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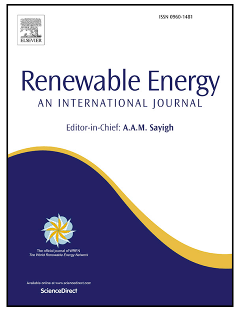

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A dynamic opportunistic maintenance model to maximize energy-based availability while reducing the life cycle cost of Wind Farms

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Abstract

Operations and maintenance costs of the wind power generation systems can be reduced through the implementation of opportunistic maintenance policies at suitable indenture and maintenance levels. These maintenance policies take advantage of the economic dependence among the wind turbines and their systems, performing preventive maintenance tasks in running systems when some other maintenance tasks have to be undertaken in the wind farm. The existing opportunistic maintenance models for the wind energy sector follow a static decision making process, regardless of the operational and environmental context. At the same time, on some occasions policies do not refer to practical indenture and maintenance levels. In this paper, a maintenance policy based on variable reliability thresholds is presented. This dynamic nature of the reliability thresholds, which vary according to the weather conditions, provides flexibility to the decision making process. Within the presented model, multi-level maintenance, capacity constraints and multiple failure modes per system have been considered. A comparative study, based on real operation, maintenance and weather data, demonstrates that the dynamic opportunistic maintenance policy significantly outperforms traditional corrective and static opportunistic maintenance strategies, both in terms of the overall wind farm energy production and the Life Cycle Cost.

Keywords: Opportunistic maintenance model, Dynamic reliability thresholds, Life Cycle Cost, Wind energy, Weather conditions

1. Introduction

The growing importance of renewable energy in terms of installed capacity and technological advances has been remarkable during the last years. This growth has been particularly notorious within the wind energy sector, which occupies a leading position among renewable energies [1]. Furthermore, the sector has not only suffered a great development for the last two decades but it is expected to continue its expansion during the following years, being firmly reinforced by the main World Powers energy plans [2].

Along with this progress new challenges have arisen, especially in terms of new technologies' reliability [3] and logistics associated to wind farms' (WF) maintenance [4]. Moreover, due to the trend of WFs' location shift towards offshore sites [5, 6], to deal with these challenges is getting even more difficult. As a result, operations and maintenance costs can rise to a 32% or a 12-30% of the total life cycle cost (LCC) in offshore or in onshore WFs respectively [7, 5].

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