



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

PNRR 117 Research Field: ANALYSIS AND OPTIMIZATION OF POWER CONVERSION SYSTEM FOR INNOVATIVE ENERGY USES IN SMALL AND ADVANCED MODULAR REACTORS

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

Energy is today at the forefront of the World as well as of the European and Italian concerns, because of the emerging, new trilemma: global warming, strategic and geo-politic dependence, economic impact. The ecological transition is one of the key pillars of the EU policies as well as of the Italian recovery plan (PNRR). Nuclear energy represents today almost 50% of the carbon-free electricity in EU and around 10% of total electricity consumption in Italy. According also to IPCC reports, the CO₂ equivalent emissions per kWh produced for nuclear are equivalent to wind power and lower than photovoltaic. In such a framework, new generation fission technologies like the Small/Advanced Modular Reactors, may play an important role in generating CO₂-free, reliable and programmable energy supply in the short run (within 2030). Flexible operation allow SMRs/AMRs to be highly integrable with renewable energy sources. In this view, the power conversion system plays a key role in enabling innovative energy-use of SMRs/AMR as cogeneration, hydrogen production, district heating, etc... Notwithstanding, a comprehensive analysis has to be carried out to assess the flexibility of the power conversion system to deal with an increased non-electrical use and to ensure that these new energy usages do not pose any concerns from a safety point of



	<p>view. The Italian industrial supply chain in the nuclear sector, where Ansaldo Nucleare is a leading company, is active and highly competitive, collaborating in the manufacturing of components and systems for current reactors and the design process for new generation reactors (SMR, Generation IV). For the above-mentioned reasons, the motivation and objective of the research can be fully considered in line with the topics targeted by DM n.352 (09/04/2022), Art.s 1.7 ("missions") and 6.4a ("companies' innovation needs"). PNRR: Mission#2C2 and Mission#4C2. More in detail, the R&D activity proposed is part of the Italian effort in the field, focusing on the capabilities of the SMR/AMR to comply with the EU strategy on energy system integration (COM/2020/299). Specific objectives of the investigation will be:- to familiarize with the power conversion systems foreseen in SMR/AMR-type reactors,- to analyse the requirements in terms of heat and electrical input asked by the different end-user applications,- to analyze the flexibility of the current power conversion systems to deal with multi energy uses and to propose optimized configurations according to different mix of end-user applications,- to dynamically model off-design conditions and to assess their compliance with operational limits,- to carry out a safety analysis of the SMR/AMRs when innovative energy-uses are considered. The PhD candidate will spend at least 6 months at Ansaldo Nucleare.</p>
Methods and techniques that will be developed and used to carry out the research	<p>A comprehensive approach will be adopted, to address fluid dynamic, thermal hydraulic, thermo-mechanics and system features. Design and dynamic analysis to evaluate power conversion for SMR/AMR flexibility features will be the main investigation method. The methods and techniques to be used will be mainly of numerical-modelling type with experimental validation, when possible. Among the state-of-the-art simulation codes: RELAP5, CATHARE (system codes), OpenFoam (CFD - multiphysics), MODELICA (object oriented modelling).</p>
Educational objectives	<p>The PhD candidate will develop a comprehensive approach, devoted to address both the design and the dynamic analysis of power conversion systems. A critical</p>



	analysis capability will be nurtured during the whole PhD programme. A further objective will be to gain a high-qualified know-how and expertise in the nuclear energy and innovative reactors area. The educational path of the PhD candidate on the main features of SMR/AMR, their behavior and interaction, will be developed together with Ansaldo Nucleare. Team working and problem solving capabilities will be key educational objectives as well.
Job opportunities	The candidate profile will be highly attractive both in the research environment, where crossdisciplinary skills are more and more appreciated, and in the expanding field of innovative, new generation nuclear reactors (e.g. system design, safety analysis), where besides large companies, start-up companies are emerging in the World, in Europe and also in Italy.
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 12 PhD Students
Name of the research directors	Stefano Lorenzi

Contacts	
Phone +39-02-23993814	
Email stefano.lorenzi@polimi.it	
Email phd-STEN@polimi.it	
Research Group web site www.nuclearenergy.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	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Ansaldo Nucleare
By number of months at the company	6
Institution or company where the candidate will spend the period abroad	Company, research center or university to be agreed with Ansaldo Nucleare



candidate will spend the period abroad (name and brief description)	Nucleare
By number of months abroad	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. The amount is about Euro 5700.

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. Accommodation in Politecnico's Residences (<http://www.residenze.polimi.it>) is available for PhD candidates; special rates will be applied to selected out-of-town candidates (detailed info in the call for application).

Research period abroad: Our candidates are strongly encouraged (6 months minimum is mandatory) to spend a research period abroad, joining high-level, research groups in the specific PhD research topic, selected in agreement with the Supervisor. An increase in the scholarship will be applied for periods up to 6 months (approx. 700 euro/month - net amount).