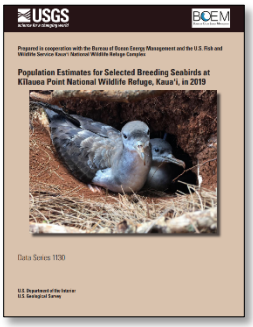
BOEM BUREAU OF OCEAN ENERGY MANAGEMENT

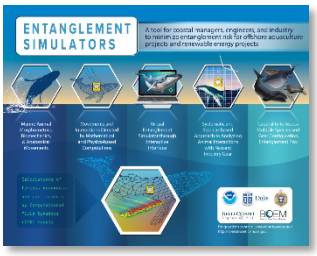
Selected BOEM-Funded Research Informing Renewable Energy Offshore Hawai`i & U.S. Pacific Territories August 2024

NEW Indicates a recently started or recently completed study.

Biological Studies



Ongoing (2017–2024) — **Atlas of Main Hawaiian Island Seabird Colonies**
This study by the U.S. Geological Survey is developing a comprehensive up-to-date atlas of Hawaiian seabird colonies. It will be used to evaluate threats to colonies and adjacent high-use offshore waters, provide a reference to measure population trends, and best inform place-based conservation and restoration actions.
Study Profile: https://espis.boem.gov/study%20profiles/BOEM-ESP-PC-17-03.pdf
USGS Report and Data Release: https://pubs.er.usgs.gov/publication/ds1130



Ongoing (2019–2025) — **Development of Computer Simulations to Assess Entanglement Risk to Whales and Leatherback Sea Turtles in Offshore Floating Wind Turbine Moorings, Cables, and Associated Derelict Fishing Gear Offshore California**
This study, in partnership with the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science, has developed morphologically and behaviorally accurate 3-D computer models of protected whale species (fin and humpback) and leatherback sea turtles. Two offshore floating wind mooring systems are currently under digital development. The whale and mooring system models will be integrated into simulations to visualize various potential interaction scenarios, including considering associated derelict fishing gear. These simulations will assist BOEM in assessing the risk and potential severity of entanglement, and potentially identify mitigation measures to reduce any risk.
Study Profile: https://espis.boem.gov/study%20profiles/BOEM-ESP-PC-19-x07.pdf
Infographic: https://www.boem.gov/pr-19-ent-infographic

Ongoing (2022–2024) — **Tag you're it! Habitat Use of Whales of the U.S. West Coast and Hawai'i**
This study by Oregon State University and the U.S. Navy will collate and analyze existing whale telemetry data to identify residence times, home ranges, seasonal shifts, hot spots of aggregation, and dive profiles of large whale species to better understand habitat usage. The first phase will focus on the Santa Barbara Channel and areas offshore Hawai'i (specifically around the island of O'ahu). The information garnered about whale occurrence, movements, and behavior will help inform decisions about the siting of offshore floating wind development offshore California and Hawai'i, and the timing of conventional energy decommissioning activities offshore southern California.
Study Profile: https://espis.boem.gov/study%20profiles/BOEM-ESP-PC-22-04.pdf

***Ongoing (2023–2026) —* Pacific Marine Assessment Partnership for Protected Species (PacMAPPS) II: Hawaiian Archipelago**

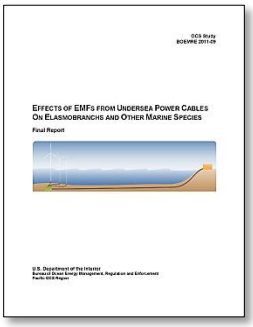
This study builds upon PacMAPPS I and continues the collaboration between BOEM, National Oceanic and Atmospheric Administration (NOAA), U.S. Navy, and U.S. Fish and Wildlife Service. This work is intended to supplement and complement ongoing efforts by NOAA Fisheries to conduct comprehensive marine mammal, seabird, and ecosystem surveys in U.S. waters in the Pacific every 3 to 6 years to estimate the abundance of protected species populations, develop spatial models of species distributions, and monitor status and trends. NOAA vessels will conduct long-range visual and acoustic line-transect surveys for protected species and collect oceanographic data in the Hawaiian Archipelago ecosystem in summer/fall of 2023 and in winter of 2025. The resulting data will be used to support up-to-date stock assessments and derived protected species use and distribution products for areas of interest to BOEM offshore the Main Hawaiian Islands.

