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Interval optimization based performance of photovoltaic/wind/FC/ electrolyzer/electric vehicles in energy price determination for customers by electricity retailer



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ABSTRACT

This paper proposes optimal management of hydrogen storage systems and plug-in electric vehicles in the scheduling of retailer under pool market price uncertainty which real-time pricing is determined in comparison with time-of-use pricing and fixed pricing. Also, pool market price uncertainty is modeled via proposed interval optimization approach for uncertainty-based profit function of retailer. In the proposed model, uncertainty-based profit function of retailer is reformulated as a deterministic bi-objective framework with average and deviation profits as the conflict objective functions which deviation profit should be minimized while average profit should be maximized. Furthermore, weighted sum approach is used to solve the proposed bi-objective model in order to obtain Pareto solutions. Finally, fuzzy decision-making approach is provided to select the trade-off solution from Pareto solutions. The proposed MIP-based model is implemented in GAMS software which can be solved using CPLEX solver. Deterministic and interval optimization approaches under fixed, time-of-use, and real-time pricing are utilized in the case studies and the results are compared with each other in order to show the effectiveness of the proposed model. The obtained results show that deviation profit of retailer decreases in the proposed interval optimization approach in comparison with deterministic approach. Also, average profit of retailer increases in the real-time pricing in comparison with time-of-use pricing and fixed pricing.

1. Introduction

In the smart grid, retailer can determinate the retail price to residential, commercial, and industrial consumers in order to maximize the expected profit (Nojavan et al., 2017a). Retailer serves the consumers' demand by procuring power from available energy sources (Nojavan et al., 2017b). Also, the hydrogen storage systems (HSSs) (Majidi et al., 2017c) and the plug-in electric vehicles (PEVs) (Fathabadi, 2018) are new options for energy storage system (ESS) which can be used for more flexible of energy management (Fathabadi, 2018). Finally, retailer should manage the pool market price uncertainty for robust scheduling in versus price fluctuation (Najafi-Ghalelou et al., 2018).

1.1. Literature review

Retail price determination problem by electricity retailer is classified to short-term and mid-term operation.

In short-term operation, the bidding curves of retailer are obtained

in order to supply consumers in the deregulated electricity market (Nojavan et al., 2017c). Also, energy service provider analysis a technoeconomic strategy in the energy market (Nojavan and Zare, 2018). Furthermore, in Nojavan et al. (2017d), optimal offering price of retailer for retail price determination to the consumers is obtained in order to maximize retailer's profit. Optimal demand function of a retailer is determined in power market in Hajati et al. (2011). In Ghazvini et al. (2015), a multi-objective framework is proposed for short-term scheduling of retailers in a retail market. In a dynamic price environment, a game theory model is provided in Zugno et al. (2013) for modeling the relationship between customers and retailer. The riskbased energy management of retailer is studied in Boroumand and Zachmann (2012), while joint price and quantity risks are modeled by intra-day hedging portfolios in Boroumand et al. (2015). In Fleten and Pettersen (2005), piecewise-linear bidding strategies are constructed by a stochastic framework linear model. Optimal offering price is determined by retailer using a clustering technique in Mahmoudi-Kohan et al. (2010). Also, a non-dominated bidding curve of retailer is obtained from a two-step linear model (Wei et al., 2015). Furthermore, in

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		V	number of plug-in electric vehicles	Pd_{v}^{Max}	upper limit of power in discharging model in PEV
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