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Marine Sector Analysis Report: Marine Renewable Energy

Final Report | October 31, 2014

prepared for:

Washington Marine Advisory Council

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NOTICE

The information presented in this report reflects data collected from readily available sources and the opinions of a limited number of individuals knowledgeable about this sector, including representatives of private business interests. The views and opinions expressed herein are those of the individuals consulted and are not necessarily representative of the views of any state agency or of the perspectives of other experts or participants in the marine spatial planning process, either within or outside the sector. Industrial Economics, Inc. is solely responsible for the content of this report.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACOE	United States Army Corps of Engineers
BOEM	Bureau of Energy Management
CZMA	Coastal Zone Management Act
DFW	Washington Department of Fish and Wildlife
DNR	Washington Department of Natural Resources
DOE	US Department of Energy
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EMF	Electromagnetic fields
EPRI	Electric Power Research Institute
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FWS	United States Fish and Wildlife Service
FY	Fiscal Year
GW	Gigawatts
GWh	Gigawatt-hours
MOU	Memorandum of Understanding
MSP	Marine Spatial Plan
MW	Megawatts
MWh	Megawatt-hours
NEPA	National Environmental Policy Act
NETS	North Energy Test Site
NMFS	National Marine Fisheries Service
NNMREC	Northwest National Marine Renewable Energy Center

NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
OCNMS	Olympic Coast National Marine Sanctuary
OCS	Outer Continental Shelf
OSU	Oregon State University
PNNL	Pacific Northwest National Laboratories
PUD	Public Utilities District
SEPA	State Environmental Policy Act
SETS	South Energy Test Site
TNC	The Nature Conservancy
TWh	Terrawatt-hours
USCG	United States Coast Guard
UW	University of Washington
WCMAC	Washington Coastal Marine Advisory Council
WSPRC	Washington State Parks and Recreation Commission

PREFACE

The Washington Department of Ecology is leading an effort to develop a marine spatial plan (MSP) for Washington's Pacific coast. The plan is being developed in coordination with an interagency team that includes the Office of the Governor, the Washington Department of Natural Resources (DNR), the Washington Department of Fish and Wildlife (DFW), Washington Sea Grant, and the Washington State Parks and Recreation Commission.[1] The planning process also involves and engages coastal stakeholders, the public and local, tribal and federal governments. In particular, the Washington Coastal Marine Advisory Council (WCMAC) is advising on the development of the plan. WCMAC is a 26-member advisory group established in the Governor's office and comprised of a diverse range of stakeholder interests. In support of this effort, DNR has engaged Industrial Economics, Incorporated and BST Associates to develop reports on five major sectors of the state's marine economy: aquaculture; fishing (non-tribal); marine renewable energy; recreation and tourism; and shipping. These reports are intended to help state agencies, the WCMAC, and other stakeholders understand the trends and potential issues associated with economically important activity in the marine environment.

This report focuses on the marine renewable energy sector. It synthesizes information from publicly available sources to provide an overview of current economic activity, major trends in activity, and potential future resource uses and needs. In addition, the report draws on perspectives and insights from industry experts and relevant government agencies to highlight critical issues affecting the sector – including any current or potential future conflicts within the sector or with other sectors – and the role of marine spatial planning in addressing these issues (see Appendix A for a complete list of individuals interviewed). It also identifies key remaining questions, data quality issues, and data gaps.

WASHINGTON MARINE SPATIAL PLANNING OVERVIEW

Marine spatial planning is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine environments to achieve ecological, economic, and social objectives. The MSP will address issues resulting from increasing pressures on the resources in the area, as well as conflicts between and among existing and proposed new uses of these resources. The planning process will also involve and

[1] For additional information on Washington's marine spatial planning efforts, see RCW 43.372 and http://www.msp.wa.gov. An interactive mapping tool is available at: www.msp.wa.gov/explore/mapping-application.

engage coastal stakeholders, the general public, and local, tribal, and federal governments. The MSP will develop a comprehensive plan for addressing these types of potential activities to avoid and minimize impacts, reduce potential conflicts, and foster a healthy ecosystem. In addition, the MSP provides a basis for improving coordination and implementation of existing state and local laws, regulations and policies. It also provides an opportunity to coordinate with federal agencies and tribes related to their authorities. The law does not create any new authority under the MSP, nor does the MSP have authority to affect any existing or proposed project, use, or activity during the development of the plan (RCW 43.372.060). Instead, the MSP provides a consistent information framework for agencies to use when applying their existing authorities in response to particular project proposals and permit processes.

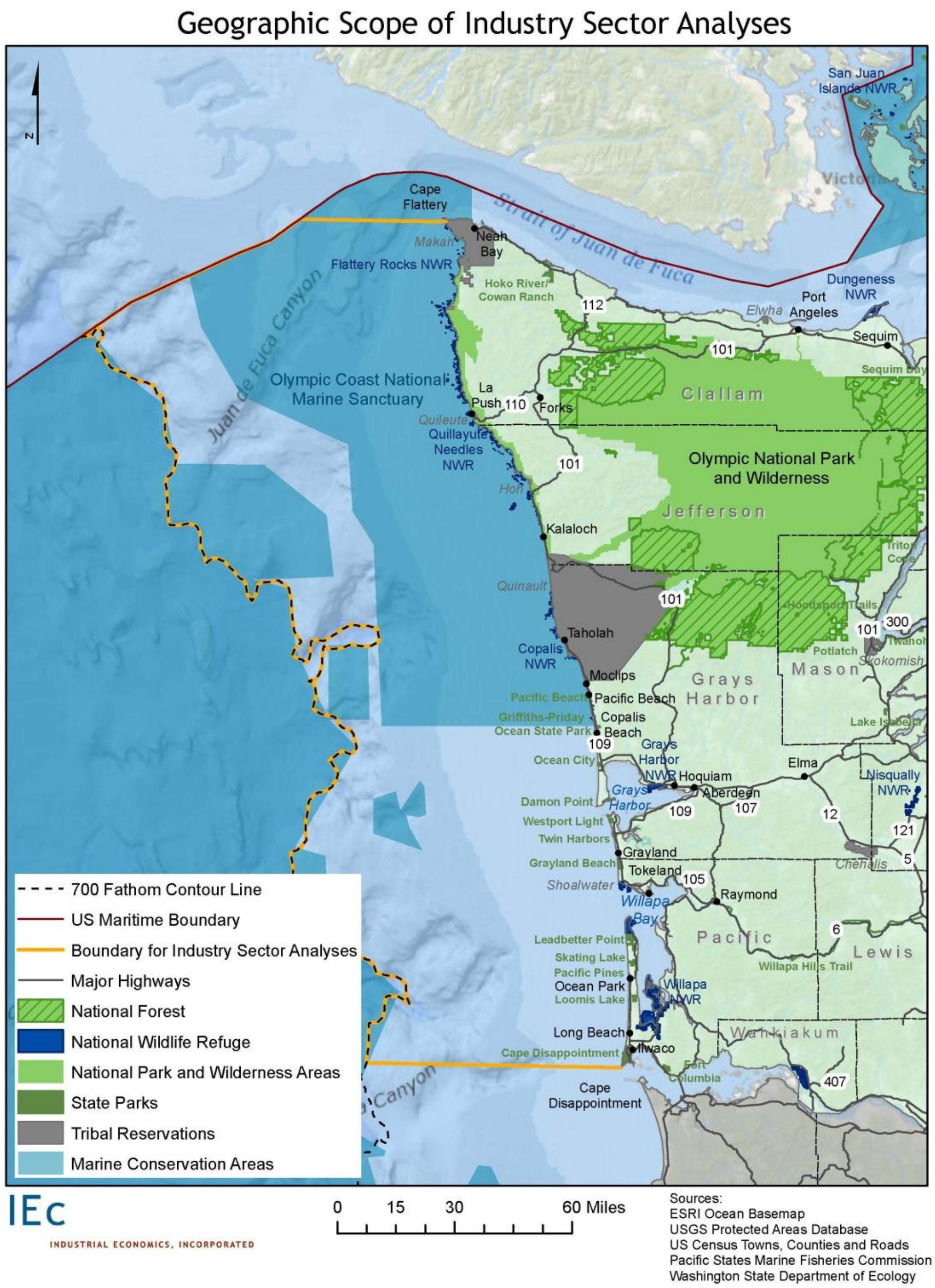
As part of the MSP planning process, the State Environmental Policy Act (SEPA) requires the state to develop an Environmental Impact Statement (EIS); the SEPA scoping summary was recently released (Ecology 2014). The EIS should be finalized within the next year; the MSP is expected to be finalized by December 2016 (Ecology 2013).

SECTOR ANALYSIS STUDY AREA

The activities considered in this sector profile are those which occur or may in occur in the future in marine or estuarine waters off the Washington Pacific coast. The area of interest includes state and federal waters from Cape Disappointment north to Cape Flattery and seaward to a depth of 700 fathoms, including Willapa Bay and Grays Harbor. The marine shoreline bordering this area includes roughly 157 miles of Pacific coastline, 89 miles in Grays Harbor, and 129 miles in Willapa Bay (Ecology 2001). The study area does not include the Strait of Juan de Fuca, the Lower Columbia River Estuary, or Puget Sound. The study area is illustrated in Exhibit P-1.

The Washington Pacific coast is mostly rural, and is supported by an economy based on tourism, recreation, and natural resources (e.g., commercial fisheries and timber). The region includes four counties: Jefferson, Clallam, Grays Harbor, and Pacific. In 2013, the total population of these counties was roughly 194,000, or three percent of the state population (Census Quickfacts 2014). In recent years, population growth and economic growth in these counties has been below the state average.

EXHIBIT P-1. MAP OF STUDY AREA INCLUDING KEY FEATURES



The Olympic Coast National Marine Sanctuary makes up most of the northern half of the study area, running north from the mouth of the Copalis River along the coast and extending seaward between 25 to 40 miles, including 2,408 square nautical miles of marine waters (Olympic Coast National Marine Sanctuary 2014). Olympic National Park occupies significant portions of the Clallam and Jefferson County coastlines. Other marine conservation areas in the study area include various federally-designated Essential Fish Habitat areas. In addition, areas off the Washington coast are designated training and testing areas for the U.S. Navy.[2]

The Makah, Quileute, Hoh, Quinault, and Shoalwater Bay Indian Tribes have reservation lands along the coast. Ocean resources are both economically and culturally important to these tribes.

The southern portion of the coast is more heavily developed than the northern coast, with a greater number of urbanized areas and a greater concentration of marine industry and infrastructure. Developed areas in the southern half of the coast include the cities of Hoquiam and Aberdeen and the Port of Grays Harbor, as well as the coastal towns of Pacific Beach, Ocean Shores, Westport, Ocean Park, Seaview, Long Beach, and Ilwaco. Numerous state park facilities are located along the southern half of the Washington coast. In addition, Willapa Bay, located in the southern portion of the study area, contains the Willapa Bay National Wildlife Refuge, and an economically important oyster industry.

