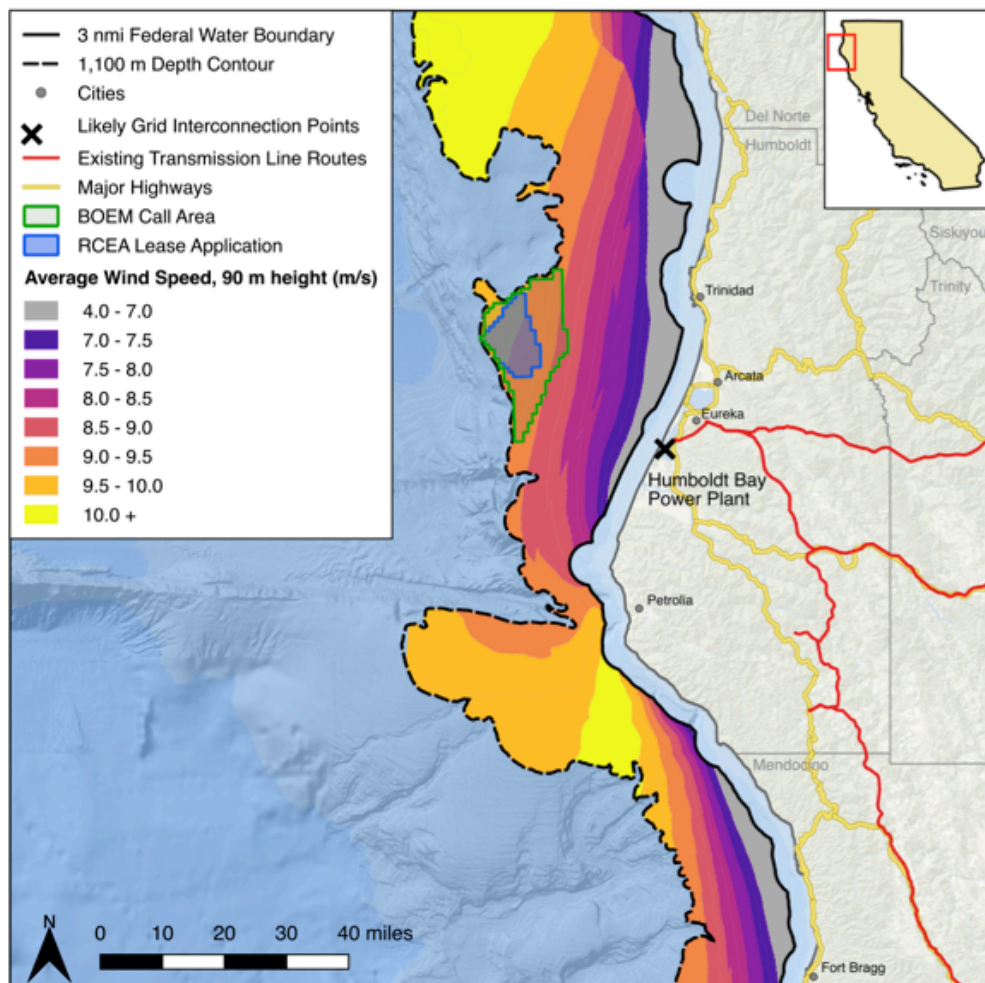



Offshore wind energy can make significant contributions to a clean, affordable, and secure national energy mix. With capital costs of offshore wind rapidly decreasing and development of floating platforms suitable for the deep waters along the Pacific Coast, wind developers have recognized Humboldt County as a promising offshore wind site because of the superb wind resource (see map below), existing deep-water port infrastructure, power interconnection capacity, and limited overlap with U.S. military operations. The National Renewable Energy Laboratory estimates that California's offshore wind has the technical potential to produce 150% of the state's electrical demand. Furthermore, offshore wind compliments the significant investment in solar generation in the state. As the solar generation ramps down in the afternoon, offshore wind can fill in the demand, which has the added benefit of making the grid more stable. The large potential of the wind resource and the compatibility with other renewable resources makes offshore wind well suited to help California reach its goal of 100% clean energy by 2045. In addition to clean energy production, offshore wind will also spur economic development and create new jobs.





However, bringing the offshore wind industry to California's North Coast involves some challenges. There are environmental issues related to birds and marine life; geologic hazards along the seismically-active coastline; electricity transmission constraints that must be overcome to deliver the power to California's main load centers; and stakeholder issues with other uses of ocean resources.

The Schatz Energy Research Center is leading three projects to understand the feasibility and potential of offshore wind on the North Coast. The research will be conducted over the next twelve months with results becoming available in winter and spring of 2020. As summarized below, the Schatz Center will evaluate a broad set of issues that cover the technical, environmental, social, and political aspects of offshore wind development.

