Environmental Studies Program: Ongoing Studies

Study Area(s): North Atlantic

Administered By: Office of Renewable Energy Programs

Title: Impact Assessment of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar

BOEM Information Need(s) to be Addressed: BOEM requires thorough environmental review and address of public concerns for its environmental assessments related to research and commercial wind lease issuance along the Outer Continental Shelf (OCS). Currently, BOEM wind energy areas offshore Rhode Island/Massachusetts, Virginia, and North Carolina pose potentially negative impacts to the U.S. High Frequency (HF) Radar Network, which falls under the auspices of the U.S. Integrated Ocean Observing System (IOOS). With the construction of the first offshore wind turbines near Block Island, Rhode Island, BOEM may now assess the impact wind turbines may pose on the HF coastal oceanographic radar network used operationally by the U.S. Coast Guard for search and rescue and by NOAA for oil spill monitoring and response, among many other societal needs.

Total Cost: $543,363 **Period of Performance:** FY 2017-2019

Conducting Organization(s): CODAR Ocean Sensors, LTD

Principal Investigator(s): Dale Trockel, dale@codar.com

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Description:

Background: Recent simulations of offshore wind turbine interaction with HF coastal radar operation (Teague and Barrick, 2012; Ling et al, 2013) indicate that rotating turbine blades cause interference with HF radar data that requires mitigation techniques for optimal use of these data. The signature and impact of turbine blade rotation on HF radar data processing have not yet been characterized sufficiently from real-world situations, and adequate simulation data have been undertaken only recently. It is known from past studies and HF radar measurements that wind turbines within the field of view have negative impacts on the received signals (Ling, 2013; Teague and Barrick, 2012). These degrade ocean current and wave processing and their output data products. Degradation can be so severe as to render data useless. This will first be felt by the HF radar systems on Block Island, because the turbine placement will be close to shore (within 6 km), where the effects of the wind turbines will be most impactful on the HF radars. Simulations of turbine impacts must be refined to include details of actual turbine construction materials and operating parameters. More importantly, these simulations must be augmented by incorporation of real-world data under a variety of conditions. This will allow BOEM to assess the impacts of wind turbines on HF radar for environmental and engineering review and the development of mitigation techniques required for unimpeded U.S. Integrated Ocean Observing System (IOOS) HF radar network operations.

Presently there are five continuously operating HF radars that collect data covering areas in and around the proposed Block Island Wind Farm. Partnering with the IOOS Program Office, BOEM will be able to obtain in situ measurements from nearby HF radars during wind turbine operation at Block Island to quantify adverse impacts of rotating wind turbines on HF radars. Applying in situ data to the creation and validation of algorithms for mitigation of the negative impacts of wind turbine blade interference to HF radars will advance the interagency coordination needed for thorough NEPA analyses and review. Real-time evaluation and optimization of the mitigation methods generated from this study will assess HF radar signal degradation and interference from wind turbine sources. The proposed impact study is needed prior to and post wind turbine installation in order to accurately investigate and mitigate potential radar interference by wind turbines and identify possible solutions that allow the coexistence of wind energy facilities and radar infrastructure and services.

Objectives: The overall objective of this study is to understand the effects of offshore wind turbines on HF radar operations. Specific objectives include the following:

- Data will be collected by the radars when the turbines are operating, in order to observe and assess the severity of the impacts. Based on these signals, work will begin on development of algorithmic methods to mitigate their impacts.
- The effectiveness of mitigation methods will be analyzed and method revisions will start, including changing the radar waveform (e.g., the repetition frequency); filtering based on knowledge of the bearing of the fixed turbine locations and attempts to notch out these angles from current and wave algorithms; and use of turbine-mounted calibrating beacons to optimize turbine echo spur excision.
- Real-time beta testing of derived methods for optimization of operational implementation will be conducted.

Methods: This study will conduct in-depth research into wind turbine operation, with data collection of specific operating parameters, e.g., turbine blade rotation rates, construction materials, and sizes of turbines and blades. In order to better simulate offshore wind turbine operations, IOOS HF radar technical staff, their regional representatives, and industry partners will exchange information directly with wind turbine industry engineers in order to improve or refine simulations using currently existing tools and methods.

The previously developed Numerical Electromagnetic Code (NEC) will be expanded to reflect real-world parameters for simulations of wind turbine rotation effects, including frequencies other than the 13.5 MHz used in prior simulations. These improved and expanded simulations will inform the evolution of field tests and interference mitigation methods. Turbine echoes affect the received signals of all HF radars in much the same way, regardless of brand because all use the same waveform (FMCW).

Field testing of HF radar in the vicinity of offshore wind turbines must be conducted to accurately assess and validate mitigation algorithms. HF radar will collect data in coastal areas where offshore wind turbines are currently in operation, e.g., Block Island, Rhode Island. The length of time required for adequate characterization of the varying conditions that may exist is about two months. Sufficient time must account for variations in wind conditions responsible for changes in turbine blade speed, pitch, and orientation to the radar; for variations in wave and ocean current conditions for examination of differences in Bragg and second-order sea echo characteristics in the presence of radar interference; and for changes in system configurations. All levels of data products from HF radar will be kept for analysis during the entire study. Data from the following US IOOS HF radar sites will be available for processing and analysis of wind turbine impacts:

- Block Island, RI (2 radars) (operated by Univ. of Rhode Island & Rutgers)
- Montauk, NY (operated by Univ. of Rhode Island)
- Misquamicut, RI (operated by Univ. of Rhode Island)
- Martha’s Vineyard, MA (operated by Rutgers Univ.)
- Nantucket Island, MA (operated by Rutgers Univ.)
  (*Note that each radar on Martha’s Vineyard and Nantucket Island is capable of 200 km ranges, hence their inclusion here.)

Current Status: The study began in October 2016 with a field visit to Block Island. The Numerical Electromagnetic Code (NEC) report to show the expected wind turbine impact on SeaSonde spectra using simulated data was delivered in March 2017. Modeling of the signal is complete and the code is revised to correct for interference. The draft report is in preparation.

Final Report Due: September 2018

Publications Completed: None.

Affiliated WWW Sites: None.

Revised Date: August 2, 2018