Field	Study Information
Title	Offshore Wind Turbine Visibility Study (AT-23-06)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	John McCarty (john.mccarty@boem.gov
Procurement Type(s)	Interagency Agreement
Performance Period	FY 2024–2026
Final Report Due	TBD
Date Revised	September 15, 2023
Problem	In 2013, BOEM published co-funded research that evaluated the visibility of wind turbines located off the shores of the United Kingdom (Sullivan et al. 2013). The study evaluated wind turbines that are 351 feet to 502 feet tall and determined six different visibility thresholds measured in miles/ kilometers from shore. Visual impact reports in the construction and operation plans (COP) submitted to BOEM commonly reference the findings of the 2013 study to support impact assessment conclusions on impact levels. However, the current generation of wind turbines proposed in the COPs are now two to three times taller that those studied in the 2013 report. Visual impact reports continue to reference antiquated findings.
Intervention	Supplement the 2013 study with a new field evaluation on the visibility of the current generation of taller wind turbines and calibrate the visibility thresholds accordingly.
Comparison	The proposed study would use 2013 evaluation protocol and compare the new findings to those of the 2013 results.
Outcome	Revised visibility thresholds measured in miles/kilometers.
Context	When funds are made available, the study would be conducted in areas where the larger generation of wind turbines are constructed and available to study. This may include U.S. Federal waters or those of foreign nations (most likely Europe). Research will be transferrable to all areas where BOEM has authority to permit offshore renewable energy development.

BOEM Information Need(s): There is a need to update the 2013 study titled “Offshore Wind Turbine Visibility and Visual Impact Threshold Distances” (Sullivan 2013) funded by BOEM in 2011. The study has been widely cited for in visual impact assessments (VIA) of offshore wind energy facilities in BOEM COPs. The VIAs use the 2013 study as a basis for establishing potentially affected areas for impact assessments and predicting visual impacts of proposed projects. The 2013 study evaluated the daytime and nighttime visibility thresholds of wind turbines located off the shores of the United Kingdom that ranged in height from approximately 351 feet to 502 feet tall (Sullivan 2013). The height of wind turbines proposed in recently submitted COPs range from approximately 853 feet to 1,042 feet, or two to three times the height of the original study. Supplementing the original study with evaluations of the larger, more current wind turbines would provide wind energy developers with new thresholds to incorporate into

viewshed modeling and delineate affected viewsheds, and serve as a basis for impact assumptions. The study will also investigate the ability to generate a calibration coefficient from a comparison of the results from the 2013 and 2023–2025 studies to adjust the findings for future generations of taller wind turbines.

Background: Apart from the two 617 feet wind turbines placed in Federal waters 27 statute miles offshore from the Virginia coast as a part of the Coastal Virginia Offshore Wind Pilot Project (Dominion Energy 2018), large-scale deployment of offshore renewable energy is absent, but inevitable. Equally inevitable is public perception of the potential visual impacts, which may rouse public opposition for some offshore wind projects (Pasqualetti 2011). Coastal communities may be guarded against the perceived industrialization of a seascape that is otherwise thought of as a pristine or special seaside environment (Firestone 2012). The potential scrutiny from these coastal communities compounds the need to have current and accurate research for VIAs to reference. As the U.S. begins large-scale deployment of offshore wind energy facilities, accurately representing potential visual effects is critical to facilitating proper public understanding of the size and scale of offshore renewable energy development and produce defensible assessments of visual impacts.

Objectives:

- Assess the visibility of utility-scale offshore wind facilities that range in height from 850 to 1,047 feet or taller that are currently operating in actual seascape settings.
- Assess the effects of distance, onshore viewing elevation, and variable atmospheric and lighting conditions on offshore wind turbine visibility.
- Formulate a calibrating equation for determining visibility and visual prominence of future taller wind turbines from a comparison of the results of the 2011 and 2023–2025 studies.

Methods: To maintain consistency, the new study would use the same basic methods from the 2013 study to evaluate visibility of the latest in wind turbine technology and recently built projects. The 2013 study was conducted by three individuals that included a landscape architect, geospatial visualization developer, and archaeologist. Data recorded included descriptions of the location of the viewpoint; weather, general lighting, and visibility conditions; and the backdrop content and color. The solar azimuth and elevation, the layout and height of the visible turbines, the shading and/or sunlight on the turbines, and the overall lighting angle were documented. Aviation and marine navigation marking/lighting was also included, as well as blade movement and other transitory effects. Additional data collected for nighttime observations included the number, type, and cycle of the aviation and/or marine lighting. For each observation, single-frame photographs and panoramic sequences were taken at a variety of focal lengths; at many locations, short videos also recorded the motion of the turning blades. Visibility assessments evaluated the effects of distance and atmospheric variables on the visibility and visual contrast levels of offshore wind facilities on a numeric rating a scale of 1 to 6. The ratings were conducted through naked-eye observations of the facilities in the field.

The method for the new study would require minor refinements to address unique circumstances not present during the 2013 study. For instance, the viewing locations may be from a sea vessel if the modern wind turbines are placed further offshore with older developments obstructing their view from shore. This study will also incorporate viewing from different onshore elevations to evaluate elevational influence on visibility distances. The study protocol may also be supplemented with new considerations or tools, for instance supplementing the still photos with video technology. The study would focus on

visibility distances and impact thresholds for the tallest offshore turbines and projects in the U.S. and/or Europe at the time the study is conducted.

Specific Research Question(s):

1. How far distant can modern wind turbines be visibly detected?
2. What are the incremental distances that define the visual impact thresholds of offshore wind turbines to the seascape character (seascape character is preserved, retained, modified, or substantially changed)?
3. How does the elevation of the onshore viewer factor into in long range visibility?
4. Can a multiplier be extracted from a comparison of the two studies to calibrate the updated findings as new and taller generations of wind turbines are manufactured?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

Dominion Energy. 2018. Amendment to the Coastal Virginia Wind Offshore Wind Project, May 21, 2018. Glen Allen (VA): Dominion Energy Services, Inc. 170 p. https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/VA/CVOW_RAP_Amendment_Memo.pdf

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Pasqualetti, MJ. 2011. Opposing wind energy landscapes: a search for common cause. Annals of the Association of American Geographers. 101(4):907–917. http://dx.doi.org/10.1080/00045608.2011.568879

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