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Quantifying uncertainties in wind energy assessment

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The constant rise of wind energy production and the subsequent penetration in global energy markets during the last decades resulted in new sites selection with various types of problems. Such problems arise due to the variability and the uncertainty of wind speed. The study of the wind speed distribution lower and upper tail may support the quantification of these uncertainties. Such approaches focused on extreme wind conditions or periods below the energy production threshold are necessary for a better management of operations. Towards this direction, different methodologies are presented for the credible evaluation of potential non-frequent/extreme values for these environmental conditions. The approaches used, take into consideration the structural design of the wind turbines according to their lifespan, the turbine failures, the time needed for repairing as well as the energy production distribution.

In this work, a multi-parametric approach for studying extreme wind speed values will be discussed based on tools of Extreme Value Theory. In particular, the study is focused on extreme wind speed return periods and the persistence of no energy production based on a weather modeling system/hind cast/10-year dataset. More specifically, two methods (Annual Maxima and Peaks Over Threshold) were used for the estimation of extreme wind speeds and their recurrence intervals. Additionally, two different methodologies (intensity given duration and duration given intensity, both based on Annual Maxima method) were implied to calculate the extreme events duration, combined with their intensity as well as the event frequency. The obtained results prove that the proposed approaches converge, at least on the main findings, for each case. It is also remarkable that, despite the moderate wind speed climate of the area, several consequent days of no energy production are observed.