SCOPE OF ECONOMIC INFORMATION CONSIDERED

This report focuses on the ocean economy, considering economic activity within the state that derives all or part of its inputs from the ocean (Colgan 2007). The report further focuses on current activities or activities that may occur in the reasonably foreseeable future. As a general guide we consider activities that are expected to occur within a planning horizon of 20 years. This timeframe should be sufficient to guide long-term planning, provided the MSP is periodically updated to take new information into account.

ORGANIZATION OF THE REPORT

The remainder of the report is organized as follows:

- Section 1 provides an introduction to the sector.
- Section 2 summarizes the current status of the sector.
- Section 3 describes the key issues facing the sector.
- Section 4 provides an inventory of the available economic data for the sector, and highlights limitations of the existing data and data gaps.
- Appendix A includes a summary of expert interviews.

[2] The Naval Undersea Warfare Center Keyport Range Complex is located within the study area. For more information see U.S. Navy 2014, www.nwtteis.com.

SECTION 1 | INTRODUCTION TO THE MARINE RENEWABLE ENERGY SECTOR

Interest in developing marine renewable energy in U.S. waters is growing, and the marine spatial planning process being undertaken in the state of Washington seeks to align this use with other ongoing uses of ocean waters. In anticipation of potential proposals for marine renewable energy projects, the Washington State Legislature directed that the final MSP include a framework for coordinating state agency and local government review of proposed renewable energy projects requiring multiple permits and/or other forms of formal approval. This framework must provide for timely review of and action on renewable energy development proposals while ensuring protection of sensitive resources and minimizing impacts to other existing or projected uses in the area (RCW 43.372.040).

DEFINITION OF THE SECTOR

For purposes of this report we define marine renewable energy to include offshore wind, wave, and tidal energy generation. A variety of devices may fall into these categories. For example, offshore wind devices may include floating platforms, monopole structures, or tripod/jacket devices, while wave energy devices tend to vary depending on the depths at which they are designed to operate (Van Cleve et al. 2013).

HISTORY, TRENDS AND OPPORTUNITIES

Marine renewable energy is an emerging use of ocean space. As noted in a recent report, "[t]he marine renewable energy industry is still very young due to limited deployment experience" (Van Cleve et al. 2013). While there have been expressions of interest in marine renewable energy and some activity in this sector in the past along Washington's Pacific Coast (see below), there are no marine renewable energy projects currently in operation in the study area, nor are any currently in development.[3] The situation is similar elsewhere in the United States; few if any projects have reached the development phase, let alone the commercialization phase. The same report notes, "[a]ll of the projects in the United States to date are pre-commercial or demonstration projects the primary purpose of which is to test and validate new or innovative uses of technology or combinations of technologies" (Van Cleve et al. 2013).

[3] The Bureau of Energy Management (BOEM) has received indications of interest in renewable energy projects on the Outer Continental Shelf (OCS) off of Washington; however, no lease requests have been received (BOEM 2014).

HISTORY

As noted above, there have been attempts in the past to develop marine renewable energy off of Washington's Pacific coast. The most prominent example is the Makah Bay Offshore Wave Pilot Project, which received initial approvals from both the Federal Energy Regulatory Commission (FERC) and the Olympic Coast National Marine Sanctuary (OCNMS).[4]

In November 2006, AquaEnergy, Ltd. filed an application for a license to construct, operate, and maintain the 1.0-megawatt (MW) Makah Bay Offshore Wave Pilot Project, to be located about 1.9 nautical miles offshore of Waatch Point in Clallam County (FERC 2007). The project as planned would have generated enough electricity to supply a minimum of 150 homes (Thomas 2007). The proposal called for installation of four wave energy conversion buoys ("AquaBuOYs"), a 3.7 mile long submarine transmission cable, a shore station at Hobuck beach, and a transmission line to connect to the existing Clallam County Public Utilities District (PUD) distribution line (FERC 2007). The PUD had agreed to purchase power from the project (Thomas 2007).

The license requested was for a five-year project to demonstrate the economic and environmental benefits of wave energy conversion power plants near coastal communities, as well as to help further development of clean, renewable energy technologies. A conditioned original license was issued to Finavera Renewables Ocean Energy Ltd. (formerly AquaEnergy Ltd.) by FERC in December 2007. The FERC license states:

> *The project will occupy about 1 acre of land on the Makah Indian Reservation and about 28.3 acres of lands, collectively, of the Olympic Coast National Marine Sanctuary (Olympic Coast Sanctuary) administered by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA); and state-owned aquatic lands administered by the Washington State Department of Natural Resources (Washington DNR). The project will generate an average of about 1,500 megawatt-hours (MWh) of energy annually (FERC 2007).*

In addition to the FERC license, the OCNMS issued AquaEnergy/Finavera a permit for a pilot project to conduct research to support a future application for installation of an alternative energy project (Personal comm. G. Galasso 2014). This permit approval was based on the involvement of the Makah Tribe, which has lands adjacent to the Sanctuary.[5]

According to a Seattle Times article, the Makah Bay project was the country's first wave-energy project to receive an operating license, but experienced delays in receiving

[4] In addition, one industry expert mentioned a project off Grays Harbor that reached the discussion phase, but has not moved forward (Personal Comm. T. Stearns 2014). Additional information on this project was not provided.

[5] OCNMS has the authority to issue such permits to an American Indian tribe adjacent to the Sanctuary (and/or its designee, as certified by the governing body of the tribe) to promote or enhance tribal self-determination, tribal government functions, the exercise of treaty rights, the economic development of the tribe, subsistence, ceremonial and spiritual activities, or the education or training of tribal members (15 CFR 922.153).

necessary state and federal environmental permits (Ma 2008). In addition, the developer experienced difficulties finding investors for the project (Thomas 2007). In 2008 the developer decided to halt all wave-energy projects and focus instead on wind power; thus, the project was never completed (Ma 2008).

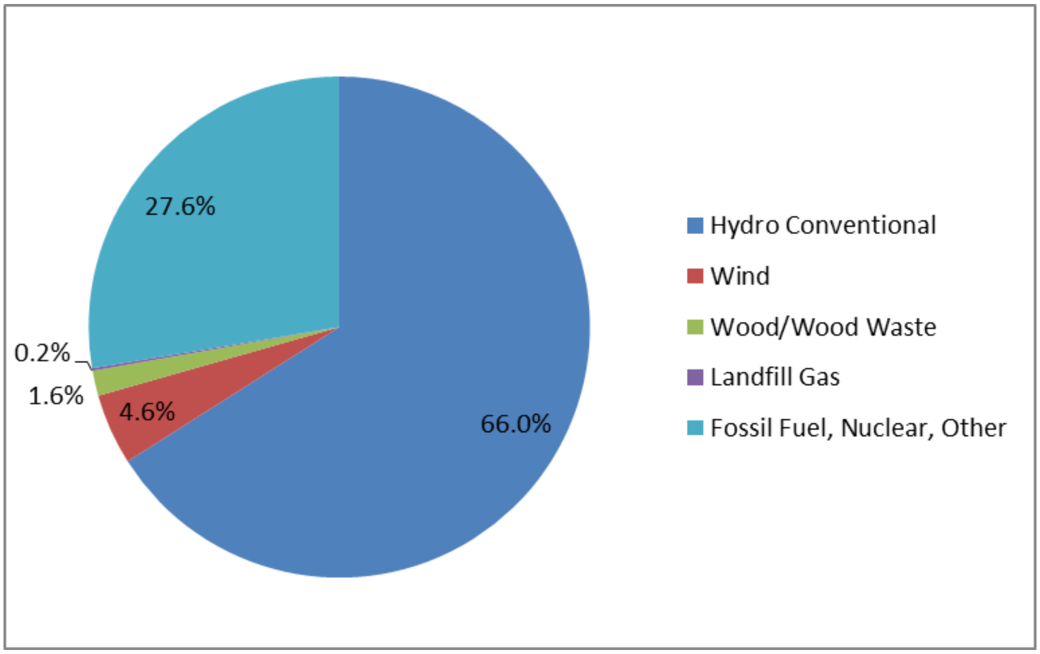
TRENDS

In order to provide context for the development of marine renewable energy in Washington, this section discusses trends in renewable energy production statewide, as well as current regional developments in the marine renewables sector.

Renewable Energy in Washington State

Washington is one of the nation's top producers of electricity from renewable resources; in 2010, renewables accounted for more than 72 percent of the electricity produced statewide. As illustrated in Exhibit 1-1, the majority of this production came from conventional hydropower projects, which accounted for 66 percent of the state's net electricity generation (EIA 2012). Most hydropower production occurs along the Columbia River, which features hydroelectric projects such as the 6,809 megawatt capacity Grand Coulee Dam (EIA 2014). Non-hydroelectric renewable energy resources provided just over six percent of Washington's net electricity generation, with wind accounting for 4.6 percent, wood and wood waste accounting for 1.6 percent, and landfill gas accounting for 0.2 percent (EIA 2012). Among non-hydroelectric renewable energy resources, wind power serves as the state's largest electricity generator. Washington currently has an installed capacity of approximately 2,800 MW of wind power, placing it ninth among states nationwide (AWAE 2014).

EXHIBIT 1-1. WASHINGTON STATE NET ELECTRICITY GENERATION BY ENERGY SOURCE AS OF 2010



Source: EIA 2012.

Development of terrestrial wind power is continuing in wind-intensive areas such as the Columbia River Gorge. Recently, however, terrestrial wind development has slowed, with only one new project starting construction in 2013 (Sickinger 2014). One stakeholder suggests that this may be indicative of a longer-term trend, and that offshore wind resources will become more competitive in approximately 20 years, once the best terrestrial wind sites are fully developed (Personal comm. T. Stearns 2014). A number of other factors have also contributed to the slowing development of wind power in the Northwest (Sickinger 2014). Specifically:

- Utilities in Washington and Oregon have satisfied early requirements under their states' renewable portfolio standards (RPS).
- California has banned the use of out-of-state sources to meet its RPS, lessening demand from that state.
- A federal production tax credit that supported the development of wind energy expired at end of 2012, and was not reinstated until late in 2013.

Regional Developments

Although there are no marine renewable energy projects currently in operation or development within the study area, there are a number of projects at various stages of licensing and development in the Pacific Northwest. Most notably, these include a tidal energy project in the Puget Sound area of Washington and an offshore wind energy project off of Coos Bay, Oregon. In addition, the Bureau of Ocean Management (BOEM) has approved a wave energy test site in Oregon. Each of these projects is discussed below.

Admiralty Inlet Tidal Project, Puget Sound, Washington

In 2012, the Snohomish County PUD filed a license application with FERC for the Admiralty Inlet Pilot Tidal Project. This U.S. Department of Energy (DOE) funded project represents approximately $10 million of federal investment. Field measurements in this location are ongoing, making this the best characterized tidal site in the United States (DOE 2013). The plant will consist of two horizontal-axis tidal turbines connected to the grid near Admiralty Head on Whidbey Island via two subsea cables. FERC released an "Order Issuing Pilot License" on March 20, 2014 (FERC 2014a). The PUD has continued pursuing other required federal, state, and local permits, and is nearing final detailed engineering design for the project. Preliminary preparation work on shore and installation of underground transmission cables will begin in spring/summer 2015, and deployment of the turbines into the water in summer 2016. Under the FERC license, the turbines will be removed following three to five years of operation (Snohomish PUD 2014, FERC 2014a). The National Oceanic and Atmospheric Administration (NOAA) is working with the PUD, the Northwest Fisheries Science Center and the Northwest National Renewable Energy Marine Center (NNMREC) at the University of Washington (UW) to determine appropriate monitoring protocols and mitigation measures for this project (NOAA 2014).

