



# PhD in INGEGNERIA ELETTRICA / ELECTRICAL ENGINEERING - 39th cycle

**PNRR 117 Research Field: DEVELOPMENT OF SOLAR RADIATION FORECASTING  
METHODS FOR ESTIMATING THE VERY SHORT-TERM PRODUCIBILITY OF  
PHOTOVOLTAIC SYSTEMS**

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

| <b>Context of the research activity</b>  |   |
|--|---|
| <p><b>Motivation and objectives of the research in this field</b></p>                          | <p>The decarbonization process, the so called “green revolution” and the “Ecological transition” are also among the Mission of the PNRR Programme, specifically with M2C2. Most of the existing micro-grids rely on internal combustion engines to ensure the stability of the network: Integration of renewable energy into the electricity grids poses technical challenges due its intrinsic variability. The ability to forecast intermittent energy sources is critical for the grid optimization and power regulation, in particular in smart-grid and micro-grid contexts. Current short term forecasting techniques are limited in terms of spatial resolution for very short term forecasts. Recently, total sky imagery became popular for forecasting solar energy availability on short time horizons. Ground observations with full-sky pictures can be used to forecast from real time up to 10-30 minutes ahead both energy production and loads. The objective of this research is the development of methods for the management of multi-good micro-grid with high penetration of renewables, resorting to robust optimization algorithms that exploit the load and generation forecasts in a very short time-horizon (nowcasting)</p> |
| <p><b>Methods and techniques that will be developed and used to carry out the research</b></p> | <p>The aim of this study is the multidisciplinary analysis of actual power production, consumptions and sky condition/prediction by means of machine learning</p>   |



|                               |  |
|-------------------------------|--|
|                               | <p>techniques, and its application to image processing and cloud tracking. On-field testing of these predictive algorithms will be conducted in the MG<sup>2</sup>Lab (<a href="https://www.mg2lab.polimi.it/activities/pv-power-forecast/">https://www.mg2lab.polimi.it/activities/pv-power-forecast/</a>), for planning optimization of multi-good energy systems to ensure efficient operation with high penetration of renewable energy sources. This activity aims at assessing the potentialities of nowcasting for solar power generation or for the electric loads. The impact of nowcasting will be evaluated in terms of revenues for selected cases in on-grid and off-grid modes for a selected number of cases and scenarios. The potentialities of the EMS developed in MG<sup>2</sup>Lab will be fully exploited by integrating nowcasting and testing in the micro-grid.</p>   |
| <p>Educational objectives</p> | <p>Educational Objectives:</p> <ol style="list-style-type: none"> <li><b>1. Meteorological Science and Technology:</b> Develop expertise in meteorological science and technology, including the use of all-sky imagers and weather data analysis.</li> <li><b>2. Artificial Intelligence (AI) and Machine Learning:</b> Acquire skills in AI and machine learning techniques, especially for nowcasting of photovoltaic power generated.</li> <li><b>3. Digital Twin Technology:</b> Understand the principles and applications of digital twin technology for fault detection and system optimization.</li> <li><b>4. Project Management:</b> Learn project management strategies for coordinating interdisciplinary teams and complex initiatives.</li> <li><b>5. Renewable Energy Systems:</b> Gain knowledge of photovoltaic systems and renewable energy technologies, focusing on their operation and maintenance.</li> </ol> |
| <p>Job opportunities</p>      | <p>Job Opportunities:</p>  |



|  |  |
|--|--|
|  | <ol style="list-style-type: none"> <li><b>1. Meteorologist:</b> Work as a meteorologist specializing in weather nowcasting, providing critical information to accurate forecast weather parameters.</li> <li><b>2. Data Scientist:</b> Analyze weather data and develop AI algorithms for predicting photovoltaic plants generated power, extreme weather events, enhancing preparedness for PV systems.</li> <li><b>3. Digital Twin Engineer:</b> Specialize in creating digital twins for fault detection and optimization in various industries, including renewable energy.</li> <li><b>4. Project Manager:</b> Lead and manage interdisciplinary projects in the renewable energy sector, ensuring efficient operation and maintenance.</li> <li><b>5. Renewable Energy Consultant:</b> Provide expertise in optimizing the performance and resilience of photovoltaic systems, advising clients and stakeholders.</li> </ol> |
| <b>Composition of the research group</b> | 2 Full Professors<br>4 Associated Professors<br>0 Assistant Professors<br>2 PhD Students   |
| <b>Name of the research directors</b>    | Prof. Emanuele Ogliari   |

| Contacts                                 |  |
|--|--|
| Phone +390223998524                      |  |
| Email emanuelegiovanni.ogliari@polimi.it |  |
| phd-elt@polimi.it                        |  |

| 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                           | 700.0 € |
| By number of months                      | 6       |



| National Operational Program for Research and Innovation   |  |
|--|--|
| Company where the candidate will attend the stage (name and brief description)                       | A2A 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. 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**

**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.