### **Humboldt Offshore Wind Feasibility Analysis proposed to the Bureau of Ocean Energy Management**

This project will evaluate the offshore wind resource and compatibility with the local and statewide electrical transmission grid. Major partners include:

- Pacific Gas and Electric Company to estimate the transmission cost upgrades
- Mott MacDonald (coastal engineering firm) for conceptual design of the subsea cable
- Dr. Steve Hackett, Professor Emeritus, Economics Department, Humboldt State University for the economic viability analysis

The project has been proposed and is pending funding from the Bureau of Ocean Energy Management. The major research areas are described below:

#### Offshore Wind Generation and Load Compatibility Assessment

The project team will use existing data sources to understand and characterize the North Coast offshore wind resource and its potential for integration into the electric grid from an economic and regulatory perspective. For a selection of potential offshore wind generator installation locations, we will characterize the predictable seasonal and daily patterns and the associated random variation expected in the power generated by offshore wind turbines. Expected patterns of wind generation will be compared to the patterns present in the historical and projected 2030 California and Humboldt area electrical loads. In addition, we will consider how the capabilities of the existing 160 MW PG&E Humboldt Bay Power Generation Station could support integration of the wind generated electricity into the grid.

#### Electricity Grid Constraints, Mitigation Measures, and Associated Costs

The project team will determine the lower and upper bounds on the installed capacity of offshore wind generators in the Humboldt Bay Region considering the limits established by the existing infrastructure and by the requirements for economically viable commercial development. At present, the power capacity of the transmission lines (ca. 60-70 MW) linking the Humboldt County grid to the larger California grid, the design of local grid infrastructure, and the existing loads in Humboldt County (averaging 110 MW with a minimum load of about 70 MW) limit the amount of wind power generation that could be used. In addition, existing grid management requirements and transmission constraints must be considered to determine the bounds of project scale.

#### Economic Viability of Offshore Wind

The cost and value of offshore wind electricity will be calculated at three scales of development. A macroeconomic model will be used to evaluate job creation, economic development impact, and co-benefits to other stakeholders. This task will also estimate the investment required to overcome financial barriers set by the limits of existing transmission infrastructure.

### Subsea Cable Analysis

A high-level evaluation of a conceptual undersea transmission system between Humboldt Bay Area and the San Francisco Bay Area will be included under this task. The primary purpose of such a system would be for exporting offshore wind energy from the Humboldt region to loads in the San Francisco Bay Area. Such a system could also provide redundancy for existing transmission lines that serve loads in Humboldt Bay. The analysis will investigate a preliminary design concept and identify potential route paths and interconnection options.

### **North Coast Offshore Wind Feasibility Analysis funded through the California Ocean Protection Council**

This project will evaluate the concerns surrounding offshore wind development including environmental impacts, stakeholder concerns, coastal infrastructure requirements, and policy analysis. Major partners include:

- H.T. Harvey Ecological Associates for environmental analysis
- Dr. Laurie Richmond, Professor, Environmental Science and Management, Humboldt State University for stakeholder engagement
- Mott MacDonald (coastal engineering firm) for coastal infrastructure assessment

This project has been awarded by the California Ocean Protection Council and is underway. The major research areas are described below:

#### Likely and Potential Environmental Impacts

The project team will analyze the most likely and potential environmental impacts associated with offshore wind development, including impacts on marine ecosystems, resident and migratory birds, benthic organisms, marine mammals, fish, Endangered Species Act (ESA, both state and federal) listed species, and other relevant organisms in offshore and onshore locations. The analysis will include an assessment of pathways for permitting an offshore wind development in the Humboldt Bay Area, including consideration of environmental and other regulatory issues associated with federal, state, and local permitting processes.

This study will analyze the environmental impact of the wind farm, transmission system, and required infrastructure changes. Three scenarios will be examined including pilot-scale (e.g., 50 MW), modest commercial-scale (e.g., 150 MW), and large commercial-scale (e.g., 1,500 MW) development efforts. The analysis will consider terrestrial and marine environmental impacts from wind farm size and location; cable landing locations, subsea cables, and electric grid connection equipment; port development, harbor deepening, and other possible infrastructure changes; and other potential environmental changes and impacts.

#### Coastal Infrastructure Modifications and their Impact on Ocean Environment, Climate Resiliency, and Local Stakeholders

This research area will assess the current conditions of coastal infrastructure and describe the anticipated upgrades required to serve an offshore wind industry by conducting site visits, reviewing documentation, and interviewing local stakeholders. Expected modifications to the Humboldt Bay harbor and coastline will be characterized in a database and shared with the project team to incorporate as a basis for the environmental analysis, economic assessment, and stakeholder outreach.

