PROPERTY VALUES AND VISUAL IMPACTS

What you should know:

- Climate change poses substantial risks to coastal communities, especially during severe weather events, which risk public health and cost trillions of dollars in damage to property and infrastructure.
- Decarbonizing our electricity supply is an effective strategy for reducing the carbon emissions that drive climate change.
- Resident communities, Tribes, and property owners are sometimes concerned that offshore wind turbines will change local views (viewshed) and coastal character, as well as potentially impact culturally significant areas.
- How visible an object is on the ocean horizon is influenced by many factors and fluctuates with weather, time of year, and time of day. Most planned offshore wind developments will be built far enough from shore (more than 20 miles) that they will be very difficult to see under most conditions.
- Evidence from communities near offshore wind farms, in the U.S. and abroad, indicate that the impact to the local economy is often neutral to positive.

Climate Change Effects

In its Sixth Assessment Report the Intergovernmental Panel on Climate Change (IPCC) concluded unequivocally that the increase of carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N_2O) in the atmosphere is the result of human activities. Since the Industrial Revolution, human influence is the principal driver of many changes observed across the atmosphere, oceans, and biosphere (IPCC, 2021). Human health, properties, infrastructure, services, coastal ecosystems, and recreation in coastal communities will all be impacted by climate change (Environmental Protection Agency [EPA], 2023).

Coastal zones are essential to local, national, and global economies. In the U.S., coastal counties make up only 10% of the country's land mass (excluding Alaska) but are home to 40% of the population and produce more than $9.5 trillion in goods and services each year (National Oceanic and Atmospheric Administration [NOAA], n.d.-a). Coastal areas also support more than 58 million jobs in industries such as fishing, tourism, real estate, transportation, and defense (NOAA, n.d.-b). Of these industries, marine transportation is one of the most crucial. More than three-fourths of all trade in the U.S. involves the nation's marine transportation system (NOAA, n.d.-b), including the acquisition of most goods sold in U.S. stores.

Climate change, and the increased frequency and severity of tidal flooding and storm surges, threatens the U.S.'s trillion-dollar coastal property market and public infrastructure. With these increased threats come cascading economic impacts (The National Climate Assessment [NCA], 2018). Under a worst-case scenario, scientists expect many coastal areas to be transformed by the latter part of this century. Even under best-case scenarios, many individuals and communities could experience financial impacts, as chronic high-tide flooding damages coastal infrastructure (NCA, 2018). Therefore, in the face of climate change, it is essential for coastal residents, property owners, and community leadership to understand local and regional flood zones and include diverse stakeholders in adaptive community planning, construction, and maintenance processes to help decrease direct losses and reduce impacts to the economy.

While adaptive strategies are helpful in mitigating the impact of climate change on coastal areas, a multifaceted approach is required to increase coastal resiliency. One of the best ways to combat climate change requires transitioning away from fossil fuels and decarbonizing electricity at its very source (Center for Climate and Energy Solutions [C2ES], 2018). Life cycle assessments on the carbon emissions of wind and solar power suggest that these technologies not only reduce carbon emissions from power production systems, but also reduce human health impacts from air pollution and environmental toxicity associated with the combustion of fossil fuels (Luderer et al., 2019). To read more on health impacts, visit Human Health.

Offshore Wind Effects

The potential impacts of offshore wind projects are continually researched and monitored to prevent adverse environmental impacts and to maintain compliance with regulatory guidelines. The identification of potential sites for offshore wind development includes an evaluation of the local environmental, economic, cultural, and community impacts, as well as other ocean uses. Project development teams, on average, spend five years on research, analysis, and negotiation with regulators and stakeholders to address community feedback before construction plans are approved. Where required, ongoing studies on coastal environments are conducted by project developers or regulatory agencies, such as the Bureau of Ocean Energy Management (BOEM), to further inform mitigation planning and implementation and reduce environmental impacts to coastal communities (BOEM, 2023-a).

