POLITECNICO DI MILANO

PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 41st cycle

THEMATIC Research Field: INTEGRATION OF SOLID OXIDE ELECTROLYSIS WITH ADVANCED NUCLEAR REACTORS AND OTHER NON-CONVENTIONAL ENERGY SOURCES FOR HIGH-EFFICIENCY HYDROGEN COPRODUCTION

Monthly net income of PhDscholarship (max 36 months)
1600.0 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	The transition toward a sustainable and climate-neutral energy system is a central challenge for the coming decades. The EU goal of achieving net-zero greenhouse gas emissions by 2050 places a strong emphasis on decarbonizing key sectors such as transport and industry. Within this context, hydrogen has emerged as a crucial energy carrier, offering the potential to significantly reduce carbon emissions when produced from low-carbon sources. While renewable energy sources are expected to play a leading role, nuclear energy offers a complementary, stable, and dispatchable source of low-carbon power and heat that can be harnessed for hydrogen production. Among the various hydrogen production technologies, Solid Oxide Electrolysis Cells (SOECs) are particularly promising due to their high efficiency and the ability to utilize both electrical and thermal energy—an ideal match for advanced nuclear systems capable of delivering high-temperature heat. In this context, the GREEN-ENERGY project (HydroGen pRoduction from nuclEar ENergy for European Net zEro emissions stRateGY, ID 2022RL5TKX, PRIN 2022 (Scorrimento), CUP D53C24004150006) aims at studying the feasibility of hydrogen production from nuclear energy, assessing the design and safety aspects of coupling a nuclear reactor with a hydrogen production plant. The

	project focuses on SOEC for H2 generation, coupled with a nuclear reactor suitable to reach the requested temperature ranges. This doctoral research aims at exploring and validate the technical, economic, and safety feasibility of coupling nuclear reactors with SOEC-based hydrogen production plants, further investigating also the potential for integration with other non-conventional energy sources (like renewable power). This research will contribute to enabling nuclear power to play a meaningful role in the emerging hydrogen economy, supporting energy system flexibility, security, and decarbonization. It will also foster innovation in the fields of both hydrogen and nuclear engineering, strengthening industrial and research capabilities at the national and European level.
Methods and techniques that will be developed and used to carry out the research	The PhD project will entail the development of process models to simulate the behaviour of the components that builds the integrate systems for hydrogen and electricity (and heat) coproduction, both from a steady-state and a dynamic point of view, as well as models to assess integration at system level by identifying optimized operational schedules. In particular, activities will i) Identify suitable nuclear technologies (including current light water reactors and Generation-IV systems) that can support SOEC operation, ii) Design and optimize the hydrogen production process, integrating it effectively with the nuclear heat and power supply, iii) Develop a dynamic model of the integrated nuclear-hydrogen system to assess flexibility, especially in response to grid demands for electricity vs. hydrogen, iv) Assess the long-term (e.g., multi-day or up to year-long) schedule of the system for optimized integration considering also the possible presence of renewables. Simulation tools such as Aspen, Ebsilon, and Modelica will be widely used in the activity, together with tools for the simulation and optimization of integrated energy systems (such as MILP-based models). Additional tools supporting the analysis of the system operational points in both steady-state and dynamic conditions are to be

	considered along the PhD project.
Educational objectives	The PhD candidate will develop high-qualified skills and expertise in both hydrogen technology and nuclear energy &innovative reactors areas, comprising both technical details and techno-economic integration aspects. The presence of several international collaborations where the research activity is integrated will allow the student to interact with the maimajorn European and non-European institutions in this research field.
Job opportunities	After the completion of the PhD, the candidate profile will be highly attractive both in the research environment, where cross-disciplinary skills are more and more appreciated, and in the industry sector both in the hydrogen and nuclear field.
Composition of the research group	2 Full Professors 6 Associated Professors 2 Assistant Professors 30 PhD Students
Name of the research directors	Paolo Colbertaldo, Stefano Lorenzi

Contacts
paolo.colbertaldo@polimi.it, stefano.lorenzi@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents	--

Scholarship Increase for a period abroad	
Amount monthly	800.0 €
By number of months	6

Stage and period abroad	
Institution or company where the candidate will spend the period abroad (name and brief description)	
By number of months abroad	0

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 approx. 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 3000 (gross amount) per year, in case of exceptional achievements in the research project, subject to the evaluation of the research directors.