



# PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 38th cycle

**PNRR\_352 Research Field: STUDY AND DEVELOPMENT OF INNOVATIVE  
ARCHITECTURES FOR POWER ELECTRONICS CONVERTERS (MODULAR PCS)**

**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**

This research focuses on topics specified by the Italian national research program (PNR) 2021-2027. This program identifies six big research topics reflecting the Horizon Europe research clusters and taking into account the national smart specialization strategy (NSSS). In particular, the proposed research will face the topics regarding the integration of storages in the grid and the reduction of the environmental impact. In particular, the proposed research is centered in the topics *5.3 - Industrial Energy* of the PNR with particular reference to the Section (Articolazione) 1 - *Generation from renewable sources, storage systems and European and intercontinental power grids*. Finally, the proposed research is completely centered in the 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 the integration of storage systems in the grid is very important since it allows to decouple the production profiles of renewable sources, that is variable and, sometime, unpredictable, with the power requirement of the loads connected to the grid. The integration of storages must be flexible to allow the complete support to the grid and efficient to reduce the environmental impact of overall system. For this reason, new power electronics interfaces must be designed and opportunely controlled. Moreover, to make the solution scalable and applicable to grids of different size and power, a modular approach should be



	<p>considered. Finally, In order to make this solution more <i>green</i> and appealing, according with the Sustainable Development Goals (SDGs) of the United Nations, the possibility to use hybrid storages (i.e. more than one technology) and/or second life batteries represents an attractive solution. This implies additional technical challenges related to the energy management of the different technologies and/or the individual balancing of second life battery modules with different aging. The main goal of this research is to study and develop modular solutions of power converters to integrate different kind of storages in the grid achieving high efficiency, good performance in control and grid support and scalability. The designed solution should also take into account all the problems related to modular solutions (e.g. equal distribution of the power demand, common mode voltages and currents, etc.).</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The methods that will be used to perform the research activity are based on traditional tools from mathematics, physics, circuit theory, and control theory, along with more advanced techniques for the design, modulation and control of power converters.</p> <p>The PhD candidate will have to design new modular power converters for the integration of the storage in the grid. The designed converter must be able to support the grid with all the required ancillary services and must be completely modular allowing the interconnection of different number of modules on the basis of the application requirements and constraints (e.g. power and voltage level, service to implement, kind of storage to connect)</p> <p>The goal to achieve high efficiency will be pursued by using very innovative technologies (i.e. SiC and GaN components) together with the implementation of soft switching techniques.</p> <p>The PhD candidate will work on reduced scale prototype in the lab of POLIMI and he will be allowed to work on full scale power converters during his experience in the company promoting this activity.</p>
<p><b>Educational objectives</b></p>	<p>The candidate will acquire and/or refine his skills in design</p>



	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. Training in actively contributing to the project team, both in academic researches and in activities with industrial partners will be also a goal of this scholarship.
<b>Job opportunities</b>	The main opportunities are offered, typically, by R&D departments of both small and large innovative companies and manufacturers, companies working on power electronics, research centres, universities, e.g., the institutions involved in this project, NHOA Energy s.r.l and Norwegian University of Science and Technology, and other actively collaborating (e.g. University of Birmingham).
<b>Composition of the research group</b>	0 Full Professors 3 Associated Professors 1 Assistant Professors 4 PhD Students
<b>Name of the research directors</b>	Prof. Luigi Piegari

<b>Contacts</b>	
luigi.piegari@polimi.it phone: 02 23994125	

<b>Additional support - Financial aid per PhD student per year (gross amount)</b>	
<b>Housing - Foreign Students</b>	--
<b>Housing - Out-of-town residents (more than 80Km out of Milano)</b>	--

<b>Scholarship Increase for a period abroad</b>	
<b>Amount monthly</b>	700.0 €
<b>By number of months</b>	6

<b>National Operational Program for Research and Innovation</b>	
<b>Company where the candidate will attend the stage (name and brief description)</b>	NHOA Energy s.r.l.
<b>By number of months at the company</b>	6
<b>Institution or company where the candidate will spend the period abroad (name and brief description)</b>	The project promotes collaboration with relevant international universities and research centers, e.g. the Norwegian University of Science and Technology (NTNU). The foreign institution will be selected during the 3 years research program in agreement with the industrial partner.



By number of months abroad	6
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**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 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.

**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.