

Seminar Thesis or Master's Thesis

Joint Sizing and Market-Oriented Operation of Electric Truck Depots with Bidirectional Charging

Motivation

With the electrification of commercial vehicle fleets, a large share of the cost shifts into the depot. Grid connection capacity, the number and power of charging points, their uni- or bidirectional capability and a stationary battery storage system (BESS) are long-lived investment decisions. Their value depends on whether vehicles and storage can trade on the day-ahead and intraday markets during standstill.

Existing approaches usually treat the charging infrastructure as fixed scenario parameters or assume a fixed electricity tariff. Investment and operation are thus optimized separately, and the potential of bidirectional charging on electricity markets is not reflected in the depot design.

Thesis topic

The aim of this master's thesis is to develop an optimization model that determines the cost-optimal depot configuration and its operation on short-term electricity markets in one joint problem. On the investment side, the model decides on the grid connection capacity, the number and power of charging points, whether they are designed for bidirectional charging, and the size of the BESS. On the operational side, it schedules charging and discharging of the fleet under given vehicle schedules and represents sequential bidding on the day-ahead and intraday markets with their different gate closure times.

Whether bidirectional charging pays off thus becomes a result of the optimization rather than a scenario assumption. As such a joint problem quickly becomes computationally demanding, suitable solution approaches such as temporal aggregation or decomposition are also part of the thesis. If desired, AI methods can be integrated, for example machine learning for price and load forecasting or learning-based surrogate models that accelerate the optimization.

What you get

- Contribute to applied research on depot electrification and bidirectional charging at the Chair of Automotive Technology
- Creative freedom at the interface of electric mobility, energy markets, optimization and AI
- In case of excellent working performance: opportunity for co-authorship in a scientific paper
- Close supervision with regular meetings

Work packages

- Literature research and state of the art on depot sizing, bidirectional charging and market participation of electric fleets
- Formulation of an optimization problem coupling investment in grid connection, charging points and BESS with dispatch and bidding on the day-ahead and intraday markets
- Implementation of the model in Python and verification against reference cases
- Case study of a commercial vehicle depot with realistic schedules and market data, including sensitivity analyses
- Evaluation of the value of bidirectional charging and derivation of design recommendations for depot operators

Requirements

- Advanced proficiency in Python
- Solid knowledge of mathematical optimization (e.g., MILP with Pyomo or a comparable framework)
- Interest in energy markets and electric mobility, independent and structured way of working
- Experience in machine learning is a plus
- Very good German or English language skills

I am looking forward to receiving your complete application with a CV, current overview of grades, brief motivation, and any other documents. **The thesis can be written either in German or English.**

Contact

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Start date

From now

Workplace

FTM (Garching Forschungszentrum) or remote