ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDY

Title	Implementation of Mitigation for Offshore Wind Turbine Interference on High-frequency (HF) Coastal Oceanographic Radar (NSL AT 19-x09)
Administered by	Office of Renewable Energy Programs
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Conducting Organization(s)	CODAR
Total BOEM Cost	$476,684
Performance Period	FY 2020–2022
Final Report Due	December 18, 2021
Date Revised	August 26, 2021
PICOC Summary	
Problem	Wind turbines interfere with HF-radar (HFR) measurements. These measurements are used to produce data products such as surface currents, waves, winds, drifter simulations, and tsunami and vessel detections—which in turn have both scientific and practical applications.
Intervention	Implementing a software fix for CODAR Ocean Sensors SeaSonde® HFR instruments.
Comparison	Ocean surface current measurements with and without turbine interference would be used to evaluate the efficacy of the mitigation measure.
Outcome	The implementation will allow for accurate current measurements in areas where wind turbines are operating.
Context	HFR sensors are used along most U.S. coasts to provide ocean surface current measurements for research as well as activities like search and rescue.

BOEM Information Need(s): With wind turbines now operating offshore in U.S. waters, the Bureau of Ocean Energy Management (BOEM) must develop and deploy a real-time mitigation for the signal distortion turbines impart on the SeaSonde coastal oceanographic HFR network used operationally by the U.S. Coast Guard for search and rescue and by the National Oceanic & Atmospheric Administration (NOAA) for oil spill monitoring and response, among many other societal needs.

Background: BOEM funded the study "Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar" (BOEM 2018-053), which characterized the interference and the wind turbine parameters, such as rotation rate, that contributed to this interference. The next steps are to (1) expand the mitigation algorithms to a large facility (100 turbines) of heterogeneously configured and rotating wind turbines spread across tens of kilometers through simulations and (2)

provide an optimized real-time operational software remedy that can be used on SeaSondes for the next 10 years.

This study will implement an HFR signal processing software solution to mitigate adverse impacts of rotating wind turbines on ocean surface current mapping HF radars operating along the Atlantic coast. Applying in situ data and simulations to the creation and deployment of real-time operational software tools that mitigate the negative impacts of wind turbine blade interference to HFRs will advance the interagency coordination needed for thorough National Environmental Policy Act analyses and review. The proposed software development, validation, and implementation study is needed in order to actively mitigate radar interference by wind turbines and provide solutions that allow the coexistence of wind energy facilities and radar infrastructure and services.

Objectives:

- Assess the impact of turbine interference, spread out in range-Doppler space, on radar-derived physical oceanographic measurements.

- Provide to the HFR community, within six months of this project's completion, a software package for mitigating interference that is capable of real-time integration with the existing operational SeaSonde data processing tool chain.

Methods: The first step will extend the simulations to include interference from an arbitrary number of turbines distributed within multiple range bins of the coverage area of a radar system. The turbines shall be simulated to allow for variation in all parameters associated with an offshore turbine, including, but not limited to, rotation rate, angle of the blades relative to the radar, height of the turbine hub, and length of the blades. The turbine locations shall encompass all possible ranges and azimuths with the nominal coverage area of the radar. All SeaSonde transmit frequency bands currently used (i.e., 5, 12, 25, and 42 MHz), as well as International Telecommunications Union-approved bands, shall be tested. The second step will develop a deployable, lasting, real-time interference mitigation solution and software.

The code will incorporate and improve upon the successful mitigation algorithm subroutines reported in BOEM 2018-053. For example, by using Bayes theorem, both the temporal and spatial structures of the observed interference can be used to improve flagging of distorted radial currents and to attempt to reduce their impact on the data. The code will be specifically designed and optimized to run in real time on SeaSonde radar station computers, interfacing with the many other tasks that must run simultaneously on these operational systems. The development and validation of the code shall be done to allow mitigation to be attempted on existing systems in the NOAA Integrated Ocean Observing System national network. There is no source code of this nature available for compiling currently; it is a phase that must be undertaken by this study.

Specific Research Question(s): What is the optimal way to reduce interference in HF radar from wind turbines?

Current Status: The kick-off meeting was held in January 2020. The first report evaluating solutions for the interference was accepted in October 2020. The compiled and source code was delivered in September 2021.

Publications Completed: None.

Affiliated WWW Sites: None.

References:

Trockel D, Rodriguez-Alegre I, Barrick D, Whelan C. 2018. Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar. Sterling, VA: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-053. https://marinecadastre.gov/espis/#/search/study/100141