Title	Hydrodynamic Modeling and Particle Tracking in the U.S. Mid-Atlantic Bight
Administered by	Office of Renewable Energy Programs
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Procurement Type(s)	Contract
Approx. Cost	
Performance Period	FY 2019–2020
Date Revised	January 30, 2018
PICOC Summary	
Problem	Offshore wind construction projects have the potential to alter local and regional physical oceanographic processes
Intervention	Hydrodynamic and particle tracking models will be utilized to assess how the introduction of commercial scale offshore wind energy facilities affect local and regional hydrodynamics under average seasonal conditions.
Comparison	These models will be used to demonstrate oceanographic conditions prior to offshore wind construction, post-installation of a single facility, and post full build-out of all current offshore lease areas, using representative turbine array layouts.
Outcome	To understand the potential and cumulative impacts to physical oceanography and transport processes due to commercial-scale build-out of offshore wind.
Context	Modeling efforts will cover the U.S. Mid-Atlantic Bight, focusing on regions offshore Rhode Island and Massachusetts.

BOEM Information Need(s): BOEM needs to understand potential changes in physical oceanographic processes, both local and regional, that may affect organic and inorganic transport patterns. BOEM also has a need to adequately assess individual and cumulative impacts of offshore wind projects as part of impact assessments pursuant to the National Environmental Policy Act and the Magnuson-Stevens Fishery Conservation and Management Act.

Background: BOEM has issued 13 offshore commercial wind energy leases in southern New England and the Mid-Atlantic. Stakeholders have expressed concerns in regards to the alteration of oceanographic transport patterns in the Mid-Atlantic Bight between Cape Hatteras and Cape Cod as a result of offshore wind construction projects. In order to address these concerns, BOEM needs to be prepared to accurately assess potential changes in hydrodynamic flows resulting from the build-out of one or several offshore wind energy facilities. Evidence shows that offshore structures change local current velocities and flows, as well as wind velocities and their effect on the water surface and vertical motions (Segtnan and Christakos, 2015) . Less understood are the cumulative impacts of large and multiple projects on regional circulation patterns. This is especially important in relation to how changes in flow may impact the transport of juvenile fish and larvae to and from habitats used at different life stages and the transport of nutrients and sediments throughout the region.

A previous BOEM-funded study (Chen et al., 2016) examined the potential impacts of a representative wind energy facility offshore southern New England on particle transport during storm conditions using the Finite Volume Community Ocean Model (FVCOM). Since the conclusion of this study, more precise facility layouts have been proposed and interest in potential impacts due to average seasonal conditions and the cumulative impacts of multiple offshore wind facilities have been expressed.

Objectives: To assess how the construction of multiple offshore wind energy facilities in the Mid-Atlantic Bight will affect local and regional hydrodynamics under average seasonal conditions and the resultant impact on circulation and sediment, nutrient, and larval transport. The results from this study will be used to evaluate the need for and the formation of mitigation measures.

Methods: The intent of the proposed study is to build upon knowledge gained during prior studies by refining the analysis methods and expanding on the scope. This study will include a desktop review of existing related studies, particularly those from Europe, that have been released since the completion of BOEM's previous study and a statistical analysis of particles of interest (*i.e.*, larval species and sediment grain sizes). This study will also incorporate average seasonal conditions, improve upon the particle release and tracking methods, and examine new scenarios involving realistic layouts of multiple facilities.

Three model segments will be necessary to address the objective: wind wake, ocean circulation, and particle tracking. The wind wake model will be used to estimate the change in surface wind velocities for input into a high resolution (est. 10 m resolution in the immediate area of the turbines), three-dimensional ocean circulation model capable of resolving small-scale physical processes throughout the water column. The particle tracking model will be an individual-based model used to release and track particles representing sediment, nutrients, and larvae. The particle tracking model will be capable of representing different particle characteristics such as size, location and timing of release, and location and duration in the water column.

The prospective model domain is an area covering the four current lease areas offshore Rhode Island and Massachusetts, with potential for additional task orders covering the Mid-Atlantic region from New York to North Carolina. The depth range of the model will be limited to 100m or less.

Example scenarios include an initial condition absent any wind energy facilities, a realistic layout of a single project, and a realistic layout of multiple projects. Additional scenarios may include layouts of varying turbine sizes (6–15 MW turbines) with appropriate number and spacing, and varying particle characteristics.

This study will assess the scale of change of offshore wind development on particles traveling through and near to the facilities. Information from the model should also permit an assessment of the susceptibility of sediment in Wind Energy Areas (WEAs) to resuspension as a result of offshore wind facility construction and operation. Models should be grounded in empirical evidence from the region(s) assessed, such as acoustic Doppler current profiles, wind measurements, and geophysical data including surficial sediment and bathymetry, which should be available from existing partners/projects.

Specific Research Question(s):

1. How do offshore wind energy facilities affect local and regional hydrodynamic processes such as currents and mixing rates in the Mid-Atlantic Bight?
2. What will be the cumulative impacts of a full build-out of all current offshore wind lease areas in the Mid-Atlantic Bight on regional hydrodynamic processes?
3. How will these changes affect the transport of sediment, nutrients, and larvae during average seasonal conditions?

References:

Ole Henrik Segtnan, Konstantinos Christakos, 2015. *Effect of Offshore Windfarm Design on the Vertical Motion of the Ocean*. Energy Procedia, Volume 80, Pages 213–222, ISSN 1876-6102, http://dx.doi.org/10.1016/j.egypro.2015.11.424. (http://www.sciencedirect.com/science/article/pii/S1876610215021566)

Changsheng Chen, R. C. Beardsley, J. Qi and H. Lin, 2016. *Use of Finite-Volume Modeling and the Northeast Coastal Ocean Forecast System in Offshore Wind Energy Resource Planning*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. BOEM 2016-050. 131pp