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Master Thesis Proposal – ESE/MST/SSE/Math

Modelling and Optimization of a Seasonal Hot and Cold Thermal Energy Storage

Climate change, driven by anthropogenic greenhouse gas emissions, is one of the greatest challenges that human society is facing today. The energy sector, accounting for three-quarters of total emissions and relying on fossil fuels for 80% of global energy, plays a pivotal role in the transition to a sustainable future. A major obstacle in this transition is the inherent variability of renewable energy sources, which requires storage solutions. While batteries effectively manage short-term fluctuations, addressing seasonal mismatches requires long-term storage. In a past master thesis, we already explored the optimal sizing and seasonal control of a heat storage, now we also want to extend this idea to also meet the cooling demands.

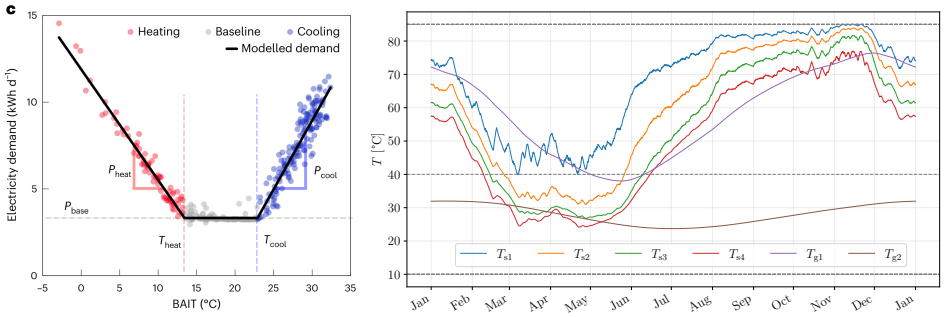

Figure 1: (left) Heating and Cooling Demand for Austin, TX, from [2], (right) Yearly Optimized Temperatures of a Heat Storage System, from [1]

Master topic: The goal of the thesis is to explore the economic and technical possibility of using both a hot, as well as a cold thermal storage solution to meet the seasonal heating and cooling demands of a heating community using optimal control methods.

Your skills: Prior knowledge in systems, control and optimization is advisable. The implementation will be in Python. Since most of the prior work was done in Python and CasADi, knowledge of both tools will be helpful.

Supervisors and contacts: Prof. Dr. Moritz Diehl, Jakob Harzer, Manuel Kollmar

If you are interested, please contact Jakob Harzer:

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[1] https://arxiv.org/abs/2501.07427

[2] Staffell, Iain & Pfenninger, Stefan & Johnson, Nathan. (2023). A global model of hourly space heating and cooling demand at multiple spatial scales. Nature Energy. 8. 10.1038/s41560-023-01341-5.