POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 39th cycle

THEMATIC Research Field: CONCENTRATED SOLAR POWER FOR PYROLYSIS AND OTHER RELEVANT INDUSTRIAL 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	Biomass pyrolysis for the production of valuable bio-oil has been widely studied in the EU over the last decades. The heat of reaction is usually supplied through the combustion of part of the pyrolysis products (char, pyrogas) representing an economic and environmentally inefficient step, as it involves the loss of high value biogenic carbon which is emitted as carbon dioxide, causing the reduction of the carbon efficiency and of the overall yield of bio-products.The objective of the thesis, within the context of the HE project PYSOLO, is to study the integration of concentrating solar power (CSP) in the process to sustain the endothermic reaction avoiding the combustion of char which could be valorized for improving the quality of soils. The process can thus achieve substantial CO_2 negative emissions on LCA basis. The potentiality of integration of CSP in other relevant industrial applications requiring medium-high temperature heat such as material transformation processes will be also assessed. The project will be developed through the following work packages (WPs): •WP1 (months 1-18): definition of the mass and energy balances of the pyrolysis process through Aspen Plus. Comparative analysis of conventional processes based on char/pyrogas combustion and novel process with the integration of concentrating solar power. Investigation of

	the use of different particle heat carriers. Design of heliostat fields for the designed target power. Development of models for economic analysis and techno-economic comparative analysis. •WP2 (months 18-30): development of models for the calculation of balances of the CSP-assisted plant through yearly simulations with hourly discretization. Optimization of the size of the CSP plant and of the thermal energy storage with respect to the pyrolysis plant. Evaluate the integration with other intermittent renewable energy supply in the process through electric/induction heating systems. Study of the potential integration of solar-assisted pyrolysis into a bio-refinery plant. •WP3 (months 24-36): Identification of other relevant industrial applications where medium-high temperature solar heat can be exploited. Techno economic analysis of the CSP-assisted solutions with respect to conventional technology
Methods and techniques that will be developed and used to carry out the research	The research program requires the use of the following computational tools: •Aspen Plus software, for the calculation of mass and energy balances of state-of-the art pyrolysis process and other industrial processes and of their possible future variants integrating concentrating solar power. •SolarPilot/Soltrace softwares for the design and calculation of the performance of heliostat fields. •Optimization software (e.g. Matlab, GAMS) for the optimization of industrial plants integrated with intermittent renewable energy supply.
Educational objectives	The PhD candidate will: • Become expert of energy pyrolysis process and of its potential integration with bio-refineries. • Become an expert on concentrating solar power system for medium-high temperature heat producction

	• Become expert in critically analysing the performance of energy conversion processes from energy, environmental and economic points of view. • Acquire specific modelling experience on the optimization of CSP-assisted energy systems • Become proficient user of software for process simulations (Aspen Plus), solar tower design (Solar Pilot/Soltrace) and optimization (Gams, Matlab).
Job opportunities	Apart from academia and research institutes, the main expected job opportunities after the PhD will be in consultancy, in CSP/Pryolsys industry and in industries that in the next decade will implement solar assisted processes and technologies to reduce their carbon footprint.
Composition of the research group	5 Full Professors 7 Associated Professors 7 Assistant Professors 40 PhD Students
Name of the research directors	Marco Binotti, Matteo Carmelo Romano

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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	750.0 €
By number of months	6

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

Educational activities:

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. This amount is equal to 10% of the annual gross amount, for 3 years.
Teaching assistantship:
Availability of funding in recognition of supporting teaching activities by the PhD student. There are various forms of financial aid 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 regulations.
Computer availability: individual use.
Desk availability: individual use.
Awards:Awards will be recognized to the PhD candidate up to Euro 4000 (gross amount) per year, in case of exceptional achievements in the research project, subject to the evaluation of the research director.