



PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 40th cycle

**PNRR 630 Research Field: GRID SERVICES AND PROTECTION LOGIC IMPLEMENTATION
ON INNOVATIVE MULTI-LEVEL CONVERTERS**

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**

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 renewables and 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.

In this context the integration of renewables and storage systems in the grid is very important. Indeed, from one side, the integration of renewables allows the reduction of traditional fossil fuels and nuclear based generation plant. From the other side, the integration of storages 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 possibility to integrate both storages and renewables within the same converter represents an interesting solution still not completely addressed in the research area. Moreover, the wide diffusion of power electronic converters in grid generation system, is causing several stability issues related to the reduction of inertia and reserve power. For this reason, the new converters must



	<p>be equipped with the possibility to emulate synthetic inertia while presenting a behavior under fault ensuring the correct intervention of the protection systems.</p> <p>The main goal of this research is to study and develop innovative power converters to integrate renewables and storages in the grid achieving high efficiency, good performance in control and grid support and scalability.</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, 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 power converters and control techniques for the integration of renewables and storages in the grid. The designed converter must be able to support the grid both in grid following and in grid forming mode, ensuring, for both the functionalities a behaviour under fault compatible with traditional and new protection schemes.</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. The opportunity to use, for such cases, current source topologies instead of the more diffused voltage source will be also investigated-</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>Educational objectives</p>	<p>The candidate will acquire and/or refine his skills in design and optimization of power converters, control and modulation techniques. Moreover, he will study in details models of different renewable sources and storage systems for their integration in the power converter.</p> <p>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.</p>
<p>Job opportunities</p>	<p>Power electronics companies (with particular reference to the company supporting this research), R&D Italian Firms,</p>



	<p>University career.</p> <p>In the project Politecnico di Milano, NHOA Energy s.r.l and Norwegian University of Science and Technology will be the main actors. Other active collaboration (e.g. University of Birmingham) could be exploited on the basis of the working progress.</p>
Composition of the research group	<p>1 Full Professors 2 Associated Professors 2 Assistant Professors 6 PhD Students</p>
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	750.0 €
By number of months	6

National Operational Program for Research and Innovation

Company where the candidate will attend the stage (name and brief description)	NHOA Energy s.r.l.
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	NTNU: Norwegian University of Science and Technology
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. 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*.