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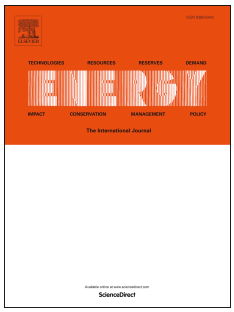

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Dynamic electricity pricing for electric vehicles using stochastic programming

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ABSTRACT

Electric Vehicles (EVs) are an important source of uncertainty, due to their variable demand, departure time and location. In smart grids, the electricity demand can be controlled via Demand Response (DR) programs. Smart charging and vehicle-to-grid seem highly promising methods for EVs control. However, high capital costs remain a barrier to implementation. Meanwhile, incentive and price-based schemes that do not require high level of control can be implemented to influence the EVs' demand. Having effective tools to deal with the increasing level of uncertainty is increasingly important for players, such as energy aggregators. This paper formulates a stochastic model for day-ahead energy resource scheduling, integrated with the dynamic electricity pricing for EVs, to address the challenges brought by the demand and renewable sources uncertainty.

The two-stage stochastic programming approach is used to obtain the optimal electricity pricing for EVs. A realistic case study projected for 2030 is presented based on Zaragoza network. The results demonstrate that it is more effective than the deterministic model and that the optimal pricing is preferable. This study indicates that adequate DR schemes like the proposed one are promising to increase the customers' satisfaction in addition to improve the profitability of the energy aggregation business.

KEYWORDS: demand response; electric vehicles; energy resource scheduling; optimal pricing; smart grid; stochastic programming;

1. Introduction

Unlike conventional generation units, renewable sources are characterized by a high level of uncertainty and variability. Smart Grid (SG) should be highly flexible to accommodate large penetration of renewable