Study Profile: https://espis.boem.gov/study%20profiles/BOEM-ESP-PC-23-02a.pdf

NEW ***Ongoing (2024–2027) —* Characterization of Water Column Habitats to Understand Potential Impacts from Deepwater Energy and Mineral Development**

This study by University of Alaska Fairbanks in collaboration with Japan Agency for Marine-Earth Science and Technology will collect environmental and ecological data (e.g., temperature, salinity, turbidity, oxygen, pH, carbon, and zooplankton species presence/absence and distribution) throughout the water column offshore northern California, Oregon, and Hawai`i; the data will contribute to baseline knowledge of pelagic systems that are highly dynamic and difficult to study. The study will also characterize the physical and chemical properties and biological communities in water column habitats near prospective lease areas for renewable energy as well as areas with potentially high concentrations of marine minerals.

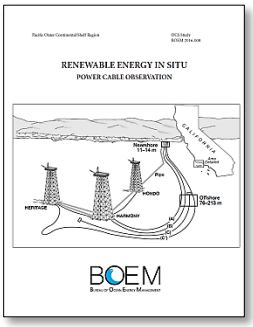
***Completed (2011) —* Effects of EMF from Undersea Power Cables on Elasmobranchs and Other Marine Species**



This study by Normandeau Associates synthesized data and information about subsea power-transmission cables and the sensitivity of marine organisms to electromagnetic fields (EMF) produced by the cables. It produced a database of information about potentially affected species of elasmobranchs (sharks and rays), other fishes, marine mammals, sea turtles, and invertebrates. It also recommended future research priorities and potential mitigation measures.

Report BOEMRE 2011-09: https://espis.boem.gov/final%20reports/5115.pdf

***Completed (2016) —* Renewable Energy *in situ* Power Cable Observation**

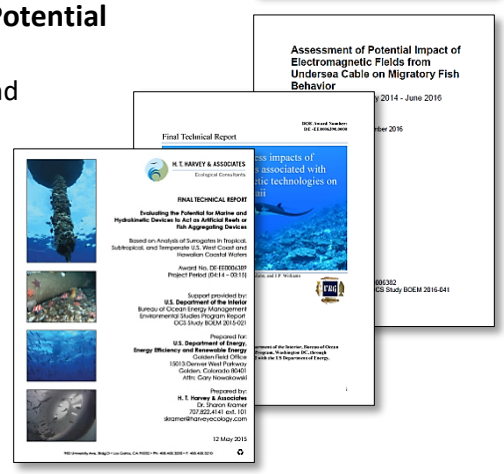


This study by the University of California, Santa Barbara measured the strength and variability of electromagnetic fields (EMF) along subsea power transmission cables in the Santa Barbara Channel, which are similar to cables used for offshore renewable energy inter-device electrical connections. It also compared fish communities in cable versus natural habitats and determined the potential effectiveness of cable burial as a mitigation measure to decrease EMF.

Report BOEM 2016-008: https://espis.boem.gov/final%20reports/5520.pdf

Webinar: https://www.boem.gov/Science-Exchange-3

***Completed (2016) —* Using Ongoing Activities as Surrogates to Predict Potential Ecological Impacts from Marine Renewable Energy**



BOEM and the U.S. Department of Energy partnered on this study to identify and analyze data from ongoing projects and activities (surrogates) with stressors and receptors similar to those expected from marine renewable energy projects. Two reports examined potential impacts of electromagnetic fields from operating power cables, and one examined mooring configurations of offshore surrogates such as aquaculture facilities and oceanographic buoys as fish attracting devices.

