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Wind Energy Assessment and Adaptive Wind turbine model for the Installation of an Onshore Wind Farm in Cameroon.

Located on the Gulf of Guinea and also known as the economic power house of the central African sub-region, Cameroon's population and industrialization has more than doubled in the last three decades. Douala, Limbe and Kribi are three of its main coastal industrial cities. The rapid increase in the population of these industrial cities, post a problem to energy shortages and distribution especially as the country solely relies on hydroelectric power and a very small percentage of thermal power generation to meet its energy demand. To meet this increase in energy demand, a thorough wind energy assessment is carried out by the application of statistical techniques like the commonly used Weibull statistics for the sole purpose of selecting the best site for the installation of an onshore wind farm. The Weibull parameters are estimated by the method of maximum likelihood, the mean power densities, the maximum energy carrying wind speeds and the most probable wind speeds are also calculated and compared over these three cities. Finally, the cumulative wind speed distributions over the wet and dry seasons are also analyzed. The result presented here show that Kribi is the best site but the wind speeds in all three locations are very low, below the cut-in wind speeds of most modern wind turbines.

Our next approach is to design a wind turbine that can adapt and function at these low wind speeds. Here, we focused more on modeling wind turbine blade geometry by varying the airfoil thickness and Reynold's number in a software called Qblade. The result of our simulations show that the best airfoil for a turbine to be used at Kribi is that with a high-lift and low Reynold's number.

Moreover, we develop a complex nonlinear model for a single-mesh helical gear train for a wind turbine gearbox by including a time varying mesh stiffness, axial vibrations, torsional vibrations, shaft and bearing damping, generator back EMF and gear backlashes. With the help of a time series and the Fast Fourier Transform (FFT) frequency spectrum, the effects of these nonlinear terms on the wind turbine and generator rotational speeds are studied under different excitation conditions by numerically integrating the associated equations using the RK4 algorithm. The results show that more damped, quasi-harmonic vibrations are attained at higher damping, tortional and axial stiffness, big helical angles will generally induce heavy nonlinear vibrations in the turbine and generator, smaller mesh frequency will induce extra noise in the generator, the external excitation due to wind gust has a greater influence in the nonlinearity of the wind turbine dynamic as compared to the internal excitations due to static transmission errors, time varying mesh stiffness and the generator back EMF.

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