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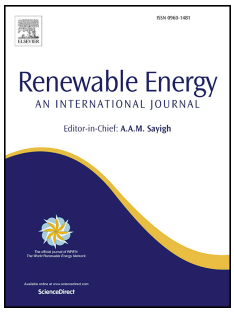

Analysis of SCADA data for early fault detection, with application to the maintenance management of wind turbines

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Analysis of SCADA data for early fault detection, with application to the maintenance management of wind turbines

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Abstract

Wind turbines are, generally, placed at remote locations and are subject to harsh environmental conditions throughout their lifetimes. Consequently, major failures in wind turbines are expensive to repair and cause losses of revenue due to long down times. Asset management using optimal maintenance strategies can aid in improving the reliability and the availability of wind turbines, thereby making them more competitive. Various mathematical optimization models for maintenance scheduling have been developed for application with wind turbines. Typically, these models provide either an age based or a condition based preventive maintenance schedule. This paper proposes a wind turbine maintenance management framework which utilizes operation and maintenance data from different sources to combine the benefits of age based and condition based maintenance scheduling. A mathematical model called Preventive Maintenance Scheduling Problem with Interval Costs (PMSPIC) is presented with modification for the maintenance optimization considering both age based and condition based failure rate models. The application of the maintenance management framework is demonstrated with case studies which illustrate the advantage of the proposed approach.

Keywords: Artificial neural network (ANN); condition monitoring system (CMS); maintenance scheduling; mathematical optimization model; wind turbine; supervisory control and data acquisition (SCADA).

1. Introduction

Wind power has been one of the most promising new sources of renewable energy for the past decade. The industry has seen a steady growth, and it can be expected that the growth shows similar trend in the future. With the development of technology, wind turbines have increased in size from a few kW to multiple MW. In addition to this, higher wind speeds have motivated installing larger wind turbines off-shore. Consequently, this has also led to a situation where failures in wind turbine components result in high revenue losses and also frequent maintenance becomes impractical and expensive. Hence, the wind turbines should be subjected to strict reliability improvement and intelligent asset management programs ([1]).

The topic of asset management of wind turbines has gathered interest in recent years, as wind power moves close to becoming utility scale in many countries. Efforts have

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