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Enhancement of Smart-Grid Control by Adding Adaptable Battery Depreciation Fees

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ABSTRACT

This paper discusses the introducing adaptable battery depreciation fees to account battery usage cost in smart-grid (SG) operation. Adaptive characteristics are calculated by a special estimated model of real battery. It is understood that the changing value of these fees will help to find more optimal solutions to control such systems.

INTRODUCTION

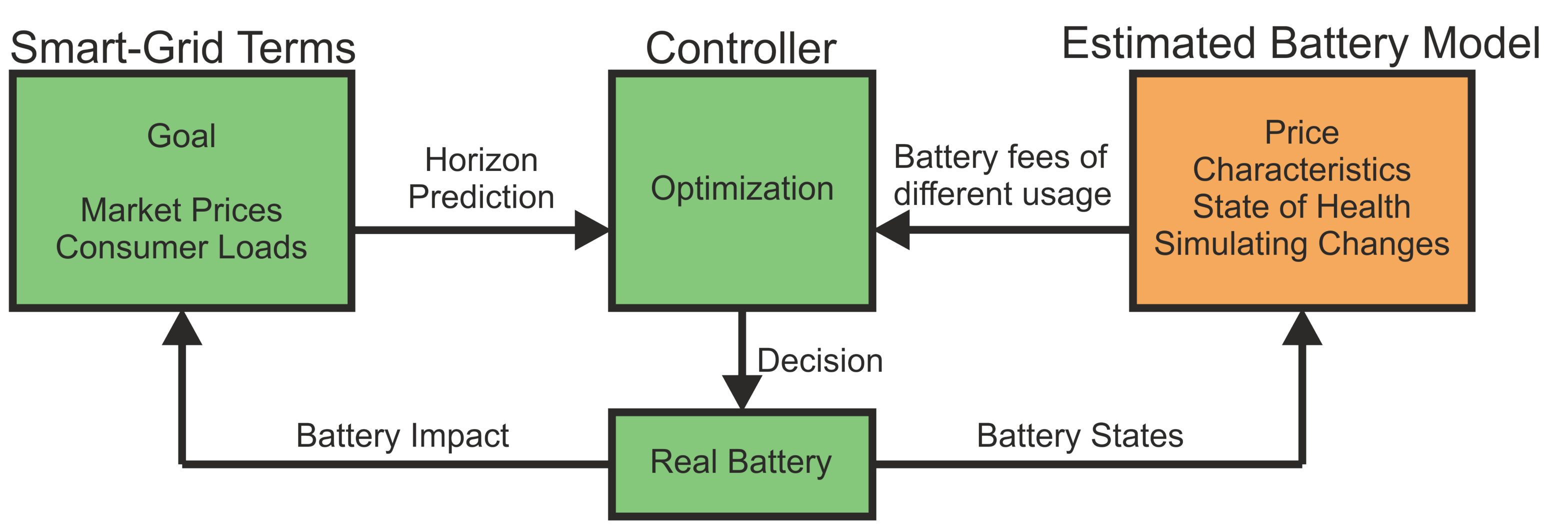
One of the main problems of various smart-grids is the demand response (DR) problem [1]. Due to the growth of renewable energy, the balance in the grid between generated and consumed energy is becoming increasingly difficult to maintain.

Electricity providers are introducing volatile price rates to solve this problem: a time-based program (TBP). In TBP, the price of electricity depends on the current or systematic imbalance in the grid. Thus, SG helps in solving the global DR problem by minimizing its own costs. It can be done by load transfer using energy storage system (ESS) [2]. But such ESSs usually based on very efficient and expensive Li-ion battery (LIB) energy storage.

METHODOLOGY

To this date, some control methods with respect to the cost of using LIB have been developed. However, many authors skip the calculation of these fees. One of the methods restricts high current with a penalty-coefficient for the squared energy [3]. Another method calculates the battery depreciation fee as a ratio of battery price to the total energy transferred over a lifetime [4]. Both methods do not achieve near-optimal solutions and do not have flexibility.