In some cases, communities and property owners are concerned about the visual impact of wind turbines on coastal properties, recreational areas, culturally significant areas, and tourist attractions. Offshore wind projects on the East Coast of the U.S. are sited on the outer continental shelf (OCS) in water depths of, on average,100 feet and at distances of about 25 miles from the mainland's coastline (Department of Energy [DOE], 2023). It is common for most offshore wind projects to have a varying range of nearest to farthest visible wind turbines within its project area. For example, the Atlantic Shores offshore lease area has the nearest wind turbine at about 9 miles off a specific location of the New Jersey shoreline, and the furthest at 45 miles off another location of the shoreline (Atlantic Shores Offshore Wind [ASOW- VIA], 2023). Similarly, the South Fork Wind Farm is located in federal waters and is approximately 35 miles east of Montauk Point, New York; 20 miles southwest of Martha's Vineyard, Massachusetts; and 19 miles southeast of Block Island (Town of New Shoreham), Rhode Island (South Fork Wind Farm [SFWF-VIA], 2020).

Spotlight Question: Will offshore wind development negatively impact property values?

Wind power is the fastest-growing source of electricity in the U.S., but it has been argued that wind turbines are a visual disamenity (Guo et al., 2024). Yet various studies show little to no effect on property values both in the U.S. and abroad. Property values are significantly more sensitive to macroeconomic conditions of housing supply and demand than to the presence of offshore wind farms (Centre for Economic Policy Research [CEPR], 2021).

In a 2024 study on the visual effects of wind turbines on property values across the U.S., Guo et al. found that there is a small (1%) average reduction of property value for houses within 10 km (approximately 6 miles) of visible wind turbines, and that the reduction in value a property experiences peaks three years after a turbine is installed. However, the study further concluded that these effects diminish with distance and time. Using data from the United States Wind Turbine database, real estate transaction records, and digital elevation models, Guo et al. found that the reduction on property value becomes indistinguishable from zero when a wind turbine is greater than 10 km from a property and/or seven years after installation (Guo et al., 2024).

A study by Dong and Lang (2022) found no evidence of negative impacts to property values in the mainland coastal community markets in Rhode Island (Westerly, Charlestown, South Kingstown, and Narragansett) nor the Block Island market from the presence of the Block Island Wind Farm. New evidence from data on residential homes and land-based wind projects show a similar lack of impacts. Review of urban counties in the U.S., with populations greater than 250,000, also indicate that the property values of homes located farther than two miles from land-based commercial wind turbines are unaffected (Brunner et.al., 2023).

Similarly, in 2018, a large-scale study analyzed the impact of onshore and offshore wind turbines on the value of nearby residential and vacation properties in Denmark, a country that has hosted offshore wind turbines for 30 years. This study included two Danish offshore wind farms that are relatively close to the shore – Nystad at 2.2 miles and Rødsand at 5.6 miles. In neither case were property prices affected by the presence of offshore wind farms (Jensen et al., 2018).

Notably, property values in the Rhode Island coastal town of Narraganset have reached historic highs in the last ten years, per the Zillow Home Value Index data (ZHVI) (Zillow, 2023). Similarly, homes in the coastal Washington county of Rhode Island are also listed at all-time highs (Federal Reserve Economic Data, 2023). These findings demonstrate that offshore wind development has limited-to-no impact on property prices. The effects are further diminished for mainland coastal areas that are, on average, at least 20 miles from the positioned wind farms.

Offshore Wind and Visual Impacts

Offshore wind turbines are typically not visible from local coastlines. The visible components of operational projects are dependent on multiple factors, including the location from which an observer may view the coastline (called a Key Observation Point or KOP), the orientation and configuration of the turbines, the distance between the coast and the turbines, lighting conditions, vegetation, and land topography. Other visibility factors include the height at which a KOP is situated and atmospheric conditions, such as waves on the ocean surface, humidity, fog, and air pollution (BOEM, 2021). Further, the off-white color of the turbines generally blends well with the sky color at the horizon line. Weather data collected by the National Climatic Data Center (NCDC) at the Newport and Block Island Stations over a six-year period (2010 to 2016) indicated that clear skies (0-30% cloud cover) occurred during daylight hours, on average, 42% of the time. Though partly cloudy and cloudy skies may still allow some level of turbine visibility based on location and height of the observation area, the presence of cloud cover substantially reduces long distance visibility of the turbines during much of the year. Additionally, an analysis by BOEM concluded that daytime visibility conditions out to 23 miles occurred approximately 61% of the year, while visibility out to 34.5 miles occurred approximately 35% of the year (BOEM, 2017).