Reports:

BOEM 2015-021: https://www.boem.gov/2015-021

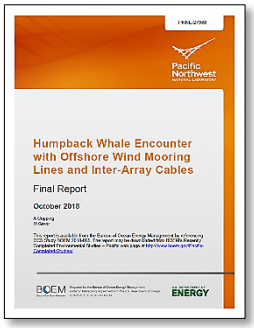
BOEM 2015-042: https://www.boem.gov/2015-042

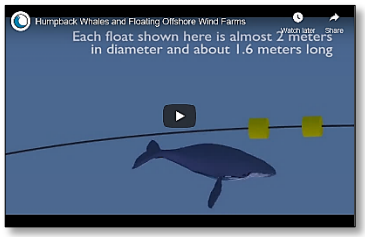
BOEM 2016-041: https://www.boem.gov/2016-041

Completed (2016) — **Developing and Applying a Vulnerability Index for Scaling the Possible Adverse Effects of Offshore Renewable Energy Projects on Seabirds on the Pacific OCS**

This BOEM-directed study, conducted and primarily funded by the U.S. Geological Survey, developed a comprehensive database to evaluate 81 marine bird species in the California Current System (CCS) in terms of their collision and displacement vulnerability from offshore wind energy infrastructure. It used existing and newly analyzed at-sea behavioral information (e.g., avian habits and activities, flight-height, and flight characteristics) and population metrics to identify species-specific vulnerabilities at the population level. The vulnerability assessment results can now be combined with recent marine bird at-sea distribution and abundance data for the CCS to help address seabird conservation during the siting and operation of offshore wind energy development projects.
Report BOEM 2016-043 (USGS Open-File Report 2016-1154): https://pubs.er.usgs.gov/publication/ofr20161154
Webinar: https://www.boem.gov/Science-Exchange-6

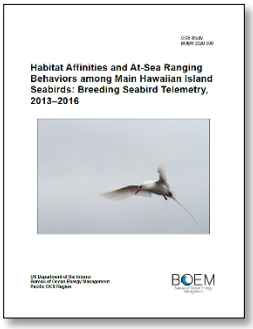
Completed (2018) — **Humpback Whale Encounter with Offshore Wind Mooring Lines and Inter-Array Cables**





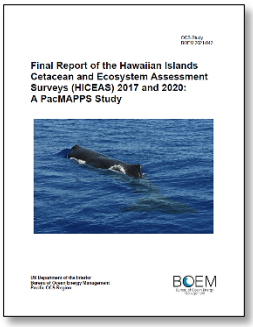
This study by the U.S. Department of Energy's Pacific Northwest National Laboratory compiled information about whale movements (e.g., dive depths and swimming speed) and created a three-dimensional video animation of how whales may move through a hypothetical offshore floating wind farm. This visual simulation will help characterize the risk of whale encounters with mooring lines and electrical cables used in offshore floating wind projects.
Report BOEM 2018-065: https://www.boem.gov/BOEM-2018-065
Video Animation: https://www.boem.gov/humpback-whales-floating-wind

Completed (2020) — **Habitat Affinities and At-sea Ranging Behaviors among Main Hawaiian Island Seabirds**



This study by the U.S. Geological Survey conducted field studies of at-sea habitat utilization and ranging behaviors for seabirds breeding within the main Hawaiian Islands. It also compiled and analyzed remotely sensed and modeled habitat data to examine habitat relationships to predict species' distributions and improve spatial vulnerability maps. Results will be used by BOEM to assess potential effects of offshore renewable energy development to main Hawaiian Island seabirds.
Report BOEM 2020-006: https://espis.boem.gov/final%20reports/BOEM_2020-006.pdf

Completed (2021) — **Pacific Marine Assessment Partnership for Protected Species (PacMAPPS) – Hawaiian Archipelago**



This study was a partnership between BOEM, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, and the U.S. Navy to conduct shipboard surveys of marine mammals, seabirds, and, to the extent possible, sea turtles in the Pacific. The data collected during 2017 and 2020 (winter) surveys of the Hawaiian Islands will help BOEM evaluate potential effects of proposed renewable energy activities on protected species, that includes an ecosystem-level context.
Report BOEM 2021-042: https://espis.boem.gov/final%20reports/BOEM_2021-042.pdf

