



PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 38th cycle

**PNRR_352 Research Field: DEVELOPMENT AND APPLICATION OF ADVANCED MACHINE-
LEARNING-BASED TECHNIQUES IN ELECTRIC TRANSMISSION SYSTEMS' PLANNING
STUDIES**

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	
<p>Motivation and objectives of the research in this field</p>	<p>The project is within the framework of Mission 4, Component 3.3, and is fully consistent with one of the main items in the National Research Plan 2021-2027. Moreover, this research activity is closely related to PNRR motivations and objectives, Mission 1 (Digitisation, Innovation, Competitiveness) and 2 (Green Revolution), respectively.</p> <p>In particular, the project aims to develop an artificial-intelligence-based decision support system for power systems planning. The application of these techniques to power systems would stem as a multidisciplinary enabling technology, marking a significant improvement for allowing a smoother and more effective energy transition towards green energy systems. In addition to this, results of the research could be exploited in other fields, where topology and computational burden are an issue.</p> <p>The electric power system is a critical infrastructure experiencing significant and potentially jeopardizing modifications due to the growth of distributed energy resources (DERs) and the consequent reduction of the overall system's inertia. The project will develop data-driven models for the efficient resolution of fundamental problems in the electrical power system, such as power flow (PF) and optimal power flow (OPF), which lie at the very basis of resilient and robust planning. Speeding up such computations would allow performing more in-depth analyses of probabilistic and/or combinatorial nature, like</p>



	<p>those needed for system adequacy and network expansion studies, in which a very high number of PF/OPF instances have to be solved. This number is ever increasing, as the renewable generation penetration and variability on future generation and load scenarios introduce more and more uncertainty.</p>
<p>Methods and techniques that will be developed and used to carry out the research</p>	<p>In the broad domain of neural networks, solutions based on graph neural networks (GNNs) will be investigated, as they are theoretically capable of learning and generalizing rules in an efficient and scalable way, also taking advantage of topological information from graphs. This property, which distinguishes GNN models from the classical convolutive or fully-connected ones defined in the Euclidean domain, is fundamental both in the adequacy analyses of existing grids (fixed topology) and, above all, in evaluating different solutions of grid expansion (where the topology changes). RSE has strong expertise on power systems planning, especially in developing new and innovative methodologies in decision support systems. RSE is also investigating on applying GNNs to PF and OPF problems. RSE will contribute by providing guidance and assistance, and by validating the results.</p>
<p>Educational objectives</p>	<p>The educational objective is to endow researchers with high scientific qualification, autonomous research ability in both the power system and machine learning areas: this includes specific skills in modelling of both technical and economic issues, in machine-learning-oriented programming languages, simulations, critical analysis and validation of results.</p>
<p>Job opportunities</p>	<p>The main opportunities are offered, typically, by R&D departments of both small and large innovative companies (e.g., generation companies, strategy consulting companies, and research companies on power systems like RSE S.p.A.), research centres, transmission and distribution operators, regulating authorities, and data analytics companies. Finally, academia is also an option.</p>
<p>Composition of the research group</p>	<p>0 Full Professors</p>



	2 Associated Professors 1 Assistant Professors 4 PhD Students
Name of the research directors	Prof. Samuele Grillo

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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)	Ricerca sul Sistema Energetico - 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. Universidad Carlos III de Madrid (Spain). 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.