Investigation of the Electromagnetic Near Field Around an Offshore Wind Farm

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The development of offshore wind energy is raising concerns about the potential impact of wind farms on marine communication and radar systems. Although the electromagnetic effects of land-based wind farms have been well studied and discussed, the offshore scenario raises some new questions that have not been addressed previously. This is due to the larger turbine structure, the presence of the sea surface, and the possibility that shipboard electronic equipment can come very close to the turbine structure within the farm.

In this work, we investigate the near-field distribution within and around a wind farm due to a transmitter located outside the farm. To simulate the near field due to the electrically large structure, several simplifications are made. First, the scattered signal from a single turbine is assumed to be dominated by the tower while that from the nacelle and blades are of secondary importance (I. Angulo *et al*., *Proc. EuCAP*, 707-711, 2011). Second, the cone-shaped tower structure is approximated by an infinite circular conducting cylinder, and a 2-D simulation is used to compute the near field. Third, the computation of the near field is accelerated by the use of the complex echo width concept. Lastly, the scattered signals from individual turbines are combined in complex form to obtain the near field around and within a wind farm. The errors introduced by the approximations are quantified against full-wave simulations done using the MLFMM (multilevel fast multipole method) solver in FEKO at 500MHz.

The near-field distribution within a wind farm on a planar, conducting sea surface is generated at different frequencies from UHF up to X-band. The results show the spatial extent and depth of the shadow region behind the turbine towers, and how they vary as a function of frequency. Outside the shadow zone, the multipath interference between the incident and scattered fields results in a rapidly oscillating fade pattern. Results from this study provide the necessary input in order to assess the potential impact of offshore wind farms on marine communication and radar systems.