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Personalized retail pricing design for smart metering consumers in electricity market

Dawei Qiu [(1)], Yi Wang [(1)], Junkai Wang [(1)], Chuanwen Jiang [(2)], Goran Strbac [(1)]
1 Imperial College London, London, UK
2 Shanghai Jiao Tong University, Shanghai, China

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Summary

Nowadays, smart meters enable retailers to provide customers with detailed information about retail tariffs and their energy usage at different times of the day, which in turn enables customers to manage their energy use more proactively. This paper drops this assumption and makes use of data acquired from smart meters to design a personalized retail pricing scheme for different types of consumers. To formulate this problem, a bi-level optimization model is proposed, with the upper-level problem representing the pricing decision made by the retailer and two lower-level problems representing the demand response of consumers and the wholesale market clearing process, respectively. The scope of the examined case studies is fourfold. First, consumers are classified based on their daily load profiles using the advanced clustering method. Second, the physical benefit of fully exploring the consumer's demand flexibility as well as the economic benefits of increasing retailers' profitability and reducing consumers' energy bills are evaluated with respect to the traditional uniform retail pricing scheme. Third, the impacts of consumers' demand flexibility on electricity market outcomes and business cases are investigated. Finally, the proposed personalized retail pricing scheme is verified to relieve the strategic retailer's market power reduction caused by the flexibility of demand, which is beneficial to the retailer's profitability.

Highlights

- A novel deep learning-based clustering method, namely deep embedded clustering, is introduced to effectively extract features of cluster consumers' load profiles from smart meter data.
- A bi-level optimization model is designed to tackle the personalized retail pricing challenge for different types of smart metering consumers.
- The personalized pricing scheme provides significant benefits to the strategic retailer by alleviating the reduction in the retailer's market power caused by consumer flexibility.
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