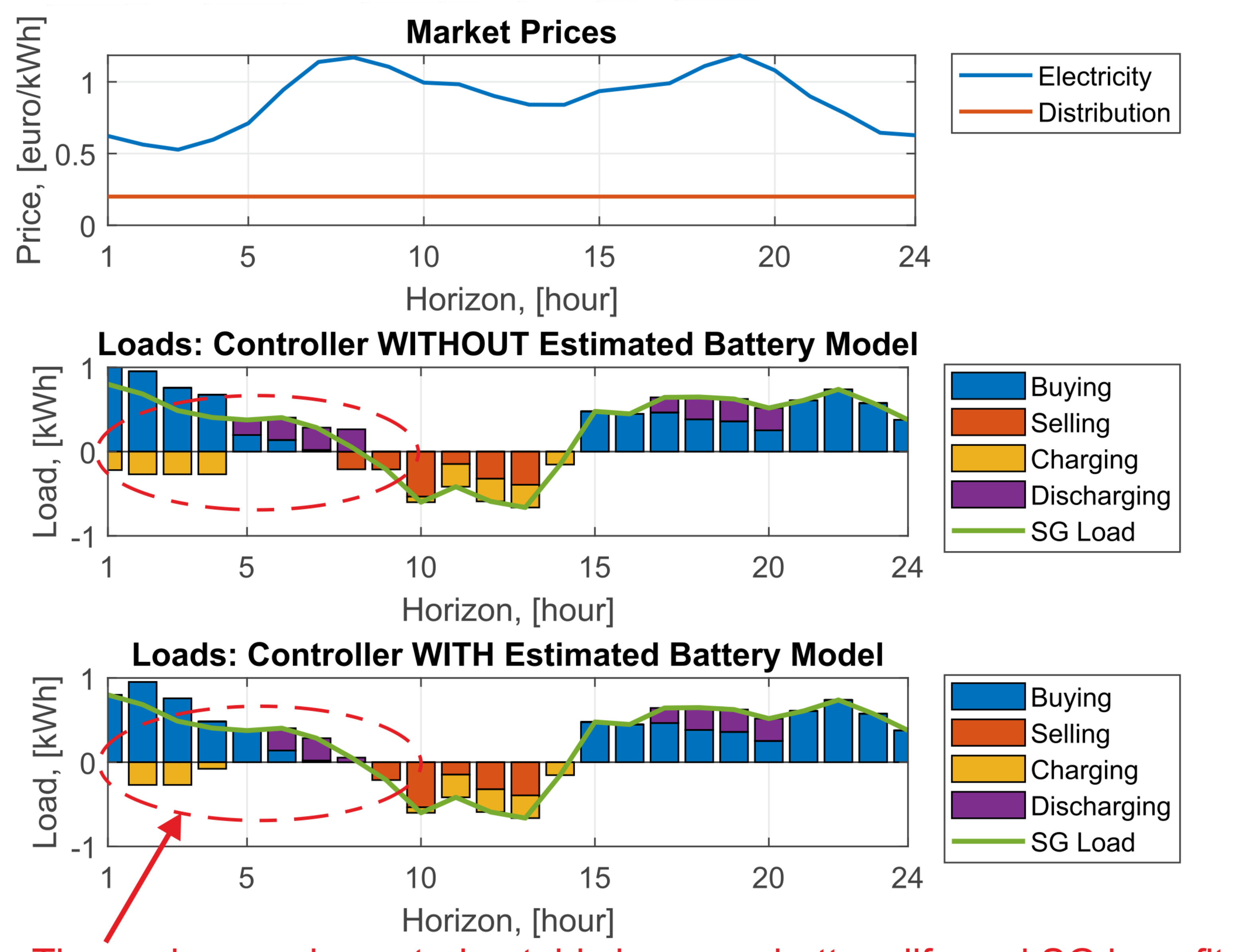
Hence, an idea occurs - to describe an adaptable battery deprecation fee using a model that describes the characteristics of the ESS during the simulation. It is assumed that the adaptable fee will change as the battery ages.



RESULTS AND DISCUSSION

The optimizer receives data from the estimated battery model. This data contains the predicted characteristics of battery loss.

Battery state of health (SOH) is spent on based on the way how it is used and under what conditions. In each new optimization step, all system states are recalculated. Thus, the optimizer can more accurately predict the loss of SOH, as it knows the price of the current battery usage. By introducing such prices into the current SG control systems, the overall benefit of the system should increase by extending the battery life.



These changes in control notably increase battery life and SG benefit compared to optimizations without the estimated battery model.

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