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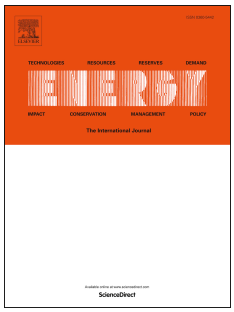

Day-ahead scheduling of virtual power plant in joint energy and regulation reserve markets under uncertainties

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Day-ahead scheduling of virtual power plant in joint energy and regulation reserve markets under uncertainties

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Abstract

This paper presents a day-ahead scheduling framework for virtual power plant (VPP) in a joint energy and regulation reserve (RR) markets. The proposed VPP clusters a mix of generation units in term of synchronous distributed generation (SDG) and wind power plant (WPP) as well as storage facilities such as electrical vehicles (EVs) and small pumped storage plant (PSP). It is assumed that VPP provides required RR through its SDG and small PSP based on the delivery request probability of day-ahead market. In order to aggregate EVs, the VPP establishes bilateral incentive contracts with vehicle owners. Moreover, impact of carbon dioxide (CO_2) emission of SDG is included by means of penalty cost function. Different uncertain parameters with regard to wind generation, EV owner behaviors, energy and RR market prices and regulation up and down probabilities are considered using a point estimate method (PEM). The case studies are applied to demonstrate the effectiveness of the scheduling model.

Keywords

Virtual power plant; Distributed energy resources; Energy and regulation reserve markets; Point estimate method.

1. Introduction

Due to the deregulating power markets and increasing environmental concerns, distributed energy resources (DERs) based on renewable generations are going to cover an important role in the power systems. These renewable energy resources (RERs) are not capable to regulate their power generations because of their stochastic primary sources. For this reason their power outputs are inherently intermittent [1]. This problem causes power imbalance between generation and consumption in power networks.

Small capacity and stochastic generation of RERs are known as an obstacle for participation of these resources in energy and ancillary service markets. Therefore, the VPP has been defined as an entity for aggregating and planning of DERs (renewable or fossil based) with the acceptable overall capacity to facilitate participating in energy and ancillary service markets and also improving technical functionality of its distribution network with implementing appropriate management of DERs. Various types of generation and

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