



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

**PNRR\_352 Research Field: PERFORMANCE AND FAILURE ANALYSIS OF PHOTOVOLTAIC  
MODULES OF DIFFERENT TECHNOLOGIES UNDER VARIOUS OPERATING CONDITIONS**

Monthly net income of PhDscholarship (max 36 months)
<b>€ 1400.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
<p><b>Motivation and objectives of the research in this field</b></p>	<p>The progressive increase of the share of renewable energy sources in the national and global energy scenario, is one of the most relevant key goals of the near future. The decarbonization process - the so called "green revolution" and the Ecological transition - is also one of the Mission of the PNRR Programme, specifically with mission M2C2 MISURA 1, 2 and 3.</p> <p>Renewable energies are main topic in "Scenari energetici del futuro" extended Partnership in PNRR Programme, specifically in M4C2 investment.</p> <p>In recent year, the technological development in the field of photovoltaics has led to the growth of the efficiency of solar modules to values greater than 20%, with a high variety of solutions.</p> <p>These solutions are already present, or will soon be, on the market. However, it is important to define the photovoltaic modules and photovoltaic generators behavior in real operating condition, taking into account different climatic areas and various installation conditions, such as tilt and azimuth angles. Also failure investigation is an important topic for PV generators performance evaluation.</p> <p>The main purpose of the research is to develop innovative and robust methods to test the performances of new and ready to market PV modules. The analysis will be performed starting from proprietary and external assets in</p>



	<p>different geographic locations.</p> <p>This research activity will be carried out both at SolarTechlab facility of Politecnico di Milano and in real world case studies, starting from the latest state of the art applications. Part of research activity will be carried at ENI's Laboratories (e.g. Solar Lab) where two laboratories dedicated to indoor and outdoor testing of photovoltaic modules are available.</p>
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>Methods and techniques of this research include Circuit Theory, Optimization Theory, Machine Learning and in general Computational Intelligence and numerical techniques. Methods and techniques have to be suitable for the analysis of micro grid, for the simulation of devices and the parameters extraction, for the modelling of nonlinear phenomena in renewable energy systems by means of mixed approaches, for the estimation and prediction.</p> <p>In particular, the models and algorithms will leverage on and, eventually, extend the existing body of knowledge on the modelling of PV modules for the evaluation of their performance.</p> <p>Numerical simulations and experimental activities will be used to carry out the research.</p> <p>The project covers different fields of investigation: energy engineering, electrical engineering, and computer science. The PhD candidate is thus expected to work within a multidisciplinary team of researchers.</p>
<p><b>Educational objectives</b></p>	<p>The aim of this Ph.D. is to form a highly qualified engineer in a highly motivated and qualified research group, gaining experience, knowledge and skills in cutting edge technologies of the power generation, energy conversion, and microgrid design and optimization. Involvement in international and EU projects, as well as in the cooperation with leading industries and R&amp;D institutions, are also possible.</p> <p>The candidate will learn how to identify critical aspects specifically linked to mathematical modelling of energy production and use.</p> <p>The candidate will learn how to communicate the results</p>



	of the Ph.D. research presenting results and analysis in a scientific and industrial context.
<b>Job opportunities</b>	This research activity will qualify the candidate for future academic and research positions, as well as for a highly qualified professional career in industries operating in the fields of energy and on field tests, e.g., the collaborating company (ENI) and some national and international universities.
<b>Composition of the research group</b>	2 Full Professors 4 Associated Professors 2 Assistant Professors 6 PhD Students
<b>Name of the research directors</b>	Prof. Sonia Leva, Prof. Alberto Dolara

<b>Contacts</b>	
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<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>	ENI
<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. The foreign institution will be selected during the 3 years research program in agreement with the industrial partner.
<b>By number of months abroad</b>	6

<b>Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information</b>
<b>Educational activities:</b> 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.