Infrastructure upgrades will also be viewed from the perspective of other ocean resource uses to identify areas where additional benefits could occur through parallel development. Using stakeholder interviews and policy review, the project team will determine what actions or investments the state and/or local government could make to increase the co-benefits provided by an offshore wind facility regarding resilience, job creation, other business sectors, and ocean resources.

Lastly, the analysis will consider how development of an offshore wind generation system could influence the region's resilience to climate change or a major seismic or tsunami event. The report will use the Humboldt Bay Area Plan Sea Level Rise Vulnerability Assessment to evaluate likely and potential impacts to offshore wind development and resiliency benefits with respect to potential sea level rise.

#### Analysis of Stakeholder Benefits and Impacts

The project team will identify stakeholder benefits and concerns with regard to offshore wind energy development, where applicable, and determine approaches to address identified concerns. Stakeholders include, but are not limited to, the Humboldt commercial and recreational fishing community, pleasure boaters, labor unions, environmental organizations, developers, regulators, barge and other maritime transport operations, marine tourism businesses (e.g., whale watching), local governments, the general business community, PG&E, and others. Additionally, the analysis will cover job creation and an assessment of skill requirements associated with development of an offshore wind project/industry.

#### Policy Evaluation and Recommendations

The project team will investigate the implications of federal, state, and local policy and regulatory decisions currently under consideration that relate to the development of offshore wind in California and determine if alterations to policies and regulatory decisions would make offshore wind development more likely. This analysis could involve recommendations to agencies at the federal (e.g. BOEM), state (e.g. PUC, ARB, Natural Resources Agency, CEC, Coastal Commission), and local (e.g. Humboldt Bay Harbor District, Humboldt County Board of Supervisors) levels.

### **North Coast Offshore Wind Feasibility Analysis proposed to the California Governor's Office of Planning and Research**


This project will evaluate the military mission compatibility with offshore wind development, geologic and seismic issues, and the environmental impacts of a subsea cable. Major partners include:

- U.S. Navy Region Southwest is a key collaborator for evaluating compatibility between offshore wind and military mission
- Mott MacDonald (coastal engineering firm) for geologic analysis and seafloor anchoring and drilling expertise
- Dr. Mark Hemphill-Haley, Professor, Geology Department, Humboldt State University for analysis of seismic issues
- H.T. Harvey Ecological Associates for environmental analysis

The project has been proposed and is pending funding from the California Governor's Office of Planning and Research. The major research areas are described below:

#### Military Mission Compatibility with Offshore Wind Development

The U.S. Department of Defense and U.S. Navy have strategic uses of the ocean that are crucial for national security, research, development, and training. Offshore locations that are suitable for



wind development may overlap or conflict with military and naval uses of that area. The compatibility between offshore wind farms and the military mission must be assessed and addressed before offshore wind development can proceed successfully in northern California.

The Schatz Center will investigate how development of offshore wind projects and associated infrastructure improvements can be done in a way that is compatible with any military testing, training, and operations in northern California. This analysis will include recommendations for the placement of turbines and infrastructure that will be compatible with the existing mission of the military on California's North Coast.

### Geologic and Seismic Issues

The northern California coast is a highly-active seismic area with steep ocean floors, underwater canyons, and varying geologic conditions. These seismic and geologic issues need to be considered when assessing the preliminary feasibility of offshore wind. Offshore wind turbines in California would be mounted onto floating platforms that are tethered to the ocean floor. The feasibility of installing floating offshore wind turbines within California's seismically-active continental margin depends on the geological conditions of the ocean floor. We will investigate the geologic and seismic issues associated with seafloor anchoring of floating offshore wind platforms considering the geologic conditions present off the coast of northern California. In addition, a geologic feasibility analysis of the onshore cable landing point will be investigated to determine best locations and methods for bringing an electrical cable onshore from the wind farm.

### Environmental Analysis of Subsea Transmission Cable

Developing large-scale offshore wind power in northern California would significantly exceed the transmission capacity of the local electricity grid. One of the electrical transmission options is a subsea cable connecting North Coast offshore wind farms to load centers in the San Francisco Bay Area. The Schatz Center will conduct a preliminary environmental analysis of a subsea transmission line including impacts to benthic organisms and other marine life and ecosystems. The work under this research area will evaluate the most likely and potential environmental impacts of possible subsea cable pathways and identify areas for future, in-depth environmental review.