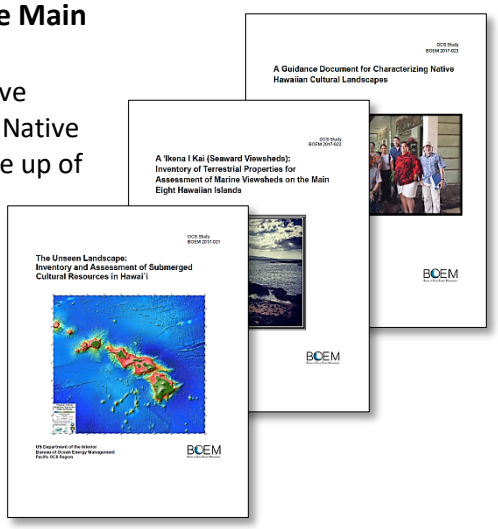
Cultural & Archaeological Studies

Ongoing (2023–2027) — **Maritime Heritage of the U.S. Pacific Islands**

This study by East Carolina University is acquiring and synthesizing archival data about underwater cultural heritage, including traditional cultural properties that could be affected by offshore leasing activities near the U.S. Pacific Islands. The study will also identify best practices for working with Indigenous communities. Work in Guam and the Northern Mariana Islands began in 2023, and work in American Samoa may start in late 2024. The results of this baseline study will inform planning and environmental reviews for possible leasing of renewable energy and marine minerals in federal waters surrounding the islands.

Study Profile: https://espis.boem.gov/study%20profiles/BOEM-ESP-PC-22-07b.pdf

Completed (2017) — **Maritime Cultural Resources Site Assessment in the Main Hawaiian Islands**



This study assessed maritime cultural resources in Hawai`i and was a collaborative effort between BOEM, the National Oceanic and Atmospheric Administration, a Native Hawaiian project facilitator, and an inter-island consultative working group made up of representatives from the main Hawaiian Islands. The study developed an inventory of submerged cultural resources on the Hawai`i OCS, an inventory of terrestrial historic properties on the eight main Hawaiian Islands that could be within view of offshore renewable energy sites, and a best-practices tool for characterizing Native Hawaiian cultural landscapes. The overarching goal of this effort was to help facilitate federal decision-making processes in support of offshore renewable energy development.

Study Fact Sheet: https://www.boem.gov/pc-13-01-fact-sheet

Reports:

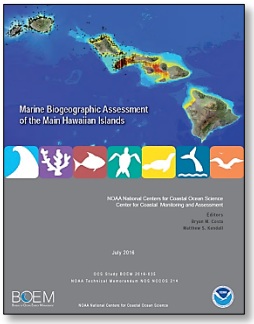
BOEM 2017-021: https://espis.boem.gov/final%20reports/5621.pdf

BOEM 2017-022: https://espis.boem.gov/final%20reports/5619.pdf

BOEM 2017-023: https://espis.boem.gov/final%20reports/5621.pdf

Information Synthesis Studies

Completed (2016) — **Marine Biogeographic Assessment of the Main Hawaiian Islands**



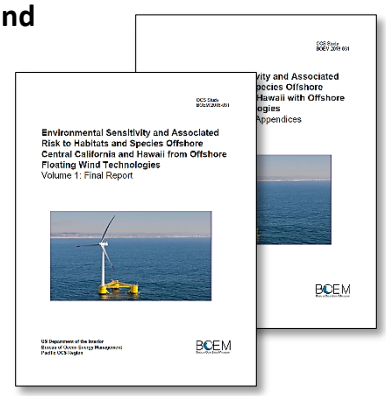
This study by the National Oceanic and Atmospheric Administration, working with Hawaiian partners, assembled and synthesized information about physical and biological resources offshore the main Hawaiian Islands, including physical oceanography, bathymetry, marine mammals, seabirds, sea turtles, fish, and corals. The assessment will help to characterize the distribution and abundance of marine resources in state and federal waters, identify knowledge gaps, support spatial planning for development of offshore renewable energy, and contribute to ecosystem-based management of marine resources.

Project Details: https://coastalscience.noaa.gov/project/marine-biogeographic-assessment-hawaiian-islands

Data Products: https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.nodc:155189

Report BOEM 2016-035: https://espis.boem.gov/final%20reports/5555.pdf

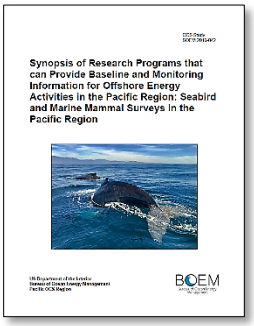
Completed (2018) — **Environmental Sensitivity and Associated Risk to Habitats and Species Offshore Central California and Hawaii from Offshore Floating Wind Technologies**



This study by ICF International identified and characterized potential impact-causing factors to the marine environment related to offshore floating wind energy development. The study developed an environmental sensitivity and relative risk model to assess impacts on biological and habitat resources from offshore floating wind technology.

