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Modeling and Optimization of an Energy Distribution System

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This work is concerned with optimization problems arising in an energy distribution system with storage. We start from the derivation of a simplified network topology model around four nodes: load aggregator, the external grid, consumption and storage, taking into account the charging (resp. discharging) efficiencies. The imported power from the external grid should balance the consumption and the storage variation. We define the merit function we want to minimize as the total price to pay in a given time interval using the external power load.
The first mathematical problem we derived is a discrete coupled linear optimization problem with some constrainst that includes bounds of storage capacity, and of charge and of discharge. We propose a simplex method as well as an interior point method to compute an effective numerical solution; we establish mathematical properties of the model. Next, we introduce a second model from the first one by taking into account power subscription possibilities. The merit function is then nonlinear and non-differentiable; we discuss two approaches to avoid a non-differentiability point and to solve numerically the problem with a non-linear method (SQP algorithm or interior point algorithm).
Finally, we introduce a sliding window algorithm that allows to reduce the computation time and to make real time simulations. Numerical results are presented on real data to highlight both models and to illustrate the performance of the sliding window algorithm.

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