Viewshed Analysis and Impacts

To understand and mitigate impacts to viewshed (a view from a certain vantage point) in early stages of a wind farm project, BOEM requires a seascape, landscape, and visual impact assessment (SLVIA) for all offshore wind projects (Sullivan, 2021). The SLVIA has two parts: seascape and landscape impact assessment (SLIA) and visual impact assessment (VIA). SLIA analyzes and evaluates impacts on both the physical elements and features that make up a landscape or seascape and the aesthetic, perceptual, and experiential aspects of the landscape or seascape that make it distinctive. This analysis is used to identify the potential visibility impact of the project and objectively determine the difference in landscape quality pre- and post- project. Daytime and nighttime visual simulations are created as part of the study to characterize the potential visibility of offshore wind turbines from shoreline locations. These simulations take into consideration visibility during different seasons, times of day, and weather conditions.

Historic properties are also accounted for in the viewshed analysis. Historic Resources Visual Effects Analyses (HRVEA) are performed by project developers and submitted to BOEM and State Historic Preservation Offices (SHPOs) for comprehensive review, mitigation, and approval where warranted (BOEM, n.d.). Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to take into account the effects of their undertakings on historic properties and give the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment. The ACHP ensures federal agencies implement their work in harmony with the National Historic Preservation Act. The ACHP also works with partners in the Section 106 process, including State Historic Preservation Officers, Tribal Historic Preservation Officers, and Federal Preservation Officers (ACHP, 2023). BOEM's Office of Renewable Energy Programs (OREP) is required to comply and meet its obligations under the NHPA by conducting detailed reviews and coordinating those reviews with OREP's analyses of the proposed projects under the National Environmental Policy Act (BOEM-OREP, 2023). BOEM has several regional Programmatic Agreements (PAs) in place to fulfill these noted obligations for renewable energy activities on the OCS. This is implemented throughout the lease area and project review process via outreach, engagement, and consultation with federally recognized Tribes, state and federal agencies, and Section 106 Consulting Parties. (BOEM-NHPA, 2023).

Finally, the proposed project is assessed by a panel of visual professionals through the United States Army Corps of Engineers (USACE) Visual Resources Assessment Procedure (VRAP). These visual impact analyses help residents better understand what a completed project might look like by accurately portraying how wind turbines might affect aesthetics (Department of Energy [DOE], 2023). Through the comprehensive assessment of visual impacts across different lines of sight, the public and stakeholders are provided with insight on the potential visual changes to their coastlines. Based on the project impacts, a variety of corrective mitigation actions can be taken where the turbines may impact daytime and nighttime viewsheds (i.e., deploying ADLS). Similarly, visual, historical, and cultural impact surveying and evaluation is completed for other land-based facilities, such as the development of onshore substations.

To recap, impacts to viewshed due to the presence of offshore wind turbines are dependent on proximity, weather conditions, and height. However, distance in the siting of offshore wind turbines further away from the mainland, turbine color, and common coastal weather conditions, reduce the negative impact to a coastal communities' viewshed, quality of life, and recreation.

Visual Impact Analysis Examples

As part of the seascape, landscape, and visual impact assessment (SLVIA) that each offshore wind farm developer must complete as part of their permit applications, a visual study area is determined. For example, a 40-mile radius around each of the proposed offshore wind turbines was defined as the visual study area for the South Fork Wind Farm. To capture areas of highest potential impact, the closest and tallest points (e.g., lighthouses) are included as key observation points (KOPs). Projects often have limited visibility due to topographic features such as forested land, cliffs, and hills within the mainland portions of the study area, significantly screening outward views. This is especially important where concerns may exist on the impact to recreational forest and land use for the public. In areas of concentrated human settlement, views of the projects may also be significantly screened by existing vegetation and buildings. Hence, potential project visibilities may be largely restricted to the ocean shoreline and water bodies immediately inland of the shoreline. Using the South Fork Wind Farm SLVIA as an example, potential visibility extended up to around 700 feet inland from the ocean shoreline before breaking up into small pockets of visibility and then dissolving completely. The line-of-sight cross sections also revealed that none of the mainland views from Rhode Island and Massachusetts would include more than the upper one-half to two-thirds of the wind turbines (SFWF, 2020). If the project design were to change, such as an upgrade to taller or higher capacity turbines, the analysis would be updated to account for the changes to the previous visual simulations and re-reviewed for changes in impacts.

