Wind Energy Operation and Maintenance

Subjects: Energy & Fuels

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A new procedure to predict wind farm failures is developed based on statistical methods in real wind farms.

wind energy new tendencies

1. Introduction

Renewable energies have become the greatest ally for the generation of electrical energy worldwide that is free of CO_2 emissions. In the first quarter (Q1) of 2020, renewable energies reached a worldwide share of electricity generation of nearly 28%, i.e., an increase of 2% compared to Q1 2019. Even with the outbreak of the COVID-19 pandemic, total global renewable electricity generation was estimated to increase by almost 5% in 2020 [1]. Taking into account that hydroelectric technology was developed throughout the 20th century, wind power is, among the current technologies for generating electrical energy from renewable sources, the most widely implemented renewable energy around the world. In 2018 (currently the last consolidated year, 31 December 2020), wind power had an installed capacity of more than 560 GW, assuming a worldwide production of more than 1.2 million GWh (Table 1).

Table 1. Wind energy data (data collected from [1] and Scopus database).

sure	Year					
	2008	2010	2012	2014	2016	2018
Capacity (MW)	1.20×10^5	1.81×10^5	2.67×10^5	3.49×10^5	4.67×10^5	5.63×10^5
Production (GWh)	2.18×10^5	3.43×10^5	5.26×10^5	7.13×10^5	9.56×10^5	1.26×10^5
Number of Articles in Scopus	1014	1558	2255	2448	2597	3167

2. Operation and Maintenance (O&M) of Wind Farms

The reliability of wind energy systems is a critical factor because decreased reliability directly affects the return string on account of increased costs of O&M, and it reduces the availability of energy due to disruption of the functioning due to the occurrence of faults.

Most approaches to reduce operating and maintenance costs for wind power projects are the same as those associated with any industrial plant, and any technique within the framework of maintenance can be applied to

wind turbines.

The most important issues [2] in the operation and maintenance of wind energy concern the following aspects:

- site and seasonal asset disturbances
- stakeholder requirement trade-off
- reliability and asset deterioration challenges
- diagnostic, prognostic and information and communication technology applications
- maintenance optimization models

Wind farm maintenance directly determines its benefits, therefore, it is necessary to analyze the typical wind generator failures and build their health management files. Zhang et al. [3] investigated the location of the failure, development and trends, based on wavelet transform of fault diagnosis. When a wind turbine is shut down due to an error, profits are not obtained and, in addition, operational and maintenance costs are increased, with the objective to reduce these operation and maintenance costs. Solutions have been developed by condition monitoring [4] that detects and diagnoses anomalies of wind turbines. The development of advanced techniques to detect the occurrence of mechanical and electrical wind turbine failures at a sufficiently early stage [5] is very important for maintenance actions. The challenges being faced in wind farm operation and maintenance, with wind turbines dispersed and positioned in remote locations, have been very difficult in terms of quick access and they are expensive.

In wind farms, there is a large amount of information and, on these grounds, the methodology of decision making using failure prognosis developed in [6] can be used to identify the best strategies to increase the robustness of the wind farm operation and maintenance in order to maximize economic and environmental benefits simultaneously.

The number of offshore wind farms is increasing due to, among other reasons, their high capacity for power generation. However, the costs [7] of operation and maintenance are high. According to the Condition Monitoring of Offshore Wind Turbines report of the Energy Research Centre in the Netherlands, the operation and maintenance costs in future offshore wind farms that will be built from larger units are expected to be EUR 30 to 50/kW per year. The integration of the health monitoring information provides the initial steps for reducing operation and maintenance costs for an offshore wind farm while increasing turbine availability and overall profit. Detection strategies have been developed by Myrent et al. [8] for these fault mechanisms with the intent of integrating them into an operation and maintenance paradigm, and the integration of the health-monitoring information provides the initial steps for reducing operation and maintenance costs in an offshore wind farm while increasing turbine availability and overall profit.

The main studies are focused mainly on the operation and maintenance, but they also have to cover offshore logistics, energy production and the total project cost. A study [9] found 49 models that address parts of the life cycle or the entire life cycle of an offshore wind farm. Tracht et al. [10] described an approach to the planning of parts considering the constraints that exist in offshore maintenance, and this model proves to be the limiting factor influencing the costs of maintenance and operation using an analytical model scenario. The difficulties of access to offshore wind farms and a shortage of appropriate transport vessels and installations are challenging [11] the operation and maintenance of these farms in these remote places, and research is beginning to develop a methodology [12] for the reliability-centered maintenance of low-accessibility facilities.

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