Probabilistic flexibility quantification of residential building HVAC systems

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Type Master project

Background In recent years, the penetration of renewable energy resources in distribution grids has been steadily increasing, raising new issues such as reverse power flows, and challenging the traditional distribution system operation. In order to mitigate these challenges, it has been proposed to operate the distribution system more flexibly. For instance, residential buildings are ideal candidates to offer energy flexibility locally and defer avoidable and expensive system expansions. Our previous work designed an energy management system that self-exports a flexibility envelope to a system operator for system-level dispatch [1]. However, the impact of uncertainties on flexibility envelope quantification has not been investigated. It is necessary to assess the accuracy of our previous data-driven flexibility quantification method [2] and further develop tools of appropriate complexity.

Description The aim of this project is to develop a probabilistic quantification of flexibility from residential building HVAC systems. Tasks include, but are not limited to:

1. Literature review on energy flexibility in residential buildings (4 weeks).
2. Set up simulation test-bed and optimization framework (4 weeks).
3. Identify major uncertainties of indoor climate control using historical data from NEST and represent them through forecast models (6 weeks).
4. Conduct a probabilistic flexibility quantification (6 weeks).
5. (Optional) Develop a practical strategy to achieve verifiable flexibility quantification (2 weeks).
6. Analyze results and write a report (4 weeks).

Prerequisites The candidate should be familiar with optimization. A good level of programming in Python (preferable) or MATLAB is a prerequisite for this project. Interested students should submit an up-to-date CV (including a list of past projects) and the transcript of records (MSc and BSc).

Reference

[1] Gasser, J., Cai, H., Karagiannopoulos, S., Heer, P. and Hug, G., 2021. Predictive energy management of residential buildings while self-reporting flexibility envelope. *Applied Energy*, 288, p.116653.

[2] Hekmat, N., Cai, H., Zufferey, T., Hug, G. and Heer, P., 2021. Data-Driven Demand-Side Flexibility Quantification: Prediction and Approximation of Flexibility Envelopes. *arXiv preprint arXiv:2110.12796*.