For other examples of visual impact assessments and studies, visit the Vineyard Wind section of BOEM's website and BOEM's Offshore North Carolina Visualization Study.

Tourism and Offshore Wind

Seaside towns and beaches are popular tourist destinations, and the emergence of offshore wind power raises questions and concerns about what impact offshore wind could have on the tourism industry (Rudolph, 2014; Carr-Harris & Lang, 2019). However, to date, there is no substantial evidence to conclude that offshore wind farms negatively impact coastal tourism.

Current perceptions tend to treat tourists and recreationists as a monolithic group: i.e., beachgoers who are primarily concerned with the beauty of the natural seascape. However, the full classification of coastal tourists embodies many aspects of the economy such as recreation, fishing, outdoor activities, community activities, culinary explorations, music experiences, and short-term stays. Observations of responses to the Block Island Wind Farm were integral in understanding how tourists felt and how they interacted with the offshore wind farm. Block Island has a resident population of approximately 1,000 people. In the summer months that population swells to nearly 10,000 people on any given day. A study was conducted where tourism and recreation professionals held focus groups to discuss experiences with the wind farm project. The results revealed diverse viewpoints, yet largely positive encounters. Of the negative responses, participants cited concerns regarding project costs and initial concerns about visual impacts. Upon deeper engagement with visual simulations, most participants described the project's appearance in neutral or positive terms (Smythe et al., 2020).

Additionally, a study was conducted to evaluate the impact of the Block Island Wind Farm on the vacation rental market. Researchers from University of Rhode Island used data from Airbnb to study tourism and short-term housing trends. Researchers compared Block Island to three nearby tourist destinations in Southern New England, before and after construction. The results suggested that the construction of the Block Island Wind Farm caused a significant increase in nightly reservations, occupancy rates, and monthly revenues for Airbnb properties on Block Island during the peak-tourism months of July and August, but had no effect in other months (Carr-Harris & Lang, 2019). The findings also indicate that offshore wind farms can act as an attractive location feature and provide opportunities for economic growth through its construction and operational phases, rather than serving as a deterrent (Carr-Harris & Lang, 2019).

Lutzeyer et al. (2017) found that a community's perception of the negative effects of wind farms is more strongly influenced by the proximity of the wind farm to shore than the number of turbines erected. Further, perceived negative visual effects from tourists diminished rapidly when turbines were placed more than eight miles from the shore. Currently, all wind farms planned for future development in the U.S. have turbines sited beyond this eight mile threshold (Lutzeyer et al., 2017).

Mitigation Innovations

All potential impacts from an offshore wind project are evaluated within a mitigation framework. The aim is to avoid, minimize, or mitigate adverse effects as much as is feasible. Opportunities to avoid visual effects for offshore wind projects are limited, given the size and physical characteristics of the wind turbine generators and the open ocean environment in which they are located. However, daytime and nighttime effects can be minimized.

Light-colored turbines are used to minimize contrast with the daytime sky under most conditions. Additionally, warning lights are required as safety measures per Federal Aviation Administration (FAA) and the United States Coast Guard (USCG) regulations, and for the safety of ocean users and communities. Where technology allows, developers can implement a radar-based aircraft detection lighting system (ADLS). This technology allows lights to turn on and off in response to detection of aircraft near the wind farm, and for the lights to remain turned off when no aircraft are in the area. These systems reduce the amount of time that the lights are illuminated, thereby minimizing turbine visibility from the shore at night (SFWF, 2020; Coastal Virginia Offshore Wind Commercial Project, 2023). An illustrative example of the ALDS is available on the BOEM website (BOEM, 2023-b).

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