WindFloat Pacific off Coos Bay, Oregon

Principle Power, Inc. is developing its WindFloat Pacific project off Coos Bay, Oregon. The project is the first offshore wind farm proposed for the West Coast of the United States, and the first in the nation to use a floating structure to support offshore wind generation. The project will be sited 18 miles offshore, within a 15 square-mile area of 1,200-foot deep water out of sight from land. The project is designed to generate electricity from five floating “WindFloat” units, each equipped with a six MW offshore wind turbine. The WindFloat system will be assembled on shore and towed out to sea, mitigating the need for costly vessels typically used to assemble offshore wind systems at sea. The turbines will be connected by electrical cables and have a single power cable transmitting the electricity to shore. The cable will make landfall on industrial land at Port of Coos Bay (Principle Power 2014). This project received strong support from potential economic development partners and cooperation from a broad range of federal and state regulatory agencies involved in the approval process (Personal comm. A. Weinstein 2014).

Principle Power Inc. submitted an unsolicited request to BOEM for a commercial wind energy lease in May 2013 as an initial step in the leasing process. In February 2014, BOEM issued a determination of no competitive interest for the proposed lease area, and is proceeding with a non-competitive lease issuance. Principle Power, Inc. has received two rounds of DOE funding: (1) in December 2012, DOE awarded $4 million for its advanced technology demonstration project, and (2) on May 7, 2014, DOE selected the WindFloat Pacific project to receive a matching grant of up to $47 million over the next four years to accelerate development of the project (Principle Power 2014a). The next steps will be to prepare an Environmental Impact Statement (EIS) as part of the National Environmental Policy Act (NEPA) process. The full permitting process will also include consultations with the NOAA's National Marine Fisheries Service (NMFS) under the Endangered Species Act and Marine Mammal Protection Act, as well as interactions with agencies such as the U.S. Army Corps of Engineers, and the U.S. Coast Guard (Principle Power 2014).

Principle Power estimates that the project will attract more than $200M in federal and private investment into the Northwest economy (Principle Power 2014).. The company believes the project will become a driver for a new maritime industry involving manufacturers, ports and shipyards involved in engineering, naval architecture, research and offshore operations and maintenance related to the offshore wind industry (Principle Power 2014).

North and South Energy Test Sties, off Newport, Oregon

With funding from DOE, NNMREC at Oregon State University (OSU) is developing the first utility-scale grid-connected wave energy test site off of Newport, Oregon. NNMREC is a partnership between OSU and the UW, focused on wave and tidal energy respectively, and receives a substantial part of its funding from DOE. NNMREC operates several sites for wave energy testing with a goal of creating a global hub for marine renewable energy development. For intermediate scale wave energy devices, UW supports open water testing in Puget Sound and in Lake Washington. For a full scale wave energy resource, the North Energy Test Site (NETS) can accommodate devices up to 100kW connected to the Ocean Sentinel, and larger devices if no grid emulation or connection is required. NETS is one square nautical mile, located between two to three nautical miles off the coast near Newport, Oregon, north of Yaquina Head. The site has depths of 45 to 55 meters, and opened in the summer of 2012. The grid-connected site currently under development off Newport, Oregon, will be referred to as the South Energy Test Site (SETS). SETS will serve as the utility-scale wave energy test facility for the United States, and is expected to be available for device testing in 2016. SETS depth range will be 55 to 70 meters (OSU 2013). After conducting a public input process, to determine whether it was appropriate to issue a lease on a non-competitive basis, BOEM published notice of determination of no competitive interest for the SETS facility on March 24, 2014 (79 FR 16050).

OPPORTUNITIES

Given the technological issues faced by this nascent industry, the likelihood of development of marine renewable energy off Washington's Pacific coast in the foreseeable future (i.e., 20 years) is limited. Development of tidal energy is highly unlikely as there are few suitable locations with adequate tidal velocity (Van Cleve et al. 2013). Tidal resources within the study area are limited to Willapa Bay, where the channel is so narrow it would limit the size of an array to such an extent that it would not be economically feasible (Personal comm. B. Polyage 2014). Wave energy development is also highly unlikely to be developed in the study area in the next 20 years, as conversion devices are still in the early stages of development. Technology developers must solve the issue of survivability in harsh ocean conditions before wave energy can be developed commercially; testing of devices off the coast of Oregon is now underway (Personal comm. B. Polyage 2014).

Based on discussions with stakeholders, the consensus is that the best opportunities for marine renewable energy projects within the study area are in offshore wind, but the likelihood of development in the foreseeable future is unclear. Some industry representatives do not believe there will be attempts to develop marine renewable energy along the Washington coast within the next 20 years (Personal comm. A. Weinstein 2014). Along the northern coast, development is unlikely for two reasons: (1) restrictions on energy development in the OCNMS, and (2) limited transmission infrastructure. In the southern half of the study area (below the OCNMS), sufficient transmission infrastructure is available, but this area has heavy shipping traffic and is more shallow due to sediments from the Columbia River, which could make siting difficult for the use of floating platforms for offshore wind (Personal comm. A. Weinstein 2014). Stakeholders also cited the Seventh Power Plan currently being developed by the Northwest Power Planning Council, which indicates marine renewable resources are not likely to be competitive in the 20-year timeframe being considered here (Personal comm. B. Polyage 2014).

In addition, there are mixed feelings about the opportunities for small scale projects. Some experts felt there is potential that small distributed or community-based power generation similar to the project proposed for Makah Bay could occur in the near future (i.e, within 10 to 15 years) (Personal comm. PNNL 2014). Others felt that given current issues with survivability, these types of wave energy projects are unlikely to be developed in the foreseeable future (Personal comm. B. Polyage 2014).

Despite these challenges, there are incentives for the development of renewable energy projects off Washington's Pacific coast. Several factors may make expansion into offshore wind attractive, including the state's renewable portfolio standard (RPS) and the availability of federal grants (ACORE 2013). The state's RPS, passed in 2006, requires all utilities serving more than 25,000 customers (85 percent of the state's electric load) to obtain at least 15 percent of their electricity from new renewable resources by 2020 (DSIRE 2014). To date, the state is only about one-third of the way towards this goal (Personal comm. T. Stearns 2014). Federal funding for marine renewable energy projects is available through various Department of Energy programs and matching grants (DOC 2014, Navigant 2013a). Given RPS goals and the history of past proposals, interest in the development of wind and other renewable energy projects off Washington's coast may grow more quickly than anticipated.

Several other factors related to the likelihood of opportunities for marine renewable energy in the study area are addressed below. These factors include the suitability of the study area for such projects and the potential economic benefits to be gained from their development.

Suitability of the Study Area

Under a previous contract with DNR, in support Washington's MSP process, Pacific Northwest National Laboratories (PNNL) developed a marine renewable energy suitability data layer to evaluate certain aspects affecting feasibility of marine renewable energy development off Washington's coast (Van Cleve et al. 2013). The objective of this analysis was to identify the suitability of large zones for potential development, rather than to evaluate the feasibility of developing individual project sites. PNNL's suitability analysis does not consider the full set of economic, social, legal, regulatory or environmental factors that would need to be considered to determine the feasibility of a particular project. Instead, suitability ratings are based on site quality factors, including:

- Minimum and maximum site depth;
- Bottom sediment type;
- Energy resource potential (wind, wave, and tidal); and
- Distance to shore, transmission lines, substations, ports and airports, and shore-side support.

The analysis developed maps for eight types of tidal, wave and wind devices. In general, PNNL found that the southern half of the Washington coast had a wider range of sites with higher suitability scores than the north coast (north of Taholah). The primary factor driving this pattern is grid connectivity (Van Cleve et al. 2013).

Another geospatial database, The Nature Conservancy's (TNC) Washington Marine Planner, looks at the suitability of areas for marine renewable energy. TNC, in partnership with Ecotrust, has developed GIS layers that score areas based on their suitability for the development of wind power, tidal power, and wave power (TNC 2014).[6] The scores for an area are based on energy potential, substrate or sediment type, depth range, distance to electrical substations, and distance to electrical transmission lines. The scores indicate that large portions of the study area offshore of the Washington

[6] Marine Planner is owned and operated by The Nature Conservancy and Ecotrust. The website notes, "[t]his website contains a compilation of data sets and is considered preliminary, subject to further change, and intended for informational purposes only. Any draft analysis layers or resulting draft maps produced in Washington Marine Planner are for planning discussion purposes only and should not be construed as approved or decided upon by any state agency or organization involved in the state's marine planning process" (TNC 2014).

coast are suitable for wind or wave energy development, while tidal energy development potential is very limited. Based on a scoring system where zero indicates least suitable and ten is most suitable, large areas offshore of the Washington coast appear suitable for wind and wave power (receiving a score of seven or higher). For tidal power, very few areas appear at all suitable, with only limited areas in Grays Harbor and Willapa Bay receiving scores from two to four (TNC 2014).

In addition, various market assessments have been produced for DOE considering the potential resources available for wind, wave, and tidal power throughout the United States.

- In 2010, the National Renewable Energy Laboratory (NREL) assessed wind power resources throughout the United States. This report indicates Washington has significant offshore wind resources, with total potential of 121 gigawatts (GW) over 24,193 square kilometers of area within 50 nautical miles of shore that have annual average wind speed of greater than seven meters/second (NREL 2010).
- In 2011, the Electric Power Research Institute (EPRI) produced a mapping and assessment of wave energy resources throughout the United States; results are presented by state. Washington has significant available wave energy resources, estimated to be 116 Terrawatt-hours (TWh) per year along the outer shelf, and 72 TWh per year along the inner shelf (EPRI 2011).
- In 2011, Georgia Tech created a national database of tidal stream energy potential, as well as a GIS tool usable by industry in order to accelerate the market for tidal energy conversion technology. This report found limited theoretical available power from tidal streams within the study area, with only 61 megawatts (MW) at Grays Harbor and 91 MW at Willapa Bay (Georgia Tech Research Corporation 2011).

