Contextual Decision-Making for Bidding in Energy Markets Under Uncertainty

Master thesis in the SYREL group in the G2ELab

- **Keywords:** Ancillary services, Energy Markets, Energy Storage, Modelling, Optimization, Stacked revenues;
- **Localization:** G2ELab, GreEn-Er building;
- **Starting date:** February 2024;
- **Continuation with a Ph.D.:** not provided by default. To be discussed during the internship.

Context

Energy storage systems (ESSs) deployment in power systems has been accelerating in recent years. This development facilitates renewables integration and clean energy while providing flexibility to ensure grid stability. One promising opportunity for ESS owners to further achieve profits is the possibility of providing various products in electricity markets.

This internship is part of an ongoing PhD that focuses on the optimal operation of a storage system participating in energy and balancing markets. The thesis focuses on increasing the system's profitability while providing various energy products based on a forecast of prices and other market indicators associated with an optimization process.

Bidding in various energy markets is a critical step to achieve profits, however, the uncertainty of prices and activation signals is not straightforward to forecast. The main objective of this internship is to solve this conditional stochastic optimization problem using contextual decision-making. That involves making decisions that are sensitive to the broad context (ex.: day of the week, hour). Moreover, parametric rules can be used for the contextual parameters to adapt the decisions for a specific context. Contextual decision-making can be enhanced by data-driven approaches that utilize relevant data (historical data) to understand and adapt to the context effectively. The contextual decision-making performance is to be assessed and improved by comparing the results with the original stochastic optimization model that depends on price forecast in terms of system revenue.

Description of the work

In addition to a bibliographical study, this internship aims to propose a battery management tool, capable of adapting action choices according to contextual conditions. This will create a de facto decision-support tool that is robust under uncertainty and capable of better-justifying choices to charge/discharge energy.

In addition to this work, other tasks related to battery management under uncertainty may also be considered, depending on the desire and time available (consideration of cycling, usage scenarios, auxiliary consumption, etc.).

References

1. Mohamed, A.; Rigo-Mariani, R.; Debusschere, V. & Pin, L.; Stacked Revenues for Energy Storage Participating in Energy and Reserve Markets with an Optimal Frequency Regulation Modeling; Applied Energy, 2023
2. Mohamed, A.; Rigo-Mariani, R.; Debusschere, V. & Pin, L.; Valuation Models for Frequency Services Provision with an Energy Storage System; IEEE PES Innovative Smart Grid Technologies Conference (ISGT--Europe), 2023

Profile and competencies

This internship requires curiosity, autonomy, and versatility.

- Technical competencies:
  - Enrollment in a last year master's studies in electrical engineering, computer science, applied mathematics, or another relevant field ;
  - Good knowledge of Smart Grids, Energy, and balancing market, as well as optimization.
  - Good programming skills in Python, and knowledge of AI-based packages (e.g. PyTorch, TensorFlow) would be a plus.
- Transversal competencies:
  - Team player with a curious and determined attitude.
  - Good verbal and writing skills in English.

NB: this list of skills corresponds to those ideally sought in a candidate (who will probably not have all of them).

To apply

Please send an email to Vincent Debusschere (vincent.debusschere@grenoble-inp.fr), Rémy Rigo-Mariani (remy.rigo-mariani@grenoble-inp.fr), and Ahmed Mohamed (ahmed.mohamed@grenoble-inp.fr), with a short CV and if possible recent grades.