Report BOEM 2018-031:
Volume 1: https://espis.boem.gov/final%20reports/BOEM_2018-031.pdf
Volume 2: https://espis.boem.gov/final%20reports/BOEM_2018-031_A.pdf

Completed (2019) — **Synopsis of Research Programs that can Provide Baseline and Monitoring Information for Offshore Energy Activities in the Pacific Region**

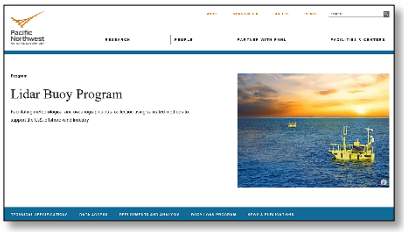


This study by the U.S. Geological Survey identified research programs that have produced databases containing information on species and habitats sensitive to offshore energy activities in the Pacific Region. It evaluated the capability of these programs to provide baseline and monitoring data to understand and mitigate potential impacts of conventional energy development offshore southern California and renewable energy development offshore southern California, Oregon, Washington, and Hawai`i.

Report BOEM 2019-042: https://www.boem.gov/2019-042

Physical Oceanography & Geology Studies

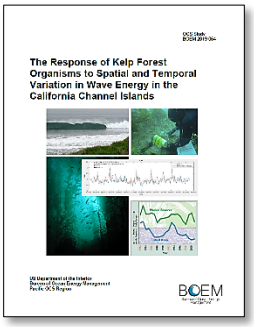
Ongoing (2022–2024) — **Collection of Metocean Resource Characterization Data off Hawai`i**



This study is a partnership between BOEM and the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) to collect information about meteorological and oceanographic conditions offshore Hawai`i using a buoy deployed for 12 months. Buoy instrumentation includes a doppler lidar for measuring wind speed and direction up to 250 meters above the ocean surface. Additional instruments measure wave height and direction, currents, salinity, and water and air temperature. The collected data will improve understanding of wind and wave energy resources, and is used by researchers and industry to inform model creation and decision making.

Website: https://www.pnnl.gov/projects/lidar-buoy-program

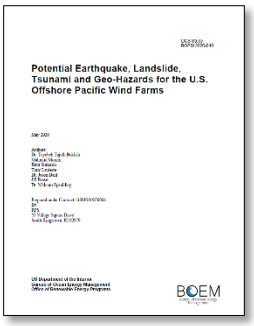
Completed (2019) — **Predicting the Consequences of Wave Energy Absorption from Marine Renewable Energy Facilities on Nearshore Ecosystems**



By calibrating a regional wave model with site-specific wave measurements and site-specific biological data (30+ year time series from the National Park Service and the U.S. Geological Survey offshore southern California), this study developed a statistical model to predict the potential effects of wave energy absorption from marine renewable energy facilities on nearshore ecosystems, especially giant kelp forests. The study found that wave energy had a significant effect on several species. But for most taxa (36/57), density was unrelated to waves. Even for those species with a statistical relationship between density and wave energy, a 15% reduction in wave height would not have a detectable effect on the density of any species.

Report BOEM 2019-064: https://espis.boem.gov/final%20reports/BOEM_2019-064.pdf

Completed (2020) — **Potential Earthquake, Landslide, Tsunami and Geo-Hazards on the U.S. Offshore Pacific Wind Farms**



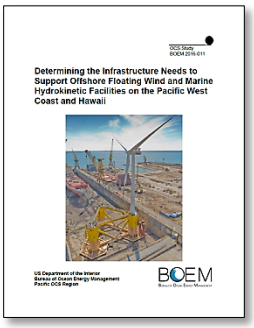
Floating offshore wind (FOW) construction and operation on the U.S. West Coast may face the risk of potential geohazards, as they are relatively new applications of older technologies (land-based wind and mobile offshore drilling units) in tectonically active regions. Seismic activities, landslides, and tsunamigenic earthquakes are threats to the U.S. West Coast and Hawai`i, and uncertainty exists over how FOW development and siting will be impacted by these threats in proposed areas of development. This study provided both a general evaluation of geohazards for floating wind areas already designated as potential lease sites and developed design considerations and criteria for structures to cope with extreme events.
Report BOEM 2020-040: https://www.boem.gov/environment/final-report-geohazards
Web Map Interface: http://boem-oceansmap.s3-website-us-east-1.amazonaws.com