Potential Economic Benefits of Offshore Wind

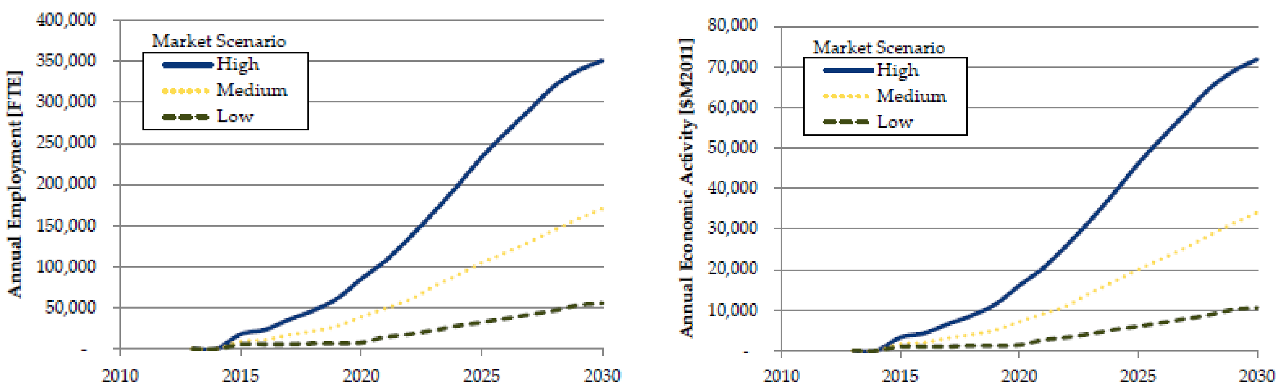
Development of offshore wind resources can drive substantial employment and other economic impacts such as investment, output, and value added. As part of the first annual analysis of the U.S. offshore wind market prepared for DOE, the Navigant Consortium forecast potential economic impacts of future offshore wind development through 2030 for the United States.[7] To conduct this analysis, Navigant employed input-output models developed by NREL known as the JEDI models (for Jobs and Economic Development Impacts). The JEDI models project employment and investment impacts related to energy development projects, including offshore wind, biofuels, coal, solar photovoltaic, marine/hydrokinetic power, and other energy sources. To forecast economic impacts, the offshore wind model requires detailed cost input assumptions for the construction and

[7] The Navigant Consortium is led by Navigant Consulting, Inc. Other members include the American Wind Energy Association, the Great Lakes Wind Collaborative, Green Giraffe Energy Bankers, National Renewable Energy Laboratory (NREL), Ocean & Coastal Consultants, and Tetra Tech EC, Inc. (Navigant 2013a).

operation of energy projects. In addition, model users must estimate the percentage of each expenditure line item that is acquired locally.

Navigant employs the JEDI model to analyze three scenarios of offshore wind development in the United States: (1) high growth with 54 gigawatt (GW) capacity by 2030, (2) moderate growth with 28 GW capacity by 2030, and (3) low-growth with 10 GW capacity by 2030. Exhibit 1-2 shows the projected employment and economic activity impacts for the three development scenarios.[8] The economic impacts shown reflect direct, indirect, and induced effects of the offshore wind deployment scenarios. Under these scenarios, by 2030 the offshore wind industry could produce substantial economic activity totaling $10 billion to $70 billion and associated employment from 50,000 to 350,000 FTEs, depending on the scenario.

EXHIBIT 1-2. ANNUAL EMPLOYMENT AND ECONOMIC ACTIVITY SUPPORTED BY POTENTIAL U.S. OFFSHORE WIND DEVELOPMENT



Source: Navigant 2013a.

In addition to forecasting employment and economic activity impacts for different deployment scenarios for the United States, Navigant also estimates impacts for the development of a single offshore wind plant in the North Atlantic. Navigant estimates construction and operation costs for a 500 MW offshore wind plant that would be completed in 2018. The JEDI outputs suggest that plant construction could support 3,500 job-years and drive $652 million in local spending during the construction period. The model also estimates that plant operations could support 284 jobs and $50 million in spending for each year of the plant's operating life.[9] Exhibit 1-3 provides a detailed look at the economic impacts resulting from plant construction and operation.

[8] In this context, economic activity refers to expenditures on components and services.

[9] We note that input-output models are static, and do not account for ways in which the economy may adjust over time, including broader implications such as displacement of alternative generation sources and impacts on electricity rates or impacts of any incentives that could encourage offshore wind development.

EXHIBIT 1-3. JEDI OUTPUTS FOR A 500 MW PLANT IN THE NORTH ATLANTIC, COMPLETED IN 2018

OUTPUT	JOB-YEARS	INVESTMENT ($2011M)
During Construction		
Project Development and On-site Labor Impacts(1)	854	$246
Turbine and Supply Chain Impacts(2)	1,454	$248
Induced Impact(3)	1,182	$158
Total	3,490	$652
During Operation		
On-site Labor Impacts(1)	28	$3
Turbine and Supply Chain Impacts(2)	174	$37
Induced Impacts(3)	79	$1
Total	284	$50

Notes:

1. Direct Impacts - production changes associated with demand.
2. Indirect Impacts - secondary activity caused by directly affected industries purchasing goods and services from other industries.
3. Induced Impacts - changes in household spending due to direct and indirect effects.

Source: Navigant 2013a.

In a similar analysis, IHS Emerging Energy Research estimates the economic impacts of developing 7,700 MW of offshore wind capacity across four Mid-Atlantic States (NJ, DE, MD, and VA). The scope of this analysis falls between Navigant's two analyses of the single North Atlantic plant and the full-U.S. deployment scenarios. Based upon detailed cost estimates for the construction and operation periods for the 7,700 MW offshore wind development, IHS uses input-output models to estimate economic impacts in terms of employment, labor income, value added, and output. Exhibit 1-4 summarizes the projected economic impacts for the construction period (10 years) and the operation period (annual) of the offshore wind farm development. An offshore wind development of this magnitude would create substantial economic impacts. Over the ten-year construction phase the development would be expected to create value added of $16 billion and nearly 150,000 jobs. During operations, expected economic impacts include total value added of $1.1 billion and approximately 9,000 jobs annually (IHS 2012).

EXHIBIT 1-4. PROJECTED ECONOMIC IMPACTS FOR 7,700 MW OFFSHORE WIND DEVELOPMENT IN THE MID-ATLANTIC

OUTPUT	JOBS	LABOR INCOME (MILLLIONS)	VALUE ADDED (MILLLIONS)	OUTPUT (MILLLIONS)
During Construction (10 years)				
Direct Effect (1)	68,933	$5,399	$7,056	$19,370
Indirect Effect (2)	36,449	$3,020	$4,659	$8,737
Induced Effect(3)	44,316	$2,497	$4,466	$7,688
Total Effect	149,698	$10,816	$16,181	$35,794
During Operation (Annual)				
Direct Effect (1)	4,086	$328	$460	$1,186
Indirect Effect (2)	2,318	$205	$308	$563
Induced Effect (3)	2,617	$160	$285	$501
Total Effect	9,021	$692	$1,054	$2,250

Notes:
1. Direct Effects - production changes associated with demand.
2. Indirect Effects - secondary activity caused by directly affected industries purchasing goods and services from other industries.
3. Induced Effects - changes in household spending due to direct and indirect effects.

Source: IHS 2012.

Finally, Principle Power provided estimates of the economic impacts of its WindFloat pilot project (off of Portugal). This project cost roughly $27.2 million (USD) and employed over 200 people (Personal comm. A. Weinstein 2014).[10]

SUMMARY OF KEY ISSUES

Industry experts identified a number of key issues confronting the marine renewable energy sector in the short and longer term, all of which are identified in Exhibit 1-5. These issues generally fall into five categories: market factors, infrastructure availability, regulatory uncertainty, conflicts with other uses, and environmental concerns. The impact of these issues on the development of the marine renewable energy sector is discussed in greater detail later in this report.

[10] Details were not available regarding what these spending and employment figure represent. We used an exchange rate of $1.36 USD to 1 Euro to get the spending figure in U.S. dollars.

EXHIBIT 1-5. LIST OF POTENTIAL ISSUES AFFECTING MARINE RENEWABLE ENERGY SECTOR

ISSUE	CONCERNS
Market factors	• Electricity prices in Washington • Development costs
Infrastructure availability	• Transmission (connection to grid) • Support for fabrication and installation, and ongoing operation & maintenance
Regulatory uncertainty	• Permitting process timing/delays • Permit conditions uncertain • Monitoring protocols and mitigation measures unknown
Conflicts with other uses	• Shipping • Fishing • Aquaculture
Environmental Concerns	• Injury to protected species (i.e., whales, seabirds)

SECTION 2 | SECTOR STATUS

RANGE OF ACTIVITIES

The marine renewable energy industry includes a range of economic activities, from technology testing to site characterization, construction of renewable energy devices (i.e., wind turbines or wave energy converters), installation, operation and maintenance, and decommissioning. All of these activities can lead to increased employment and output in the region in which they are based. For example, planning efforts will employ scientists, engineers, and business managers. Similarly, fabrication, installation and operation of marine renewable energy projects will require shipyards and offshore supply vessels and skilled labor. Future marine renewable energy development off of Washington's Pacific coast could come from three general sources: offshore wind, wave, and tidal energy. Additional information on these technologies is provided below.

OFFSHORE WIND ENERGY

Offshore wind technology applies the same basic turbine design as that used to harness wind power on land. Wind flows over airfoil-shaped blades of the wind turbines, causing the blades to spin. The blades are connected to a drive shaft that turns an electric generator to produce electricity. Modifications are made to the turbines to withstand the harsher conditions associated with offshore installation (i.e., corrosion from salt water, storm conditions). The turbines used in offshore installations can be up to 500 feet tall, with rotor diameters of 250 to 430 feet (BOEM 2014a).

There are various substructure and foundation system designs employed for offshore wind turbines. Newer foundation technologies, such as "WindFloat" semi-submersible floating platforms, are being developed so that wind power projects can be based in deeper waters further offshore. The three foundation types considered in PNNL's suitability analysis for the study area include monopile, floating platform, and tripod/jacket substructures. Monopile construction is the most common installation method for depths ranging from 15 to 100 feet. In Washington, however, the depth of offshore areas typically exceeds 100 feet. In these areas, floating platforms may prove to be more viable (Van Cleve et al. 2013).

Wind turbines have been installed offshore in a number of countries to harness the energy of the moving air over the oceans and convert it to electricity. Offshore winds tend to flow at higher sustained speeds than onshore winds, making offshore turbines more efficient. For example, a turbine at a site with an average wind speed of 16 mph produces

50 percent more electricity than the same turbine at a site with average wind speeds of 14 mph (BOEM 20014a).

WAVE ENERGY

There is tremendous energy in ocean waves. Wave power devices extract energy directly from the surface motion of ocean waves or from pressure fluctuations below the surface. A variety of technologies have been proposed to capture that energy, and some of the more promising designs are undergoing demonstration testing. The Northwestern coast of the United States has especially high potential for wave energy development, and is one of only a few areas in the world with abundant available wave power resources (BOEM 2014b). The PNNL suitability analysis for the study area identified three general types of wave energy devices (Van Cleve et al. 2013):

- Nearshore wave energy devices,
- Mid-depth wave energy devices, and
- Deepwater devices.

These devices harness the energy of passing waves through differing technologies. For example, nearshore systems include coastline converter devices that harness energy generated by a flap moving laterally in response to wave motion in shallow water. Mid-depth systems include oscillating water column devices, offshore pressure devices, and mid-depth surge devices operating in 30 to 150 feet. Deepwater options include point absorber, oscillating water column, offshore surge, and attenuator and pivot device types, and can be anchored at depths of 150 to 375 feet (Van Cleve et al. 2013).

TIDAL ENERGY

Tidal streams have become one of the more promising energy sources due to their continuous, predictable and spatially-concentrated characteristics. Tidal energy devices generally fall into two general categories: vertical-axis or horizontal-axis turbines (Bedard 2007). As mentioned earlier, while tidal energy technology is currently being tested in Puget Sound (Admiralty Inlet), tidal resources in the study area do not meet minimum conditions to make development likely in the foreseeable future.

