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Robust optimization based self scheduling of hydro-thermal Genco in smart grids

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ABSTRACT

This paper proposes a robust optimization model for optimal self scheduling of a hydro-thermal generating company. The proposed model is suitable for price taker Gencos which seeks the optimal schedule of its thermal and hydro generating units for a given operating horizon. The uncertainties of electricity prices are modeled using robust optimization approach to make it more practical. It considers various technical constraints like water balance and water traveling time between cascaded power stations and emission allowance. Finally, different case studies are analyzed to demonstrate the strength of the proposed model.

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1. Introduction

1.1. Motivation and approach

The renewable energy sources have recently become an essential generation option for many countries to mitigate pollution and promote clean and sustainable energy development [1]. The volatility of output power in renewable energy resources can be compensated by using fast-acting dispatchable sources, like gas turbines or hydro power units [2] or both of them. The fast ramping and storage capabilities of cascaded hydro units [3] can be used for profit making in a deregulated power market environment. Different uncertainty resources have been identified for hydrothermal scheduling problem like load demand, reservoir water inflows, fuel price and thermal unit forced unavailability, market price, random natural gas infrastructure interruptions [4,5]. The existing models of the literature tried to model the aforementioned uncertainties using probabilistic approaches. One drawback of stochastic optimization technique is that they are computationally expensive and the decision maker needs to know the PDF (probability density function) of them. However, in some practical applications the computational burden becomes an important factor. On the other hand, the decision maker does not always have complete information about the distribution and behaviors of the uncertain parameters. The decision maker (Genco) needs some computational tools to be robust against the variation of uncertain input data which does not add complexity to the existing problem. The aim of this paper is to provide such a tool. The focus of this paper is just on modeling the uncertainty of price values in the day ahead electricity market.

1.2. Literature review

The previous works in hydrothermal scheduling can be categorized into two major groups: the first category deals with proposing the new methods for solving the hydrothermal scheduling problem while the second group tries to propose a model for hydrothermal scheduling problem with different constraints and goals. The methodological based group contains various methods for solving the hydro-thermal coordination problem like: Lagrangian multipliers correction procedure [6], clipping-off interior-point algorithm [7], CEA (co-evolutionary algorithm) based on the Lagrangian method [8], bundle trust region method [9], diploid genotype based genetic algorithm [10], SPPSO (small population-based particle swarm optimization) approach [11], augmented Lagrangian approach [12], stochastic dual dynamic programming algorithm [13], benders decomposition approach [14,15], stochastic midterm financial risk constrained [16], semi-definite programming [17]. The present work falls into the second category since it provides a comprehensive model for hydrothermal scheduling. In order to have a better sketch of what has been done for hydrothermal scheduling models, some of these approached are compared in Table 1.

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