



PhD in SCIENZE E TECNOLOGIE ENERGETICHE E NUCLEARI / ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY - 40th cycle

THEMATIC Research Field: DEVELOPMENT OF INNOVATIVE ELECTROCHEMICAL DEVICES BASED ON HYDROGEN PRODUCTION FOR LONG TERM ENERGY STORAGE

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

Considering the indications of PNIEC 2030 (Piano Nazionale Integrato per l'Energia e il Clima), the development of storage technologies is fundamental to boost the penetration of renewable energy sources, permitting a reduction of overgeneration and a flexible and efficient operation and management of the electric grid. As reported in PNIEC, to tackle this issue the development of storage technologies with energy-to-power ratio higher than 8 will be necessary by 2030. In this scenario, vanadium redox flow batteries (VRFBs) are a promising technology due to the high cycle life and the intrinsic possibility to decouple energy and power. However, the high and variable cost of vanadium electrolyte hinders technology competitiveness for long term energy storage applications. The presented research project will be performed in the framework of MIAMI project (Materiali Innovativi per Sistemi di Accumulo Ibrido, CSEAA_00014, CUP D43C22004420001) with the aim to design a hybrid storage system, based on the integration of VRFBs and electrochemical devices for hydrogen production. This will be tackled using innovative materials, through a holistic approach that aims to the development of high-performance electrochemical energy storage systems promoting sustainability and circularity and relying on advanced electrochemical and analytical techniques. The following activities are identified: a)



	<p>analysis of the available materials and solutions for electrochemical hydrogen production in acidic environment; b) design of prototypes for electrochemical hydrogen production with the possibility to adopt innovative materials developed within the MIAMI project; c) experimental characterization during load profiles representative of real operation and integration with VRFBs.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The experimental analysis will be carried out through the experimental facilities available at MRT Fuel Cell & Battery Lab research group (https://www.mrtfuelcell.polimi.it/) and Pro-e-Storage interdepartmental laboratory. The experimental analysis will mainly consist of electrochemical characterizations, such as charge-discharge cycles, polarization curves, electrochemical impedance spectroscopy, that will be measured in advanced segmented cell hardware equipped with local hydrogen reference electrodes. Modeling analysis will be developed starting from proprietary codes based on Matlab[®] and/or ANSYS FLUENT to simulate system operation.</p>
<p>Educational objectives</p>	<p>The research topic is extremely interdisciplinary, ranging from material science to the engineering of the electrochemical device. The student will deepen his/her theoretical knowledge in thermodynamics, heat and mass transport phenomena and electrochemistry. The student will develop advanced expertise regarding electrochemical measurement techniques and physics-based modelling. Coordination of graduating students is also expected.</p>
<p>Job opportunities</p>	<p>Placement in enterprises operating in the field of energy storage, materials manufacturing, electrochemistry, modelling of energy systems. The acquired experience permits to continue the research career in academia and in research centres.</p>
<p>Composition of the research group</p>	<p>1 Full Professors 2 Associated Professors 1 Assistant Professors 7 PhD Students</p>



Name of the research directors	prof. Matteo Zago
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Contacts	
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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	750.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Increase in the scholarship for stays abroad: euro 750 per month, for up to 6 months.

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. *Computer availability:* individual use. *Desk availability:* individual use.

Awards: Awards will be recognized to the PhD candidate up to Euro 2000 (gross amount) per year, in case of exceptional achievements in the research project, subject to the evaluation of the research director.