SITING CONSIDERATIONS

While specific site requirements vary by type, the areas most suitable for marine renewable energy development are generally within 25 miles of the Washington coast. Much of the study area has depths greater than 330 feet (55 fathoms), limiting the areas available for devices that require shallower depths (Van Cleve et al. 2013). Regardless of the type of marine renewable energy, developing these resources requires connection to the grid to bring the power to market. There are limited opportunities for bringing the power onto the grid along the coast. These are factored into PNNL's study on suitability. In particular, while there are connection points close to Cape Flattery (Neah Bay) in the north and Grays Harbor or Willapa Bay in the south, the mid-coast lacks infrastructure such as transmission lines and substations. Distance to ports that can provide shoreside support is another siting consideration. For example, given the requirements for constructing and transporting offshore wind turbines, proximity to a deepwater port (e.g., channel depth greater than 30 feet) is important; thus, locations near Grays Harbor may be favored.

AVAILABLE STATISTICS

Because the marine renewable energy sector is still a nascent industry, economic data on the sector is relatively limited. As previously noted, there are no marine renewable energy projects currently in operation or being permitted off Washington's Pacific coast. In the absence of activity within the study area, the discussion that follows provides some general data on the current status of the industry statewide and in the United States as a whole. The discussion begins with an overview of offshore wind projects in the United States. Next, it provides available information on proposals for marine hydrokinetic (i.e., wave and tidal) energy projects in Washington, as well as throughout the United States.

OFFSHORE WIND PROJECTS

NREL has estimated the total generation potential for offshore wind throughout the United States at 17 million gigawatt-hours (GWh) or 4,223 GW. For Washington, technical potential for offshore wind power includes 488,025 GWh or 121 GW (NREL 2012). For context, installed global offshore capacity through 2011 is estimated at 4.1 GW (Navigant 2013a).

As noted on the BOEM website, "there are thousands of megawatts (MW) in the planning stages, mostly in the Northeast and Mid-Atlantic regions. Projects are also being considered along the Great Lakes, the Gulf of Mexico, and the Pacific" (BOEM 2014). Based on a list of offshore wind projects proposed at one time or another, serious consideration has been given to 88 offshore wind projects in U.S. waters (The Wind Power 2014). A 2013 assessment cited 33 offshore wind projects currently in varying stages of development throughout the United States, nine of which were considered to be in an advanced stage of development (Navigant 2013a). The nine projects are summarized in Exhibit 2-1. Some of these projects are in the outer continental shelf (OCS) and require BOEM leases, while others are located in state waters. Estimates of current employment and investment in the U.S. offshore wind industry ranges from 150 to 190 full-time equivalents (FTEs) and investment of $21 million to $159 million (Navigant 2013b).

EXHIBIT 2-1. CURRENT ADVANCED-STAGE OFFSHORE WIND PROJECTS IN THE UNITED STATES

OUTPUT	PROPOSED CAPACITY (MW)	TARGET COMPLETION DATE [1]
Block Island Offshore Wind Farm (Deepwater) (RI)	30	2015
Cape Wind Offshore (MA)	468	2014
Fisherman's Energy: Phase I (NJ)	25	2013
Fisherman's Energy: Phase II (NJ)	330	2017
Galveston Offshore Wind (Coastal Point Energy (TX) [2]	150	2016
Garden State Offshore Energy Wind Farm (NJ)	350	2017
Lake Erie Offshore Wind Project (Great Lakes) (OH)	27	2016
Baryonyx Rio Grande Wind Farm (TX) [2]	1,000	2018
Baryonyx Mustang Island Wind Farm (TX) [2]	1,000	2018

Notes:

1. Dates shown in this table are based on developer statements and may change based on permitting, leasing, surveying and other activities.
2. This project is sited in Texas state waters and does not involve FERC or BOEM permitting.

Source: Navigant 2013a.

HYDROKINETIC (I.E., WAVE AND TIDAL) ENERGY PROJECTS

There are currently no wave or tidal energy projects located within the study area, either in operation or under development; however, research on hydrokinetic energy projects elsewhere in Washington State or the United States is well underway. DOE's Wind and Water Power Technologies Office has funded a number of research and development efforts related to Marine and Hydrokinetic Energy Projects between Fiscal Year (FY) 2008 and FY 2012. A summary of DOE-funded projects within Washington State is included in Exhibit 2-2. These projects fall under two activity areas: (1) technology development and (2) market acceleration and deployment. The purpose of these projects includes:

- Reducing technical barriers to marine hydrokinetic device development, improving device reliability and performance, and enhancing the understanding and evaluation of various technology types.
- Reducing time and costs associated with siting water power projects; better quantifying the potential magnitude, costs, and benefits of water power generation; and identifying and addressing other barriers to deployment (DOE 2012).

EXHIBIT 2-2. DOE-FUNDED MARINE AND HYDROKINETIC RESEARCH AND DEVELOPMENT PROJECTS IN WASHINGTON STATE

PROJECT TITLE	PROJECT RECIPIENT	DOE FUNDING	FISCAL YEAR(S)	LOCATION
Northwest National Marine Renewable Energy Center - Tidal Energy Research	University of Washington	$440,000	FY10	WA
Advanced Anchoring Technology	Sound & Sea Technology, Inc.	$239,899	FY10	WA, BC
Puget Sound Pilot Tidal Energy Project	Snohomish County Public Utility District # 1	$10,000,000	FY10	WA
Puget Sound Pilot Tidal Energy Project	Snohomish County Public Utility District # 1	$475,750	FY09	WA
Study of the Acoustic Effects of Hydrokinetic Tidal Turbines in Admiralty Inlet, Puget Sound	Snohomish County Public Utility District # 1	$522,550	FY09	WA
Puget Sound Tidal Energy In-Water Testing and Development Project	Snohomish County Public Utility District # 1	$1,200,000	FY08	WA
Northwest National Marine Renewable Energy Center	Oregon State University	$13,021,170	FY10,FY09, FY08	OR, WA
Direct Drive Wave Energy Buoy	Columbia Power Technologies, Inc.	$1,500,000	FY10	VA, WA
Benchmark Modeling of the Near-field and Far-field Wave Effects of Energy Arrays	Columbia Power Technologies, Inc.	$1,417,990	FY09	VA, WA
Source: DOE 2013.				

Exhibit 2-2 illustrates that there are a range of small-scale hydrokinetic research projects occurring in Washington. Exhibit 2-3 provides an overview of marine and hydrokinetic projects throughout the U.S., based on FERC licensing data as of April 2014. As illustrated in Exhibit 2-3, activity to date in this area has been quite limited. For example, there have only been four licenses issued for pilot projects totaling 2.45 MW of generating capacity, including the Snohomish PUD's Admiralty Inlet tidal pilot project. In addition, there have been six preliminary permits issued for a total of 2,208 MW of power generation in the United States, as well as various permits in varying stages in the process.

EXHIBIT 2-3. SUMMARY OF CURRENT MARINE AND HYDROKINETIC PROJECTS IN THE U.S.

PROJECT STAGE	NUMBER OF PROJECTS	TYPES OF PROJECTS	CAPACITY (MW)	PROJECT TITLE AND DESCRIPTION
Issued Preliminary Permits	5	1 tidal 1 wave 3 inland	8.2	n/a
Pending Preliminary Permits	16	4 tidal 5 wave 7 inland	3,969.0	n/a
Projects in Pre-Filing for License	3	2 tidal 1 wave	25.1	• P-12665 New York East River (NY) Tidal Pilot (0.2 MW) • P-13015 Muskeget Channel (MA) Tidal Pilot (4.9 MW) • P-14616 Pacific Marine Energy Test Center South Energy Test Site (OR, Outer Continental Shelf) Wave Test Center (20 MW)
License Issued	1	1 wave	1.5	• P-12713 Reedsport OPT Wave Park (OR) Wave Commercial (1.5 MW)
Licenses Issued for Pilot Projects	4	3 tidal 1 river	2.5	• P-12611 Roosevelt Island (NY) Tidal Pilot (1.5 MW) • P-12690 Admiralty Inlet (WA) Tidal Pilot (1.0 MW) • P-12711 Cobscook Bay (ME) Tidal Pilot (0.3 MW) • P-13305 Whitestone Poncelet (AK) In-River Pilot (0.1 MW)
Source: FERC 2014.				

EXISTING POLICIES AND LAWS

Marine renewable energy development on the Washington Pacific coast is managed under a complex array of policies and regulations that are implemented by various federal, state and local government entities. If a project is proposed within three miles of shore in state waters, the Washington Governor's Office for Regulatory Innovation and Assistance would help a project proponent develop a permitting path, tailoring the approach to the specific project. If a project is proposed in federal waters, it would be overseen by BOEM. We note that in states that have expressed interest in development of offshore renewable energy, BOEM has established Intergovernmental Task Forces to collect and share information. To date, Washington has not initiated formation of such a task force (Personal comm. A. Weinstein 2014, BOEM 2014b).

