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Bidding Decision of Wind-Thermal GenCo in Day-Ahead Market

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Abstract

This paper deals with the self-scheduling problem of a price-taker having wind and thermal power production and assisted by a cyber-physical system for supporting management decisions in a day-ahead electric energy market. The self-scheduling is regarded as a stochastic mixed-integer linear programming problem. Uncertainties on electricity price and wind power are considered through a set of scenarios. Thermal units are modelled by start-up and variable costs, furthermore constraints are considered, such as: ramp up/down and minimum up/down time limits. The stochastic mixed-integer linear programming problem allows a decision support for strategies advantaging from an effective wind and thermal mixed bidding. A case study is presented using data from the Iberian electricity market.

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Keywords: Bidding strategy; stochastic programming; mixed integer linear programming; wind thermal coordination.

1. Introduction

Exploitation of renewable sources either alone or in coordination with other renewable or non-renewable sources is social and political supported as a major involvement to a sustainable development, avoiding the negative environmental impact of fossil fuel burning. Exploitation of renewable sources has been supported by political procedures providing subsidy and normative incentives [1]. Exploitation of wind power either onshore or offshore has been and will be further in usage, but as the wind power technology matures and goes into parity with conventional sources of energy incentives are due to be less significant. Already, incentives are in way of less significance, i.e., incentives are becoming flawed as wind power penetration increases [2].

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Nomenclature

R_t	revenue of a GenCo for hour t
λ_t^D	day-ahead market-clearing price
P_t^{offer}	power at the close of the day-ahead market accepted
I_t	imbalance income resulting from the balancing penalty of not acting in accordance with the accepted trade
Δ_t	total deviation for hour t
$F_{\omega it}$	cost for a thermal unit
A_i	fixed production cost
$u_{\omega it}$	binary variable, unit state of operation
$d_{\omega it}$	added variable cost associated with the amount of fossil fuel consumed by the unit
$b_{\omega it}$	start-up costs of the units
C_i	shut-down costs of the units
F_i^l	slope of each segment
$\delta_{\omega it}^l$	segment power
$p_{\omega it}$	power of the unit
$p_{\omega t}^g$	actual power generated by the thermal units for the day-ahead market
p_{mt}^{bc}	power contracted in each bilateral contract m

Consequently, a generation company (GenCo) for having profit by the management of wind power conversion into electric energy has to go into the electricity market [3]. Although, in the future some normative incentive is expected to hold in the market environment in support of a GenCo exploiting wind power to account for the added exposition to the uncertainty of the source, bad bidding due to incorrect consideration of this uncertainty curtails profit.

The electric energy supply is reported as having fossil fuel majority usage, although of the increased worldwide renewable energy exploitation. Statistics for electric energy supply accounts that the usage of fossil fuel burning is more than 60% in 2012 [4]. But as time goes eventually a change will be laid down. In EU 2014 is the seventh year running that over 55% of all additional power capacity is form renewable energy and the added new deployment of wind power accounts for 43.7% all new renewable deployment in 2014 [5]. So, exploitation of wind power either alone or in coordination with other renewable or non-renewable sources is becoming a significant contribution to mitigate the need for fossil fuel burning in EU. The paradigms of smart grid ambient and cyber-physical systems (CPS) [6] is a convenient upbringing for exploiting wind power and facing the competition of electric energy market in order to