STOCHASTIC BIDDING OF ELECTRIC VEHICLES AT DIFFERENT ENERGY MARKETS

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Overview

To reduce the dependency on fossil fuels and to slow down climate change, the replacement of combustion engine based vehicles by plug-in hybrid vehicles and electric vehicles is required [1]. Thereby it is possible to use multiple electric vehicles as a new form of flexibility for the power grid. In aggregation, several electric vehicles can be a part of a virtual power plant and provide ancillary services.

This paper focuses on the provision of reserve power from an electric vehicle fleet especially at the German minute reserve market. As a power company may bid at different energy markets, trading at the day-ahead market is also regarded.

Methods

From the perspective of a power company, it is important to optimize simultaneously the trading strategies at the electricity markets and the unit commitment. Therefore we use a multi-stage stochastic bidding model optimizing a mixed integer program. At the first stage, the power company makes an offer for the reserve power market. The accepted biddings are paid as bid. Hence it is important to identify the optimal reserve capacity price [2] . If a too high bid price is chosen, the bid might not be selected. On the other hand, a too low bid price will result in a loss of revenue for the power company.The second stage constitutes the day-ahead market. The optimization regards different price scenarios and produces a bidding curve for energy trading. At this market, the power company is a price taker. For this reason it is important to use adequate price forcasts to trade the optimal amount of electricity of the power company's power plants, taking into account technical restrictions in operation. After the second stage the traded quantities are given to the model for the last stage with the unit-commitment planning. Several electric vehicle pools with different vehicles' dynamic behaviors are considered to provide more flexibility for a power company. The vehicles' dynamic behavior is based on the behavior of the German mobility survey [3].

Results

Through trading with a virtual power plant consisting of electric vehicles, the power company may optimize the use of the power plant fleet and achieve additional profit . The power drawn from electric vehicles is not inducing additional costs like start-up costs or a minimum power output of a conventional starting power plant. Therefore many electric vehicles could be used to avoid a start up of an expensive power plant for only a small amount of electricity within a short time.

The possible benefits will be evaluated using a stylized power plant portfolio including CHP plants. The optimization will be performed for selected weeks using price and load data from the German market.

Conclusions

Electric vehicles lead to more flexibility at energy markets and therefore should be included in the optimization of electricity trading and unit-commitment planning of a power company.

References

[1] G. Glanzer, T. Sivaraman, J. Buffalo, M. Kohl, and H. Berger, “Cost-efficient integration of electric vehicles with the power grid by means of smart charging strategies and integrated on-board chargers,” in Environment and Electrical Engineering (EEEIC), 2011 10th International Conference on, may 2011, pp. 1 –4.

[2] D. Swider, C. Weber, “Bidding under price uncertainty in multi-unit pay-as-bid procurement auctions for power systems reserve” in European Journal of Operational Research 181(3): 1297-1308

[3] KiD 2010, Bundesministerium für Verkehr und digitale Infrastruktur, Braunschweig, 2010