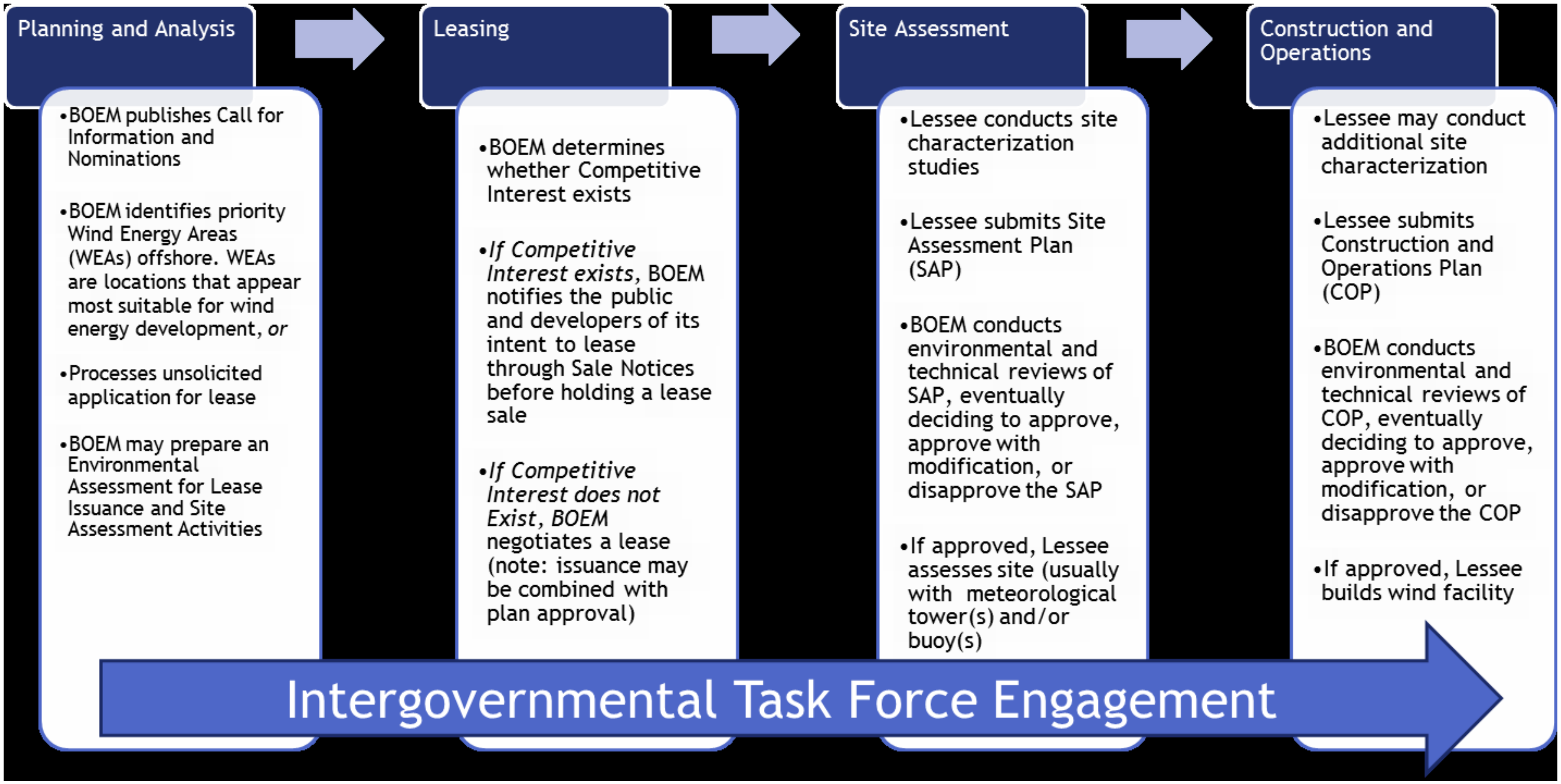
An example of the BOEM leasing process for commercial wind energy is presented in Exhibit 2-4. While the BOEM leasing process is generally well-defined, the number of additional agencies involved and other permits required make the process uncertain. In the remainder of this section, we identify the relevant agencies and their areas of jurisdiction, and next summarize the key policies, laws and guidance documents relevant to development and operation of marine renewable energy projects in Washington.

AGENCIES AND ENTITIES INVOLVED IN MARINE RENEWABLE ENERGY PERMITTING

Federal agencies involved in marine renewable energy permitting and licensing include BOEM, FERC, the U.S. Army Corps of Engineers (ACOE), the U.S. Environmental Protection Agency (EPA), the U.S. Coast Guard (USCG), the U.S. Fish and Wildlife Service (FWS), and the National Oceanic and Atmospheric Administration (NOAA). State agencies may include: Ecology, DNR, DFW, Washington State Parks and Recreation Commission (WSPRC), and the Energy Facility Site Evaluation Council. In addition, county and local authorities may be involved in marine renewable energy permitting through Shoreline Master Planning programs.

While BOEM is involved in all types of marine renewable energy projects, FERC is only involved in hydrokinetic (i.e., wave and tidal) projects, not offshore wind. According to the Energy Policy Act of 2005, FERC licenses hydrokinetic projects and BOEM is responsible for leasing and decommissioning of the project. BOEM signed a Memorandum of Understanding (MOU) with FERC to facilitate coordination of federal approvals of marine hydrokinetic facilities in 2009 and is negotiating MOUs with other federal agencies, including USCG and ACOE. In addition, marine renewable energy proposals will be evaluated in project-specific analyses under the NEPA (BOEM 2014a).

EXHIBIT 2-4. BOEM WIND ENERGY COMMERCIAL LEASING PROCESS



Source: BOEM 2014b.

The roles of the key government entities are described generally below. Additional detail on the laws, policies, and guidance documents referred to below is included in Exhibit 2-5.

- **ACOE:** ACOE issues Clean Water Act Section 404 (Dredge and Fill) permits, which may be required for activities such as installation of structures or devices on the seabed (Personal comm. T. Stearns 2014). Nationwide permit 52 deals with water-based renewable energy generation pilot projects, including wind or hydrokinetic proposals (ACOE 2014). BOEM has signed a Memorandum of Understanding (MOU) with ACOE to facilitate coordination of federal approvals of offshore wind facilities (BOEM 2014a). A project proponent may need to contact ACOE to ascertain whether ACOE authorizations are necessary.
- **BOEM**: BOEM is responsible for offshore renewable energy development in federal waters (generally beyond three miles of shore) under the Energy Policy Act of 2005. BOEM is responsible for leasing and decommissioning of projects. Regulations for the Outer Continental Shelf Renewable Energy Program provide a framework for issuing leases, easements, and rights-of-way for OCS activities that support production and transmission of energy from sources other than oil and natural gas. These regulations generally prohibit BOEM from issuing a lease within a National Marine Sanctuary (BOEM 2012). BOEM regulations for marine hydrokinetic leases are found at 30 C.F.R. Part 585. In accordance with the requirements of the NEPA, BOEM will also be the lead agency for preparing EIS for proposed projects.
- **FERC**: FERC oversees hydrokinetic activities (wave and tidal energy), not offshore wind. Most wave and tidal energy projects will need to obtain a FERC license; however, some types of projects may conduct limited testing under a BOEM lease without a FERC license (BOEM 2012). FERC regulations for licenses are found at 18 C.F.R. Parts 4 and 5.
- **USCG**: The Ports and Waterways Safety Act requires USCG to conduct studies to provide safe access routes for vessel traffic. USCG is involved as a cooperating agency when BOEM prepares an EIS for a project. A Navigation and Vessel Inspection Circular (NVIC) provides guidance on USCG's roles and responsibilities for offshore renewable energy installations (USCG 2007).
- **NMFS:** During the site assessment phase, BOEM will enter into section 7 consultation with NMFS to ensure that any actions it authorizes or undertakes such as issuing a lease, will not jeopardize the existence of any federally listed endangered or threatened species or adversely modify designated critical habitat. Should an action be determined to affect a listed species or its critical habitat, reasonable and prudent alternatives will be suggested by NMFS.

- **Washington Department of Natural Resources (DNR):** DNR has jurisdiction for leasing of marine lands within state waters (generally up to three miles from shore). DNR authorization would be required for the use of those lands to lay cable. In addition, in any permitting process, DNR ensures that the land is managed according to the state mandate including minimizing damage to natural resources, reducing impact to navigation, monitoring effects of sediment and habitats, and minimizing effects to threatened or endangered species (Personal communication L. Whiting 2014).

- **Washington Department of Commerce (DOC), State Energy Office:** Under RCW 43.21.F.062, DOC is tasked with providing guidance and procedures for coordinating the views and responsibilities of state agencies with jurisdiction over renewable energy facilities in coastal and estuarine marine waters. DOC's State Energy Office also administers a mix of projects under the Clean Energy Fund, a revolving loan fund that supports the widespread use of renewable energy technologies that may face constraints on development due to poor access to capital. For example, funds are currently available for demonstration projects that develop or demonstrate clean energy technologies (DOC 2014a).

- **Washington Department of Ecology (Ecology):** An activity requiring a Federal permit must be determined by Ecology to be consistent with the policies and guidelines laid out in the state's Coastal Zone Management Program. In addition, Ecology is responsible for issuance of Construction Stormwater General Permits and verification that a project meets requirements under Section 401 of the CWA Clean Water Act (Water Quality Certification).

- **Washington Governor's Office for Regulatory Innovation and Assistance:** This office helps project proponents develop a permitting path, tailoring the approach to the specific project.

- **Washington Department of Fish and Wildlife (DFW):** DFW is in charge of hydraulic project approval, permitting construction activity in or near the water (DFW 2014).

- **Washington State Parks and Recreation Commission (WSPRC):** WSPRC upholds habitat and wildlife protections during construction and operation, and may be involved in permitting if transmission lines cross state conservation areas under their oversight.

KEY POLICIES, LAWS AND GUIDANCE

Exhibit 2-5 summarizes the key policies, laws and guidance documents relevant to development and operation of marine renewable energy projects in Washington.

EXHIBIT 2-5. SUMMARY OF KEY POLICIES, LAWS AND GUIDANCE

POLICY/LAW/GUIDANCE	RESPONSIBLE AGENCY	DESCRIPTION	RELEVANT LINK(S)
Federal			
Federal Power Act of 2005/30 C.F.R. Part 585	BOEM	BOEM regulations for issuance of marine hydrokinetic leases. BOEM is not allowed to grant leases for projects within a National Marine Sanctuary or National Wildlife Refuge. FERC may be able to grant a license without a BOEM lease for wave or tidal energy located on the OCS within the OCNMS (Van Cleve et al. 2013).	http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title30/30cfr585_main_02.tpl
BOEM/FERC Guidelines on Hydrokinetic Energy Projects on the OCS (BOEM 2012)	BOEM/FERC	Guidelines for applicants on navigating the process of obtaining a marine hydrokinetic lease and license on the OCS.	http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics/pdf/mms080309.pdf
18 CFR Parts 4 and 5	FERC	Regulations pertaining to obtaining a FERC license.	http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics.asp
Memorandum of Understanding (MOU) between the U.S. Department of the Interior and FERC (executed April 9, 2009)	BOEM/FERC	Intended to clarify jurisdictional responsibilities between BOEM and FERC.	http://www.boem.gov/Renewable-Energy-Program/DOI_FERC_MOU.aspx
Hydrokinetic Pilot Project Licensing Process (FERC 2013)	FERC	Information regarding pilot process allowing developers to test new hydrokinetic technologies, to determine appropriate siting of these technologies, and to confirm their environmental effects, while maintaining FERC oversight and agency input. The process completes licensing in as few as six months to allow for project installation, operation, and environmental testing as soon as possible.	http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics/energy-pilot.asp
Rivers and Harbors Act (RHA) Section 10 Structures and Work in Navigable Waterways	ACOE	All structures placed offshore in state waters are subject to the 1899 Rivers and Harbors Act and must receive a permit from the ACOE.	http://water.epa.gov/lawsregs/guidance/wetlands/sect10.cfm

