



PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 38th cycle

PNRR_352 Research Field: HYBRID ENERGY STORAGE SYSTEM

Monthly net income of PhDscholarship (max 36 months)

€ 1275.0

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 widespread use of renewable energy sources has a relevant impact on the power systems, which requires solutions to increase flexibility and security. To achieve this result and as indicated in "Programma Nazionale per la Ricerca 2021-2027", it is fundamental the development of energy storage solutions with performances that can take into account the required services and the evolution of the system towards distributed, integrated, intelligent and interconnected solutions (Smart Grids). In this context, hybrid energy storage systems, which can increase the performances, the autonomy and the services offered by a battery, play a fundamental role to enhance the hosting capacity of the grid as required in "Mission 2 -. Green revolution and ecological transition" of the PNRR with particular reference to component 2 (Renewable energy, hydrogen, grid and sustainable mobility).

In this context, some of the major objectives of the research activity are: (i) the design of a tool for the optimal design of a hybrid storage system considering the required services, (ii) the modelling of power intensive storage and energy intensive storage, (iii) the modelling and design of high efficiency power electronic converters to integrate the storage in the grid, (iv) the design of optimal management strategies to exploit storage capabilities providing the ancillary services required by the grid.

The design and development of innovative hybrid storage systems will open new perspectives for the reliability and



	<p>efficiency of the electric power grid facilitating the achievement of several SDGs (Sustainable development goals) highlighted by the European Green Deal.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>The methods that will be used to perform the research activity are based on traditional tools from mathematics, physics, control theory, along with more advanced techniques such as mathematical programming and model predictive control.</p> <p>The PhD candidate will develop models for electronics components and energy storage systems considering also experimental activities for parameter identification and validation tests. Moreover, he will design control techniques and schemes to optimize static electrical energy conversion devices. Finally the design and implementation of algorithm for the optimal management of energy storage devices with respect to different objective functions (e.g., ancillary services provision, maximization of life cycle, economic benefits) will be also investigated.</p>
<p>Educational objectives</p>	<p>The candidate will acquire and/or refine his skills in design and optimization of power converters, drives and modulation techniques. Moreover, he will study in details models of different innovative storage systems for their integration in the power converter. Finally, knowledge of different storage technologies and their specific peculiarities will be acquired.</p> <p>Training in actively contributing to the project team, both in academic and industrial activities will be also a goal of this scholarship.</p>
<p>Job opportunities</p>	<p>The main opportunities are offered, typically, by R&D departments of both small and large innovative companies and manufacturers, companies working on power electronics, batteries and battery management systems, research centres, universities, e.g., the institutions involved in this project, RSE and RWTH, and other actively collaborating (e.g. University of Birmingham, University of Kiel).</p>
<p>Composition of the research group</p>	<p>0 Full Professors</p>



	3 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Prof. Luigi Piegari

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	637.5 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	RSE S.p.A.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	The project promotes collaboration with relevant international universities and research centers, e.g. RWTH Aachen University and Forschungszentrum Jülich (Germany). The foreign institution will be selected during the 3 years research program in agreement with the industrial partner.
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>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.</p> <p>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.</p> <p>Computer availability: individual use.</p> <p>Desk availability: individual use.</p>



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.