



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

**PNRR\_352 Research Field: THERMAL HYDRAULICS AND PASSIVE SAFETY SYSTEMS IN SMALL 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 ecologic 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 CO<sub>2</sub> 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 CO<sub>2</sub>-free, reliable and programmable energy supply in the short run (within 2030).

Moreover, flexible operation and cogeneration capabilities (hydrogen, district heating, desalination, biofuels) allow SMRs/AMRs to be highly integrable with renewable energy sources. Safety concerns are furtherly reduced and practically eliminated, by the adoption of passive safety systems. Construction time and cost concerns are addressed by a modular, shop construction and by size reduction.

The Italian industrial supply chain in the nuclear sector,



	<p>where Ansaldo Nucleare is a leading company, is active and highly competitive, collaborating in the manufacturing of components and systems for current reactors and in the design process for new generation reactors (SMR, Generation IV).</p> <p>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 ("<i>missions</i>") and 6.4a ("<i>companies' innovation needs</i>"). PNRR: Mission#2C2 and Mission#4C2.</p> <p>More in detail, the R&amp;D activity proposed is part of the Italian effort in the field, focusing on the SMR/AMR safety features, namely the passive systems for the removal of heat in accident conditions. Specific objectives of the investigation will be:</p> <ul style="list-style-type: none"> <li>- to familiarize with the different types of passive systems applicable to SMR/AMR-type reactors,</li> <li>- to analyze the relevant physical phenomena, the stand-by conditions and the final state conditions,</li> <li>- to analyze the dynamics and functioning of passive systems through system codes,</li> <li>- to carry out the integrated safety analyzes of the plant in enveloping conditions,</li> <li>- to address issues related to the reliability of passive systems,</li> <li>- to evaluate the integration at the plant level and to propose further improvements.</li> </ul> <p>The PhD candidate will spend at least 6 months at Ansaldo Nucleare.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>A comprehensive approach will be adopted, to address fluid dynamic / thermal hydraulic and system features. Dynamic analysis to evaluate SMR/AMR safety features will be the main investigation method.</p> <p>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, MELCORE (system codes), OpenFoam (CFD - multiphysics), MODELICA (object oriented modelling), Matlab-Simulink (control system).</p>



<p><b>Educational objectives</b></p>	<p>The PhD candidate will develop a comprehensive approach, devoted to address both the design and the dynamic analysis of passive safety systems. Passive safety strategies will be analysed and possibly innovative solutions developed.</p> <p>A critical 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.</p> <p>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.</p> <p>Team working and problem solving capabilities will be key educational objectives as well.</p>
<p><b>Job opportunities</b></p>	<p>The emerging candidate's profile will be highly attractive both in the research environment, where cross-disciplinary 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.</p> <p>Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research: EdF, CEA (FRA), VTT, Fortum (FIN), Tractebel-Engie (BEL), GRS (GER), ENEA, SIET (ITA), ICN (ROM).</p>
<p><b>Composition of the research group</b></p>	<p>1 Full Professors 2 Associated Professors 2 Assistant Professors 10 PhD Students</p>
<p><b>Name of the research directors</b></p>	<p>prof. Marco Ricotti</p>

<b>Contacts</b>
<p><i>Phone</i> +39-02-23996325  <i>Email</i> marco.ricotti@polimi.it  <i>Email</i> phd-STEN@polimi.it  <i>Research Group web site</i> www.nuclearenergy.polimi.it</p>

**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, Corso F.M. Perrone, 25, 16152 Genova
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	(azienda, centro di ricerca o università europee o extra-europee, da concordare con Ansaldo Nucleare; es. EdF-FRA, VTT-FIN, Tractebel ENGIE-BEL)
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).