POLICY/LAW/GUIDANCE	RESPONSIBLE AGENCY	DESCRIPTION	RELEVANT LINK(S)
Nationwide Permit 52	ACOE	Provides a mechanism for expediting review of small-scale water-based renewable energy generation projects under Section 404(e) of the Clean Water Act.	http://www.nww.usace.army.mil/Portals/28/docs/regulatory/NWPs/NWP52.pdf
Olympic Coast National Marine Sanctuary Regulations	NOAA's Marine Sanctuary Program	Sanctuary regulations place restrictions on certain activities including altering the seabed/submerged lands of the sanctuary. The Director may issue a permit to conduct a prohibited activity if the activity will not substantially injure Sanctuary resources and will either: • Advance research related to the Sanctuary; • Advance the educational, natural, or historical value of the Sanctuary; • Advance salvage or recovery operations in connection with an abandoned shipwreck in the Sanctuary; or • Be issued to an American Indian tribe adjacent to the Sanctuary. The following activities may be eligible for special use permits: • The placement and recovery of objects associated with public or private events on non-living substrate of the submerged lands of any national marine sanctuary. • The continued presence of commercial submarine cables on or within the submerged lands of any national marine sanctuary.	http://sanctuaries.noaa.gov/library/national/15cfr922.pdf http://sanctuaries.noaa.gov/management/permits/welcome.html
Marine Mammal Protection Act of 1972 (MMPA), as amended (16 U.S.C. 1371(a)(5))	NMFS	Provides a mechanism for allowing, upon request, the "incidental" taking of small numbers of marine mammals. NMFS oversees the issuance of a letter of authorization or an incidental harassment authorization for certain activities.	http://www.nmfs.noaa.gov/pr/permits/incidental.htm#iha
Endangered Species Act	NMFS	Under the Endangered Species Act, for any actions it authorizes or undertakes such as issuing a lease, BOEM will need to conduct a section 7 consultation with NMFS to ensure that will not jeopardize the existence of any federally listed endangered or threatened species or adversely modify designated critical habitat. Should an action be determined to affect a listed species or its critical habitat, reasonable and prudent alternatives will be suggested by NMFS.	http://www.nmfs.noaa.gov/pr/consultation/

POLICY/LAW/GUIDANCE	RESPONSIBLE AGENCY	DESCRIPTION	RELEVANT LINK(S)
State			
Shoreline Management Act (RCW 90.58)/Shoreline Master Program Guidelines	Ecology	A goal of the Shoreline Management Act is to "prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." Shoreline master programs are local policies and regulations designed to manage shoreline use. The Shoreline Master Program (SMP) Guidelines (Chapter 173-26 WAC, Part III), developed by Ecology with stakeholder input, provide the state standards to which local governments must adhere in developing their shoreline master programs.	http://www.ecy.wa.gov/programs/sea/sma/st_guide/intro.html http://www.ecy.wa.gov/programs/sea/sma/guidelines/index.html
Clean Water Act (CWA) Section 401 Water Quality Certification (State implementation)	Ecology	Issuance of a CWA 401 water quality certification indicates that Ecology has been reasonably assured that an activity associated with discharges to state waters will comply with state water quality standards and resource protection policies and requirements under Ecology's jurisdiction.	http://www.ecy.wa.gov/PROGRAMS/sea/fed-permit/index.html
Coastal Zone Management Consistency Determination (State implementation)	Ecology	An activity requiring a Federal permit must be determined by Ecology to be consistent with the policies and guidelines laid out in the state's Coastal Zone Management Program "to the maximum extent practicable." Along the Pacific coast, for federal actions occurring in Washington's coastal zone, including state waters out to three nautical miles, the state will need to determine if the project is consistent with the enforceable policies laid out in the state's federal-approved Coastal Zone Management Program. For federal actions beyond three nautical miles, the state may request approval from NOAA to review those projects that the state determines will have effects on Washington's coastal resources or uses.	http://www.ecy.wa.gov/PROGRAMS/sea/fed-permit/index.html
Aquatic Land Use Authorization (WAC Chapter 332-30)	DNR	Requires an authorization from DNR for projects in, on, or over state-owned lands. These authorizations specifically outline the terms and conditions of the use, and require rent for certain property rights.	http://www.dnr.wa.gov/BusinessPermits/Topics/ShellfishAquaticLeasing/Pages/agr_aquatic_land_leasing.aspx
Siting Process Guidelines	Washington State Energy Facility Site Evaluation Council	Not required for marine renewable energy projects, but proponents could choose to undertake this process (Personal Comm. T. Stearns 2014).	http://www.efsec.wa.gov/default.shtm
RCW 43.372.040	State Ocean Caucus	The Washington State Legislature directed that the final MSP include a framework for coordinating state agency and local government review of proposed renewable energy development uses requiring multiple permits and other approval.	

POLICY/LAW/GUIDANCE	RESPONSIBLE AGENCY	DESCRIPTION	RELEVANT LINK(S)
Washington Executive Order 14-04	Department of Commerce	Clean Technology – This executive order related to Clean Technology instructs the Department of Commerce in cooperation with Washington State University (WSU) and other stakeholders to develop a new state program to encourage research, development, and deployment of new renewable energy and energy efficiency technologies. This program proposal must include specific ideas for dedicated and sustained program funding.	http://www.commerce.wa.gov/Documents/May-2014-energy-%20news.pdf
Clean Energy Fund	Washington Department of Commerce	Grants are available for Washington research institutions for eligible projects that develop or demonstrate clean energy technologies that have been demonstrated as viable in prior published work, yet are not commercially-available products.	http://www.commerce.wa.gov/Documents/May-2014-energy-%20news.pdf
Local			
Shoreline Master Program (Guidelines at WAC 173.26)	Multiple County and Town governments	Shoreline master programs are local land use policies and regulations designed to manage shoreline use. They typically encompass a comprehensive plan, zoning ordinance and development permit system. Shoreline master programs may include use standards, as well as requirements for substantial development permits and conditional use permits.	http://www.ecy.wa.gov/Programs/sea/shorelines/smp/index.html

SECTION 3 | ISSUES FACING THE MARINE RENEWABLE ENERGY SECTOR

The experts interviewed for this report identified a number of challenges facing the marine renewable energy industry that may affect the viability and economic success of this industry within the study area. The primary concerns identified include market factors, infrastructure availability, regulatory uncertainty, conflicts with other uses, and environmental concerns. Each of these issues is discussed in detail below.

MARKET FACTORS

There are various market-related factors that affect the potential for marine renewable energy development in the study area. One is whether there is demand for the power that will be produced. Another is the whether the project can be developed at a cost that makes sense economically.

DEMAND AND PRICE FOR POWER

Finding a purchaser for the power that will be produced is a concern for any renewable energy developer. Locally, electricity is supplied to residents in the four coastal counties by Public Utility Districts (PUDs) in Clallam, Grays Harbor, and Pacific Counties. Jefferson County residents in the area are served by Clallam and Grays Harbor PUDs.

There may be some demand for locally-produced power that could be more reliable along the northern areas of the coast. These areas are at the end of the transmission line, which can lead to some reliability issues, especially at peak times (Personal comm. T. Stearns 2014). It is unlikely, however, that these communities would be willing to pay the premium prices which would be associated with renewable energy production in the near term. Until marine renewable energy production reaches a commercial scale, the prices that would be charged will be premium prices (Personal comm. A. Weinstein 2014). This makes it difficult for the industry to be competitive without government incentives, such as an RPS mandate that a portion of energy production come from renewable sources (Navigant 2013b). This market factor is especially important in Washington, which has some of the lowest electricity prices in the nation.

ELECTRICITY PRICES IN WASHINGTON STATE

Due to the extensive development of its hydropower resources the State of Washington has some of the lowest electricity prices in the nation. In 2013, Washington had the lowest residential electricity prices in the nation (EIA 2014). Average prices for industrial electricity are between four to six cents/kWh (CESA 2013). In comparison, the production of wind-generated power may cost roughly 15 cents/kWh (Personal comm. PNNL 2014).

DEVELOPMENT COSTS

As discussed in DOE's annual assessment of the Offshore Wind Market, high costs are one of the most significant challenges faced by the offshore wind industry (Navigant 2013b). This report states that capital costs for offshore wind projects are expected to be approximately $6,000 per installed kW, nearly three times that of land-based wind projects (Navigant 2013b). These high costs are due to a number of factors. In part, the industry is still emerging and learning curve effects have not yet been realized. In addition, the high costs of developing offshore installations are exacerbated by policies that further increase costs. Under the Jones Act, for example, the foundation of an off-shore wind project is considered a port, and thus can only be served by U.S.-flagged vessels. This restriction limits competition, adds complexity, and can drive up project costs (Navigant 2013b).

For all types of marine renewable energy, the cost of installing undersea cables to transfer the power back to shore is an issue. While industry may not see cabling as a new challenge – its technical aspects are well understood – there are still risks involved. A speaker at the recent Global Marine Renewable Energy Conference stated that underwater sea cabling is the primary source of insurance risk on a marine renewable energy project (Personal comm. PNNL 2014); another stakeholder notes that cable failures are 80 percent of insurance claims for these types of projects (Personal comm. T. Stearns 2014).

INFRASTRUCTURE AVAILABILITY

Several important infrastructure needs affect the development of offshore wind: transmission infrastructure, fabrication facilities, and port facilities for operations and maintenance support.

Generally, coastal areas are at the end of the transmission line, and the lines serving these areas may not offer much capacity. The northern Washington coast is no exception to this rule. Transforming the end of the line into an on-ramp for power generated offshore could be a challenge.

The closest major transmission infrastructure to connect a marine renewable energy project off the Washington coast is in the Grays Harbor area. Transmission lines were put in place there in the early 1980s as part of plans to construct a nuclear power plant in Elma, a project that was never completed (Personal comm. T. Stearns 2014). Given current infrastructure availability, connecting to the Bonneville Power Association infrastructure through these transmission lines would be the most likely route to connect to the grid for long-haul transmission). Any connection to major transmission lines would likely require a full Environmental Impact Statement, a costly and lengthy process (Personal comm. B. Polagye 2014).

Another factor is that the infrastructure required to build, install, and support offshore wind turbines is not currently available. Deepwater ports and facilities that can fabricate the turbines would require investment. While there are sites in Washington where such facilities might be constructed, the facilities at present do not exist (Personal comm. A. Weinstein 2014).

REGULATORY UNCERTAINTY

Regulatory uncertainty is a barrier for development of marine renewable energy projects in general, not just in Washington, because of the early stage of the technologies involved. Permitting agencies will need to learn about these technologies in order to assess a project (Personal comm. T. Stearns 2014). In addition, the regulatory environment for marine renewable energy projects is complex. Numerous agencies, for example, have authority over the siting, permitting and installation of offshore wind facilities. These types of projects are facing a new and untested permitting process in the United States. As stated in the Offshore Wind Market and Economic Analysis, "BOEM staff estimated that the lease process might require three EISs and may extend seven to nine years" (Navigant 2013a, p. 47). This type of uncertainty and potential delays are a barrier to entry into the marine renewable energy sector. MSP may create a context for expectations around the regulatory process, reducing some of this regulatory uncertainty (Personal comm. T. Stearns 2014).

CONFLICTS WITH EXISTING USES OF OCEAN AREA

Fishing grounds and established shipping lanes throughout the study area will need to be considered when siting marine renewable energy projects off the coast of Washington. Because of the limited deployment of these technologies to date, there are few examples of how fishing and shipping needs may influence siting of marine renewable energy projects. USCG is in charge of setting the exclusion zones that could be required around a marine renewable energy installation. These zones would depend on numerous factors and would be determined on a project specific basis. According to a 2012 BOEM presentation, the only exclusion zones for existing OCS structures are 500 meter safety zones for vessels 100 feet or greater not engaged in towing (BOEM 2012). Similarly, the channel distance between wind turbines, which could affect the potential for continuation of existing uses such as shipping and fishing, is not known and would be dependent on the specific project. A 2012 BOEM presentation suggests that for a typical wind farm, the average separation distance between wind turbines could be 0.3 to 0.6 nautical miles (BOEM 2012). While some stakeholders believe that this distance will not preclude existing uses such as shipping (Personal comm. B. Polagye 2014), other stakeholders believe that this type of development would preclude fishing in the area (Personal comm. M. Cedergreen 2014).

