Onshore Wind Farms Maintenance Optimization Using a Stochastic Model

ANA SANCHEZ[2], ISABEL MARTÓN[1], SOFÍA CARLOS[1] SEBASTIAN MARTORELL[1]
[1]Departament d'Enginyeria Química i Nuclear.
[2]Departament d'Estadística, Investigació Operativa Aplicades i Qualitat.
Universitat Politècnica de València.
Camí de Vera 14, 46022. València.
aisanche@eio.upv.es, ismarllu@upvnet.upv.es scarlos@iqn.upv.es smartore@iqn.upv.es

Wind power is regarded as a key technology to meet the planned targets of carbon emission reductions and the diversity of energy supply sources. During the last decade a rapid expansion of this energy technology has been observed. In Spain, the actual capacity nearly reaches 20000 MW, what corresponds to a 16% of the total capacity available to supply the electricity demand. On the other hand, operation of onshore wind farms is a challenging business [1]. In particular the operational conditions of wind farms are quiet different from traditional power stations, such as nuclear, gas, etc.

A specific feature of wind power generation is the stochastic behavior of wind velocity what determines the energy produced, and also influences the turbine degradation process due to the stochastic load suffered by the wind turbine. Moreover, the failure rate of the wind turbine components is also a stochastic variable that modifies the aeging process. Thus, wind turbines present a degradation process more complex than the equipment that work under stationary conditions. Moreover, the maintenance plan is determined by the meteorological conditions, as the best option to perform maintenance is when the electricity production is minimum, thus is when wind velocity is low [2]. Current maintenance practice for wind farms mainly consists of scheduled maintenance and corrective maintenance. The selection of maintenance strategy, that comprises the date to perform a maintenance activity, the maintenance frequency and the duration of such activity have a great influence on the operational cost, what determines the plant viability.

To develop the analysis, real data of wind velocity is required. Using these data the daily wind velocity probability distribution can be obtained [3], and an estimation of the electric power produced by the wind farm is obtained using a Monte Carlo sampling. Taking these data as starting point it is possible to calculate the cost associated to loss of production due to perform maintenance on the wind turbine. The final objective of the work consists of finding the best maintenance strategy that minimizes the total cost of a wind turbine farm, using as objective function the stochastic model developed to estimate the total cost and considering as decision variables the maintenance frequency and the date to start the scheduled tasks.

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