Resource, Technology & Infrastructure Studies

Completed (2015) — **Pacific Offshore Time Series Wind Resource Analysis**

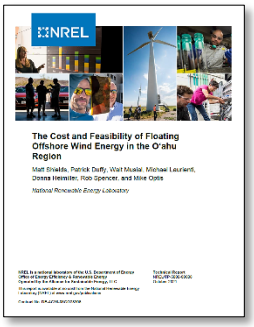
This study by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) addressed time-series analysis of wind speed data along the coasts of Washington, Oregon, California, and Hawai`i, scaled to BOEM's aliquot grid (a unit of leasing). Average wind speed was provided by month, by hours of the day, and for a long-term (17-year) time series. Although NREL's web-based GIS application Wind Prospector is retired, the wind resource datasets are available for download.
Data: https://gds-files.nrelcloud.org/archive/wind-prospector.zip

Completed (2016) — **Determining the Infrastructure Needs to Support Offshore Floating Wind and Marine Hydrokinetic Facilities on the Pacific West Coast and Hawaii**



This study by ICF International evaluated the current infrastructure and vessel requirements and capabilities existing on the Pacific West Coast of the U.S. and the Hawaiian islands of O`ahu, Maui, and Kaua`i to support the burgeoning offshore renewable energy industry. Understanding the infrastructure needs of the offshore renewable industry will help to identify the port-related requirements for offshore floating wind development and marine hydrokinetic industries and assess the utilization of the available marine equipment and facilities along the U.S. West Coast.
Report BOEM 2016-011: https://espis.boem.gov/final%20reports/5503.pdf

Completed (2021) — **The Cost and Feasibility of Floating Offshore Wind Energy in the O`ahu Region**



This study by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) evaluated the costs of floating offshore wind in the region surrounding O`ahu and provided data visualization to inform Hawai`i's energy planning process. NREL used the most up-to-date floating offshore wind technology information, cost model input assumptions for the unique Hawai`i market, and the Offshore Regional Cost Analyzer model to evaluate floating offshore wind costs on a levelized cost of energy (LCOE) basis. The study also compiled preliminary feedback and information from local stakeholders on the benefits and drawbacks of offshore wind and suggested future studies and activities to help inform decision makers about offshore wind in the region.
Report BOEM 2021-070: https://www.boem.gov/BOEM-2021-070

NEW *Completed (2024) —* **Hawai`i Floating Offshore Wind Regional Ports Assessment**

This study by Moffatt & Nichol analyzed the current and planned infrastructure of Hawai`i ports to assess their ability to support the growing floating offshore wind industry's demand. It used spatial analysis, interviews, and available records to collect the necessary data regarding infrastructure readiness. The findings culminated in a report that outlines port requirements and deployment scenarios to support the industry and provide a basis of analysis with which Moffatt & Nichol will conduct a regional feasibility analysis of existing and planned port facilities and infrastructure.

Report BOEM 2024-039: https://www.boem.gov/boem_2024-039

Socioeconomic Studies

Ongoing (2023–2025) — **Evaluating Hawaiian Fisheries and Potential Impacts of Offshore Wind Energy Development**

This study by AECOM Technical Services, Inc. will engage a diverse group of individuals knowledgeable about recreational, subsistence, and commercial Hawaiian fisheries (including their integration into local traditions, culture, and the State's economy) and potential offshore wind energy in structured discussions to understand issues and areas of importance to Native Hawaiians and the local community (e.g., ports, harbors, and coastal areas). The study will identify potential effects that offshore wind energy development may have on fishing resources and infrastructure, and propose how fishing activities and wind energy development can best coexist.

