Doctoral Programme in Civil, Environmental and Mechanical Engineering

Research subjects proposed for the 41st cycle – second call

Additional position with scholarship

Curriculum B - Mechanics, Materials, Chemistry and Energy

- *Reference person:* Vincenzo Trovato (UNITN/DICAM)

B3 - scholarship on reserved topics

Funded by: Enel Green Power (EGP)

Title: *Revenue maximization for an integrated PV - BESS with optimal capacity repowering due to different types degradation. System-level and local-level applications*

Project Description:

Battery Energy Storage Systems (BESS) are expected to contribute to mitigate the uncertainty and variability of renewable sources (e.g., photovoltaic energy). The might be installed in standalone configurations or integrate and co-operated with a renewable generator (e.g., PV farms). The BESS flexible operation may be able to support system stability and contribute to maintain supply/demand balance in scenarios where the level of renewable generation is higher/lower than expected.

Time-varying energy market prices may justify arbitrage operation of the BESS, with indirect benefit of flattened system demand and reduced need for high-emitting and cost-intensive peak generators. BESS may also contribute to the security of supply by participating to Capacity Markets (CM). Nonetheless, BESS are subject to energy capacity degradation as result of their charging/discharging operation. If this feature is not properly managed, the financial feasibility of a BESS project could be highly affected by an excessive degradation of the energy capacity, shortening the useful life of the asset or requiring unplanned, cost-intensive revamping actions.

Initial modelling and relevant evidence has been produced by the proposing research group. Nonetheless, driven by several feedback from scientific and industrial stakeholders, fundamental advancement in the modelling is requested to facilitate the application of the proposed algorithm in the financial assessment of real industrial BESS or BESS-PV project. The Ph.D. project is therefore made of six work-packages:

• **WP1**: adoption of a non-deterministic framework. The first novel feature of the proposed project regards the ability to describe and capture the intrinsic uncertainties associated to WEM prices and/or PV output and/or costs for cell replacement and/or parameters of the asset degradation.

• **WP2**: a wide revenue-stacking paradigm for the BESS. The objective of the BESS operation will need to acknowledge the economic value of contracting multiple services, operating in different energy and ancillary services markets

• **WP3**: battery management algorithm. The development of a battery management algorithm to command the operation of racks of battery cells is paramount in order to better exploit the energy capacity of single racks and distribute evenly the operational effort

• **WP4**: impact of temperature dynamics and calendar aging. The energy/power operation of the cells of a BESS is also affected by the operating temperature of the cells and the ambient one. The Ph.D. project aims to perform a series of laboratory tests in order to validate different formulations of energy capacity degradation, matching them with actual simulation results

• **WP5**: Implementation and validation of the proposed methods and algorithms to actual case studies for industrial innovation. The results of this WP are the essence of the Ph.D. program since they summarize all the milestones and developments above, enabling a true and effective knowledge transfer to Industrial partners, potentially leading to the definition of an actual business project for a BESS project.

Research Outcomes:

The main tasks facilitating the promotion of the results of the Ph.D. program are:

• The submission of scientific articles to high-impact international peer-reviewed journals. Where possible, the open access publication option will be chosen in order to support the dissemination of the research to the Industry and Institutions.

• Presentation of the results achieved at national and international conferences and to technical exhibitions.

• Organization of dissemination and exploitation events, such as seminars for researchers and workshops for industrial partners or other external relevant stakeholders.

• In partnership with the industrial sponsor, the digital communication campaign, including the opening of a project web site and the possible creation of an account on social networks (e.g. LinkedIn, Instagram).