A Stochastic Adaptive Robust Optimization Approach to Build Day-Ahead Bidding Curves for an EV Aggregator

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Abstract-

This paper proposes a stochastic adaptive robust optimization approach to build the bidding curves of an aggregator managing a fleet of electric vehicles (EVs) participating in the day-ahead and intraday electricity markets. These bidding decisions are made hourly, one day in advance, within an uncertain environment. In this context, uncertainties comprise market prices, as well as driving requirements of EV users. These uncertainties are accounted for by using a set of scenarios and confidence bounds, respectively. In this way, this paper combines classic stochastic optimization techniques with adaptive robust optimization, realistically modeling multiple sources of uncertainty. EVs are equipped with vehicle-to-grid technology so that they can both buy and sell energy to the market. The resulting stochastic adaptive robust optimization problem is solved by using the column-and-constraint generation algorithm, which ensures the attainment of the optimal solution in a finite number of steps. Simulations are run by applying CPLEX under GAMS. A case study demonstrates the effectiveness of the proposed approach. Results show that the bidding decisions of the EV aggregator are sensitive to the uncertainty in driving requirements of EVs, which can be controlled through the uncertainty budget. This highlights the usefulness of the proposed approach to prevent the attainment of suboptimal bidding decisions. Moreover, the good performance of the algorithm in terms of obtaining the optimal solution with computational times lower than 6 min suggests potential for model expansion and increased complexity in future works.

Index Terms- Adaptive robust optimization, aggregator, bidding strategy, electric vehicle, electricity market, stochastic programming, uncertainty

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