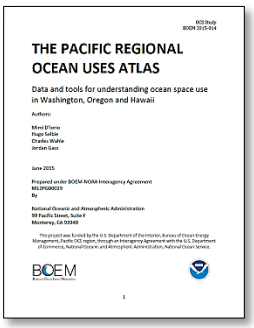
Study Profile: https://espis.boem.gov/study%20profiles/BOEM-ESP-PC-23-05.pdf

Completed (2015) — **Pacific Regional Ocean Uses Atlas**

This partnership between BOEM and the National Oceanic and Atmospheric Administration documented patterns of existing and emerging ocean uses in OCS areas off the states of Washington, Oregon, and Hawai`i through participatory mapping workshops. The project also identified potential areas of conflict and/or compatibility between proposed renewable energy areas and other ocean uses. The atlas documents a full range of human activities and sectors in the ocean to support offshore renewable energy planning.

Report BOEM 2015-014: https://www.boem.gov/2015-014

Project Information: https://marinecadastre.gov/oceanuses

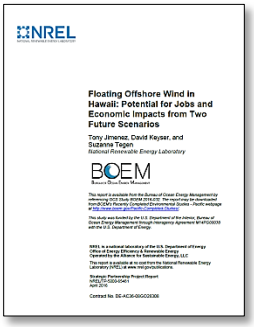


Completed (2016) — **Floating Offshore Wind in Hawaii: Potential for Jobs and Economic Impacts from Two Future Scenarios**

This study by the U.S. Department of Energy's National Renewable Energy Laboratory conducted an analysis of the employment and economic potential for floating offshore wind in Hawai`i. The study examined two scenarios: 400 MW of offshore wind installed by 2050 and 800 MW of offshore wind installed by 2050. The results of this analysis can be used to better understand the general scales of economic opportunities that could result from offshore wind development.

Report BOEM 2016-032: https://www.boem.gov/2016-032

Website: https://www.nrel.gov/analysis/jedi/wind.html



Other Studies Informing OCS Renewable Energy (not specific to Hawai`i or U.S. Pacific Territories)

BOEM 2017-057 **Phased Approaches to Offshore Wind Development and Use of the Project Design Envelope**
https://www.boem.gov/Phased-Approaches-to-Offshore-Wind-Developments-and-Use-of-Project-Design-Envelope

BOEM 2018-053 **Impact Assessment and Mitigation of Offshore Wind Turbines on High Frequency Coastal Oceanographic Radar**
https://espis.boem.gov/final%20reports/BOEM_2018-053.pdf

BOEM 2018-057 **Metocean Characterization Recommended Practices for U.S. Offshore Wind Energy**
https://www.boem.gov/Metocean-Recommended-Practices

BOEM 2020-039 **Radar Interference Analysis for Renewable Energy Facilities on the Atlantic Outer Continental Shelf**
https://www.boem.gov/environment/radar-interferance-atlantic-offshore-wind0pdf

BOEM 2021-030 **Floating Offshore Wind Turbine Development Assessment**
https://www.boem.gov/renewable-energy/studies/study-number-deliverable-4-final-report-technical-summary

BOEM 2021-032 **Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States**
https://www.boem.gov/environment/environmental-studies/boem-2021-032

BOEM 2021-053 **Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations**
https://www.boem.gov/environment/wind-turbine-foundations-white-paper-final-white-paper

BOEM 2022-081 **Assessment of BOEM's Role in Reviewing Hydrogen Production as a Complement to Offshore Wind**
https://www.boem.gov/sites/default/files/documents/renewable-energy/studies/BOEM%20-%20H2-OSW%20Assessment%20Final%20Report%20%28140M0121C0006%29%20Submitted%20OCS%20Number.pdf

For more information about BOEM-funded research:

- **BOEM Environmental Studies Program (ESP):** https://www.boem.gov/environment/how-we-do-research
- **BOEM ESP Hub** (an ArcGIS Online tool to explore information about ESP studies)**:** https://www.boem.gov/environment/environmental-studies/environmental-studies-information
- **BOEM Environmental Studies on GovInfo.gov** (a searchable repository of reports and other documents from ESP studies): https://www.govinfo.gov/collection/boem
- **Pacific OCS Environmental Studies** (studies managed by BOEM's Pacific Regional Office): https://www.boem.gov/Pacific-Studies
- **Renewable Energy Research** (studies managed by BOEM's Office of Renewable Energy Programs): https://www.boem.gov/environment/environmental-studies/renewable-energy-research

For information about BOEM's renewable energy activities:

- **Hawai`i Activities:** https://www.boem.gov/Hawaii
- **Guam Activities:** https://www.boem.gov/Guam