PhD Students</p>
<b>Name of the research directors</b>	Prof. Giovanni Dotelli

<b>Contacts</b>	
<p><i>Prof. Giovanni Dotelli:</i> <i>giovanni.dotelli@polimi.it</i> <i>Materials For Energy and Environment website:</i> <i>mat4en2.cmic.polimi.it</i></p>	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	700.0 €
<b>By number of months</b>	6



**Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information**

**Confidentiality (Agreement with company):** since this is a thematic scholarship, the management of Confidential Information, Results and their publication is subordinate to the restrictions agreed upon with the funding company. Upon acceptance of the scholarship, the beneficiary must sign a specific commitment.

**Individual budget for research (5.700 euro):** 1<sup>st</sup> year: 1.900 euro; 2<sup>nd</sup> year: 1.900 euro; 3<sup>rd</sup> year: 1.900 euro

**Teaching assistantship (availability of funding in recognition of supporting teaching activities by the PhD student):** there are various forms of financial for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.