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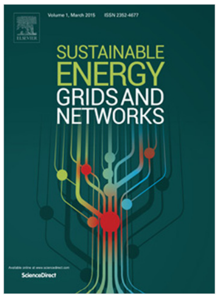

A bi-level robust optimization model to determine retail electricity price in presence of a significant number of invisible solar sites

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A Bi-Level Robust Optimization Model to Determine Retail Electricity Price in Presence of a Significant Number of Invisible Solar Sites

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Abstract: This paper presents a bi-level model for day-ahead electricity pricing and dispatch problems faced by a distributed generation (DG)-owning retailer who plays an intermediary role between the wholesale electricity market and end-use consumers. In this approach, the stochastic programming is addressed in the upper level to study behavior of the retailer in the wholesale electricity market in presence of self-generation facilities, including thermal DGs, wind farms and roof-top photovoltaic (RPV) sites. Regarding increased penetration of RPV sites, a data dimension reduction technique through *k*-means clustering and principal component analysis (PCA) methods is used to hedge against large-scale output power data of RPV sites. In addition, to forecast day-ahead power output of RPV sites, a similar-day detection (SDD) technique is addressed to investigate the impacts of climate variables, e.g. irradiation, sunshine hours and temperature, on 24-hour-ahead power of RPV sites. In the lower level problem, information gap decision theory (IGDT) is proposed to determine robustness of retail electricity price against uncertain clients' consumption. In this way, robustness and opportuneness functions are discussed to evaluate immunity against failure and windfall reward, respectively. Finally, numerical results based on actual data from PJM market and North Carolina solar sites are presented to demonstrate the usefulness and proficiency of the proposed framework.

Keywords: Retailer, roof-top solar sites, stochastic, robust, electricity price

Nomenclature

Indices

t	Index of time
ω	Index of scenarios
i	Index of thermal self-generation facilities
k	Index of blocks for cost function of thermal self-generation facilities
j	Index of wind distributed generations
m	Index of informative (reduced) RPV sites
n	Index of RPV sites

Constants

N_ω	Number of scenarios
N_W	Number of wind self-generation facilities
N_T	Number of time hours
M	Number of informative (reduced) RPV sites
N	Number of all RPV sites
$\pi(\omega)$	Probability of occurrence of scenario ω
N_{DG}	Number of thermal self-generation facilities
N_s	Number of blocks for cost function of thermal self-generation facilities
S^{DG}	Cost of related blocks for thermal self-generation facilities ($)