Research theme title:
Intelligent algorithms for the management of stationary storage systems

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Description:
Performances of newly installed storage systems degrade over time, until they come to the end of their useful first life. In the specific case of batteries, however, they can still be used for different, and often less demanding, applications. Giving batteries a second life leads to economic and environmental benefits, by reducing the amount of waste and preventing the additional depletion of natural resources. In this context, the research activity aims to develop intelligent management algorithms related to first and second life stationary storage systems, especially to estimate their State Of Health (SOH) and State Of Charge (SOC). The activity will be first focussed on the mathematical modelling of the system, considering the different scenarios in which the storage system will operate, both as regards the residential dimension, including energy communities, and industrial applications up to the Gridscale. Then, such models will be adopted, together with the historical data available, to develop innovative prediction algorithms for estimating both SOH and SOC. Finally, the activity will consider how to integrate such estimations for optimal management and control of the storage system. All the algorithms will be possibly implemented and tested in the Battery Management System (BMS) developed by the company which co-finances the doctoral scholarship, MIDAC Spa.

Requirements:
Good background is required in probability and statistics, system identification, systems and control theory and machine learning. Additional background in storage systems, as well as coding skills are encouraged.

References:
- Plett, G. L. (2015). Battery management systems, Volume I: Battery modeling (Vol. 1). Artech House.
- Hu, X., Feng, F., Liu, K., Zhang, L., Xie, J., & Liu, B. (2019). State estimation for advanced battery management: Key challenges and future trends. *Renewable and Sustainable Energy Reviews*, 114, 109334.
- Park, S., Ahn, J., Kang, T., Park, S., Kim, Y., Cho, I., & Kim, J. (2020). Review of state-of-the-art battery state estimation technologies for battery management systems of stationary energy storage systems. *Journal of Power Electronics*, 20, 1526-1540.
- Vachtsevanos, G. J., Lewis, F., Roemer, M., Hess, A., & Wu, B. (2006). Intelligent fault diagnosis and prognosis for engineering systems (Vol. 456). *Hoboken: Wiley*.

Type of scholarship:
DM 117/2023

Study and research period outside the Hosting Institution:

- Up to 18 months of the study shall be performed at:
  - MIDAC Spa (in the following sites)
    - Via A. Volta, 2 Z.I. - 37038 Soave (Verona), Italy
    - Via G. Ansaldo 8 - 62012 Civitanova Marche (MC), Italy
  - www.midacbatteries.com
  - Contact persons
    - Ing. Marco Fiorani, marco.fiorani@midacbatteries.com
    - Ing. Matteo Cavalletti, matteo.cavalletti@midacbatteries.com
- 6 months of the study shall be performed as a research period abroad, in an institution to be defined later.