



PhD in CHIMICA INDUSTRIALE E INGEGNERIA

CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 39th cycle

**PNRR 118 PA Research Field: CIRCULAR ECONOMY AND RENEWABLE SOURCES:
THERMOCHEMICAL VALORIZATION OF BIOMASS, WASTE AND PLASTICS**

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

The worldwide push for a transition towards a carbon-neutral economy calls for renewable sources and new concepts in all the production chains; in this respect, waste biomass is an important resource for the energy market and the circular economy, the true pathway to sustainability. Due to its chemical nature, lignocellulosic biomass is not suitable for the chemical and biochemical technologies currently applied for first generation biomass conversion. Thermal processes based on pyrolysis offer instead an opportunity to tackle by heat the complex biomass components and favor their conversion into a pool of products, with chemical nature and energy content of great interest (bio-H₂, bio-oil, bio-char). Extensive research is still needed to optimize the thermochemical conversion processes depending on the nature of bio-feedstock and the targeted energy products; building a sound scientific and technological know-how will contribute to inform the national energy strategies and bring biomass and waste exploitation closer to the society needs. To this scope, the PhD project will pursue the following objectives:

- (a) Resource: update the data-base of the national biomass supply as a basis for future regulation framework;
- (b) Needs: identify market needs where biomass can play a role through thermochemical conversion processes



	<p>to fuel gases, logistic fuels or biochar;</p> <p>(c) Scientific challenge: characterize the kinetics of biomass pyrolysis (the key step of thermochemical processes), and develop descriptive models able to correlate the chemical nature of the bio-feedstock with the product slate;</p> <p>(d) Technological challenge: apply the developed models to reactor design and optimization to maximize the quality and yield of energy products (e.g. H₂ or SAF, sustainable aviation fuels) or biochar for agricultural uses;</p> <p>(e) Biomass and/or plastics?: explore the exploitation of hybrid feedstocks, combining biomass and other C-waste, including thermo-plastics and elastomers;</p> <p>(f) Informing the policy maker: assess the technological feasibility of Biomass to X-processes in the Italian energy market and circular economy.</p> <p><i>Connections with PNRR</i> The research objectives are fully consistent with Mission 2 – Green revolution of the PNRR agenda, and in particular M2C1 (Sustainable agriculture and circular economy – See research on biomass conversion, waste management) and M2C2 (Renewable energy, hydrogen, grid and sustainable mobility – see projects on production or conversion of renewable energy carriers and fuels)</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>This project will tackle the study of thermochemical processes for the valorization of biomass and waste with a multidisciplinary approach, as required by the complex and multi-faceted nature of the subject. The project will combine experimental studies and modeling activities with market analyses and techno-economic investigations. To this purpose, the complementary competences and background of Polimi and RSE, the project partner, will be pooled and synergistically exploited.</p> <p>The LCCP group at Polimi has pioneered multidisciplinary research in the science and engineering of heterogeneous catalysis, expanding from applications in industrial chemical processes to novel fields associated with energy conversion, environmental protection and sustainable production of chemicals. The group has developed in-depth competences and experimental facilities for the study of biomass and plastic conversion processes.</p>



	<p>The CRECK group at Polimi brings its experience in the field of the modelling of chemical reactors and industrial processes, specializing in pyrolysis, gasification and combustion of fossil and alternative fuels, including biomasses.</p> <p>The two groups have been collaborating on previous projects related to thermo-catalytic processes for the valorization of biomass and plastic waste . In addition, these groups are currently engaged in the PNRR-project Agritech - National Research Centre for Agricultural Technologies (Spoke 8 – New models of circular economy in agriculture through waste valorization and recycling). The groups have active collaborations with international research groups, among which is the group of prof. DE Chen at the Department of Chemical Engineering at NTNU, Norway, where the student will spend a 6-month period.</p> <p>RSE has a consolidated experience in the field of energy research and innovation, focusing on national and European strategic projects. Key areas of expertise include development of renewable energy technologies by experimental and modelling studies, technology demonstration at high TRL, supporting decision-making processes and regulatory frameworks.</p> <p>During the 6-moth stage at RSE, the PhD student will carry out research activities with focus on the obtainment of high-purity energy products, including bio-H₂, via separation technologies of complex bio-derived mixtures.</p>
Educational objectives	<p>The main educational goal is to raise a highly qualified young researcher in the field of thermochemical conversion of biomass and waste into fuels and chemicals, focusing on kinetics, experimentation and modelling. The PhD candidate will also be trained to energy market analysis and techno-economic studies.</p>
Job opportunities	<ul style="list-style-type: none"> •R&D activities in chemical and energy companies •Engineering companies •Energy companies •Energy expert for Public Administration, policy makers and regulatory agencies.



Composition of the research group	6 Full Professors 4 Associated Professors 4 Assistant Professors 25 PhD Students
Name of the research directors	Prof.ssa Beretta, Prof. Lietti, Prof. Frassoldati

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

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	0

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	RSE Via R. Rubattino 54, 20134 Milano https://www.rse-web.it/
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	NTNU www.ntnu.no
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>Financial aid per PhD student is available for purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences, instrumentations and computer, etc..</p> <p>Confidentiality the management of Confidential Information, including results and their publication, associated to the activity with the company is subordinate to possible restrictions agreed upon with the company. Upon acceptance of the scholarship, the beneficiary must sign a specific commitment.</p> <p>Individual budget for research (5.700 euro): 1st year: 1.900 euro; 2nd year: 1.900 euro; 3rd 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</p>



within the limits allowed by the regulation.