ENVIRONMENTAL CONCERNS

The primary environmental concern with respect to marine renewable energy is impacts to marine or migratory species in the study area, with the highest level of concern for listed threatened or endangered species; followed by marine mammals, and lastly ecologically, commercially, and recreationally important species. Concerns include (Personal comm. PNNL 2014):

- **Injury to whales or other marine mammals** from noise during the construction phase for certain types of installations, such as driving pilings for offshore wind installation, and from entanglement in mooring lines.
- **Adverse effects to species from electromagnetic fields** (EMF) associated with undersea transmission lines. The primary concern is that the presence of higher-than-background EMF levels may interfere with navigation or predator/prey recognition, or create avoidance/attraction behaviors that affect migration or distribution.
- **Reefing effects (i.e., aggregation of fish)** around mooring lines or buoys, which could alter the predation of fish**.**
- **Issues related to lighting the structures** (especially wind turbines) that can affect birds and fish.
- **Concerns that presence of marine renewable energy devices could drive fish away.**

Because the industry is in such early stages of development, the risks and impacts are not well understood. As one stakeholder pointed out, marine renewable energy impacts are much more benign than technologies such as nuclear power plants or dams, because marine renewable energy devices can be removed relatively easily if they are shown to cause harm (Personal comm. PNNL 2014). In addition, some issues, like percussive noise, have already been dealt with by the oil and gas industry; thus, mitigation options may be known. The February 2013 Offshore Wind Assessment notes,

> *At this point in time, the environmental impacts of offshore wind in the U.S. are not well understood. Cultural resources, such as historic preservation sites and tribal resources, must also be considered. In addition, public opposition may arise, especially with offshore wind sites near the shore that could impact viewsheds, environmental resources, and competing human uses such as fishing* (Navigant 2013a, p. 48).

Various studies are underway to assess the environmental impacts of marine renewable energy. Studies into electromagnetic fields and acoustic impacts, including a study on the effects of pile driving sounds on auditory and non-auditory tissues of fish, are ongoing (BOEM 2012).

SECTION 4 | INVENTORY OF AVAILABLE DATA

KEY ECONOMIC QUESTIONS AND DATA GAPS

Given the status of the marine renewable energy sector as an emerging industry, relatively little economic information on the industry is available. In addition, as no marine renewable energy projects have been developed to date in the study area, there are no data available specific to the study area.

Relevant data at the state, national and global level do exist to provide context for the industry, as highlighted in Exhibit 4-1. In particular, the 2013 Offshore Wind Market and Economic Analysis provides a solid overview of the industry. In addition, the geospatial analyses developed by PNNL and TNC provide information related to the suitability of the study area for marine renewable energy (Van Cleve et al. 2013, TNC 2014).

Key questions concerning the economics of the industry include:

- What types of limitations might be placed on marine renewable energy projects, with respect to exclusion zones or mitigation for environmental concerns?
- What is the process and prescribed timeline for obtaining the necessary regulatory approvals, permits and licenses?
- When might electricity prices and/or development costs shift enough to make offshore wind more cost-competitive?

Data to answer these questions are not currently available, but as the industry develops, regulators and the market will shift, and this information may become easier to obtain.

SUMMARY OF EXISTING DATA SOURCES

In this section, we present an inventory of the data sources identified to date which may support development of an economic analysis of the marine renewable energy industry (see Exhibit 4-1). We include in this inventory the name and owner of the data source, a brief description of its contents, any known caveats or limitations to using the data, and a contact or website from which the data are available.

EXHIBIT 4-1. INVENTORY OF KEY DATA SOURCES RELATIVE TO THE MARINE RENEWABLE ENERGY INDUSTRY

DATA SOURCE TITLE (REFERENCE)	OWNER	DESCRIPTION	CAVEATS AND LIMITATIONS	AVAILABLE FROM
Assessment of Energy Production Potential from Tidal Streams in the United States (Georgia Tech Research Corporation 2011)	DOE	Assessment of U.S. ocean tidal current resource.	Tidal energy is applicable in very limited area of Washington Coast.	http://www1.eere.energy.gov/water/pdfs/1023527.pdf http://www.tidalstreampower.gatech.edu/
Assessment of Offshore Wind Energy Resources for the United States (NREL 2010)	NREL	Summarizes offshore wind resource potential for the U.S., including areas up to 50 nautical miles off the State of Washington.	Presents results at by state.	http://apps2.eere.energy.gov/wind/windexchange/pdfs/offshore/offshore_wind_resource_assessment.pdf
Assessment of the Economic Benefits of Offshore Wind in the Mid-Atlantic (IHS 2012)	IHS Emerging Energy Research	Projects economic impacts of developing 7,700 MW of offshore wind capacity across four Mid-Atlantic states (NJ, DE, MD, and VA).	Data are not specific to the study area. Also, input-output models do not account for ways in which the economy may adjust over time, including broader implications such as displacement of alternative generation sources and impacts to electricity rates.	http://atlanticwindconnection.com/uploads/doc/IHS-AWC-EI-Review.pdf
Geospatial Analysis of Technical and Economic Suitability for Renewable Ocean Energy Development on Washington's Outer Coast (Van Cleve et al. 2013)	DOE/PNNL	Through consultation with industry experts, PNNL developed a geospatial database to evaluate suitability of sites within the study area for marine renewable energy development.	The suitability data layer only evaluates certain aspects affecting feasibility of marine renewable energy development. It does not consider all economic factors, such as the cost of developing the project, or socioeconomic, legal, regulatory and environmental factors that would need to be considered to determine a particular project's feasibility.	http://www.msp.wa.gov/wp-content/uploads/2013/07/PNNL_EnergySuitability_Final-Report.pdf

DATA SOURCE TITLE (REFERENCE)	OWNER	DESCRIPTION	CAVEATS AND LIMITATIONS	AVAILABLE FROM
JEDI (Jobs and Economic Development Impact) Marine and Hydrokinetic Model: User Reference Guide (NREL 2011)	NREL	Reference guide for DOE's JEDI marine and hydrokinetic model.		http://www.nrel.gov/docs/fy11osti/50402.pdf
Mapping and Assessment of the United States Ocean Wave Energy Resource (EPRI 2011)	Electric Power Research Institute (EPRI)	Assessment of U.S. ocean wave energy resources.	Presents results at by state and at an aggregate level for the West Coast (WA, OR, CA). Incorporates data from NREL 2010.	http://www1.eere.energy.gov/water//pdfs/mappingandassessment.pdf
Marine and Hydrokinetic Projects, Fiscal Years 2008-2012 (DOE 2013)	DOE	Summary of DOE funded projects related to marine renewable energy.	Limited information regarding each project is included.	http://energy.gov/sites/prod/files/2013/12/f5/mhk_projects_2013.pdf
Offshore Wind Market and Economic Analysis (Navigant 2013a and 2013b)	DOE	Provides a current in-depth assessment of the offshore wind market globally and in the United States. Includes information on project development, market segmentation, financing trends, technology and policy developments, and barriers to development. Projects economic impacts from the sector using DOE's JEDI model. Includes a literature review of existing studies related to economic impacts of offshore wind (mainly international). Original February 22, 2013, updated October 17, 2013.	Results of the model are not specific to the study area. Also, input-output models such as JEDI do not account for ways in which the economy may adjust over time, including broader implications such as displacement of alternative generation sources and impacts to electricity rates.	http://www1.eere.energy.gov/wind/pdfs/offshore_wind_market_and_economic_analysis.pdf
State Wind Energy Statistics (AWEA 2014)	AWAE	State wind energy statistics (terrestrial), including wind projects, current wind generation, wind generation potential, jobs and economic benefits.	Terrestrial wind energy data are not specific to offshore wind or the study area.	http://awea.rd.net/Resources/state.aspx?ItemNumber=5179
U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis (NREL 2012)	DOE	Provides estimates of the technical potential of specific renewable energy technologies,	Estimates do not consider economic or market constraints and are not specific to the	http://www.nrel.gov/docs/fy12osti/51946.pdf

DATA SOURCE TITLE (REFERENCE)	OWNER	DESCRIPTION	CAVEATS AND LIMITATIONS	AVAILABLE FROM
		including offshore wind.	study area.	
Washington Marine Planner (TNC 2014)	The Nature Conservancy (TNC)	TNC, in partnership with Ecotrust, has developed a geospatial database including GIS layers for Wind Power Score, Tidal Power Score, and Wave Power Score on its website.	The data layer does not consider all economic factors, such as the cost of developing the project, or socioeconomic, legal, regulatory and environmental factors that would need to be considered to determine a particular project's feasibility.	http://washington.marineplanning.org
Washington Opportunities for Offshore Wind Businesses (CESA 2013)	Clean Energy States Alliance	Provides an overview of Washington's policies and incentives related to renewable energy and offshore wind.		http://www.cesa.org/assets/2013-Files/OSW/DW-OSW-State-Profiles/Washingtonfinal.pdf
Washington State Energy Profile and Washington: Summary Renewable Electric Power Industry Statistics (EIA 2014)	EIA	Overall and renewable electric power statistics for Washington State.	Statewide statistics are not specific to the study area.	http://www.eia.gov/renewable/state/washington/pdf/washington.pdf http://www.eia.gov/state/print.cfm?sid=WA

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APPENDIX A

SUMMARY OF EXPERT INTERVIEWS

CONTACT NAME (AFFILIATION)	DATE OF INTERVIEW	CONTACT INFORMATION	MODE OF CONTACT
Tim Stearns (WA Dept. of Commerce)	April 21, 2014	Senior Energy Policy Specialist State Energy Office Office of Economic Development and Competitiveness Washington Department of Commerce 2001 Sixth Avenue, Suite 2600 Seattle, Washington 98121 Phone: 206-256-6121/360-725-3125 Fax: 206- 256-6158 E-mail: tim.stearns@commerce.wa.gov	By phone
Jeff Ward (PNNL and WCMAC member)	April 22, 2014	Senior Project Manager Pacific Northwest National Laboratory Sequim Marine Sciences Laboratory 1529 West Sequim Bay Road Sequim, Washington 98382 Phone: 360-681-3669 Mobile: 360-461-9604 Fax: 360-681-4559 E-mail: ja.ward@pnnl.gov, jaward@olypen.com	By phone
Simon Geerlofs (PNNL)	April 22, 2014	Marine Sciences Laboratory Pacific Northwest National Laboratory 1529 West Sequim Bay Road Sequim, Washington 98382 Phone: 360-683-4151 E-mail: Simon.Geerlofs@pnnl.gov	By phone
Alla Weinstein (Principle Power Inc.)	April 25, 2014	Principle Power Inc. 93 S. Jackson Street #63650 Seattle, Washington 98104 Phone: 206-905-1139 E-mail: allaw@principlepowerinc.com	By phone (Skype)
Dr. Brian Polyage (NNMREC/UW)	May 9, 2014	Northwest National Marine Renewable Energy Center/ University of Washington(College of Engineering) Phone: (206) 685-2171 E-mail: bpolagye@u.washington.edu	By phone