POLITECNICO DI MILANO

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

THEMATIC Research Field: CARBON DIOXIDE SUPERCRITICAL CYCLES FOR NEXT GENERATION CSP PLANTS

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	**Borsa Finanziata su progetto PRIN 2022 "MUSIC": CUP D53D23003850006 (per 20 mesi da Febbraio 2024 a Settembre 2025)** **La quota rimanente sarà finanziata sul progetto Horizon Europe "P2P - Powder to power" (16 mesi da Ottobre 2025 a Gennaio 2027)** Future power generation systems will require the use of power plants based on technologies that would allow to enhance the efficiency, reduce the cost and improve the dynamic response. The development power plants using carbon dioxide as working fluid in supercritical or trans-critical cycles (sCO2 cycles) is widely recognized as a keystone technology for several type of power production systems based on both renewable energies (i.e. high temperature concentrating solar power, CSP), conventional sources (i.e. fossil fuels and nuclear) but also waste heat recovery. Goal of the research is to develop numerical methods able to optimize sCO2 power plants from techno-economic perspective and simulate them in off design conditions. The code will be then applied for the comparison of sCO2 with conventional technologies for CSP applications. Main focus of the project will be on concentrating solar power but analysis will be then expanded to different use cases based on other energy sources. The research is financed by the

	MUR Progetto di Rilevanza Nazionale (PRIN2022) "MUSIC - MUlti-tower small-scale concentrating Solar power plants based on efficient and flexible sCO2 cycles to provide dispatchable electricity and hydrogen production for the Italian Context", within a consortium coordinated by Politecnico di Milano and with the participation of Università degli Studi di Firenze, and partially financed by Horizon Europe "P2P - Powder to Power" project coordinated by Promes CNRS.
Methods and techniques that will be developed and used to carry out the research	Numerical model will be developed in Matlab or Phyton working on different boundaries. Outer level will allow to select and describe different use cases from renewable energy exploitation, conventional sources and waste heat recovery with a complete characterization of the system boundaries, specification and relevant quantities. Intermediate level will focus on the optimization of the power plant selecting the optimal layout among a large database of possible configurations and by optimizing them from technoeconomic perspective using optimization tools possibly based on pareto front analysis. This model will also integrate subroutines specifically developed for the sizing of the different components with a particular focus on the heat exchangers and the turbomachinery. The inner level will aim at testing the selected cycles in off design providing understanding of the annual behavior and performances. Iterations between the different model levels are expected in order to identify the optimal configuration able to fulfill the case requirements.
Educational objectives	To prepare a modern and professional expert in the design and optimization of future power plant and CSP systems based on supercritical carbon dioxide, with a deep knowledge of the sizing criteria of the different components and a strong background in cycle thermodynamic and numerical methods for the energy engineering.
Job opportunities	Safety specialist, risk analyst, risk engineer, risk manager, safety data analyst with competences fit for the risk-based design, operation, management and regulation of complex systems and critical infrastructures (e.g., aerospace,

	nuclear, chemical, energy generation and distribution, etc.)
Composition of the research group	0 Full Professors 3 Associated Professors 1 Assistant Professors 0 PhD Students
Name of the research directors	Paolo Silva, Marco Astolfi

Contacts
paolo.silva@polimi.it, marco.astolfi@polimi.it

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.

Joint/Double PhD program: -

Computer availability*:* individual use.

Desk availability*:* individual use.