



PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 38th cycle

**PARTENARIATO PNRR Research Field: PARTENARIATO PNRR ECS-PC-ECOSISTER -
RESEARCH TITLE: ECOSYSTEM FOR THE SUSTAINABLE TRANSITION IN THE EMILIA-
ROMAGNA REGION - INDUSTRIAL HEAT PUMPS AND WASTE HEAT RECOVERY
SOLUTIONS**

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

CUP D73C22000800001

Decreto di Concessione D.D. 1052 del 23/06/2022

In the framework of the PNRR funded Project 'Ecosistema per la transizione sostenibile in Emilia Romagna', clean energy systems, their components and their optimal integration with future Renewable Energy Sources (RES) based networks are studied.

High temperature heat pumps are among the most interesting technologies for the decarbonization of 'process heat' via electrification, especially in industrial sectors where natural gas is still the major thermal source and where waste heat is still unexploited, such as food and beverage, chemicals processing, paper manufacturing, textiles, etc. The main goal of this research activity will be to study the upgrading of the industrial waste heat available (optionally combined with ambient heat) up to different temperature levels, depending on the application: both medium temperature levels between 100 and 150 °C (where mature heat pump technologies are available, but need to be optimized) and high temperature levels from 150 °C up to 250 °C will be targeted in the research (where the TRL is lower and new

Motivation and objectives of the research in this field



	<p>pilot plants must be designed). The main activities performed will be:</p> <ul style="list-style-type: none"> • Map and assess different industrial sectors where high temperature heat pumps may have a potential from the point of view of integration, exploitation of waste heat available and replicability and impact in terms of energy and emission savings and costs • Identify the best working fluid, heat pump cycle configuration and operating conditions for two case studies. New working fluids and mixtures, ensuring thermal/chemical stability at high T and leading to improved cost and thermodynamic efficiencies compared to conventional refrigerants will be studied. Thermodynamic (i.e. Equations of state) and cycle models will be developed to simulate the performances of the heat pump, including the heat recovery system. • The most critical pieces of equipment (e.g. compressor, heat exchanger), in terms of design and operation, will be identified and preliminary design will be conducted, where relevant, to provide initial information suitable for a pilot plant installation. • Process integration studies, possible optimized operation of the HP, techno-economic assessments (to understand the feasibility) and preliminary evaluation of the potential impact and replicability of the heat pumps for two selected sectors will be carried out. <p>The research group promoting this PhD theme will be in charge of contributing to such a Project both directly from the Polimi side, and by coordinating researchers of the LEAP Lab (www.leap.polimi.it), a consortium company participated by Polimi and active in the fields of renewable energy valorisation with dedicated research programs.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The research will cover several tasks of the Project entailing the development of numerical models, process design and thermodynamic modelling activities, as well as techno-economic feasibility studies.</p> <p>The PhD candidate will deal with data from real plants or from models/literature. Process engineering analysis tools</p>



	<p>and software (e.g. Aspen Plus, gProms, Matlab, Phytion, Thermoflex, etc.) will be used for process modelling and simulation purposes. In the framework of the research Project funding the PhD position, the candidate will be involved in project meetings, deliverables preparation, as well as in the operational execution of specific tasks (spanning from modelling, to testing, to dissemination and communication activities). PhD results shall be published in scientific papers, submitted to international journals, and/or presented at conferences.</p> <p>Most of the research will be carried out in collaboration with researchers operating at LEAP Lab in Piacenza.</p>
Educational objectives	<p>In the course of this job experience, the candidate will develop:</p> <ul style="list-style-type: none"> •scientific and technical skills thanks to the guidance of experienced professors and research staff of the POLIMI research group and LEAP lab. •A detailed know-how in the field of heat pumps, technologies for waste heat valorization and Renewable Energy Sources (RES) •Skills in teaching and supervision of younger students. •Project management skills. •Skills in the preparation of research projects proposals for competitive calls.
Job opportunities	<p>The PhD research will qualify the candidate with skills in applied research and technology transfer in the field of RES and heat pumps. After PhD graduation the candidate may work on design and optimization of industrial heat pumps and RES-based systems within industry or the academia.</p> <p>In this area, Politecnico di Milano and LEAP are involved in national and international collaborative research projects in partnership with companies and other R&D institutions. There is a significant request of highly skilled profiles in this field.</p>
Composition of the research group	<p>1 Full Professors 1 Associated Professors 2 Assistant Professors</p>



	6 PhD Students
Name of the research directors	Federico Viganò, Manuele Gatti, Stefano Consonni

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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	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>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.</p> <p>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.</p> <p>Computer availability: individual use.</p> <p>Desk availability: individual use.</p> <p>Awards: Awards up to 4000 € net per year may be granted upon achievement of satisfactory results in terms of scientific performance and contribution to side activities. More details will be provided by the supervisors/tutor and PhD school.</p>