LPRO: LEGISLATIVE POLICY AND RESEARCH OFFICE

MARINE ENERGY

BACKGROUND BRIEF

MARINE ENERGY POTENTIAL

Marine energy encompasses both wave power, such as power from surface waves, and tidal power, which is obtained from the kinetic energy of large bodies of moving water. According to the Electric Power Research Institute, Oregon's wave energy resource potential is 143 billion KWh/yr – enough energy to power more than 13 million homes. Additionally, the Pacific Northwest is well suited for the development of offshore wind due to its ocean and wind resources. Marine energy projects are not yet in commercial operation, but they have the potential to support Oregon's existing power resources, providing more constant power output than wind or solar resources. Wave energy output is strongest during winter months, coinciding well with peak electricity demands in the state while also complementing other carbon-free resources such as hydro, which peaks in the spring, and solar, which peaks in the summer.

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Marine energy does face barriers to adoption, as the high costs of these technologies, compared to other generating sources and limited transmission access in coastal Oregon, currently hinder the cost-effective development of this potential resource.

Oregon's Renewable Portfolio Standard recognizes ocean energy as an eligible resource. In 2007, the Oregon Innovation Council (**OIC**) selected wave energy as an economic innovation focus. As a result of funding from the OIC, the Oregon Wave Energy Trust, a nonprofit, public-private partnership, was established with the goal of responsible development of wave energy projects in Oregon.

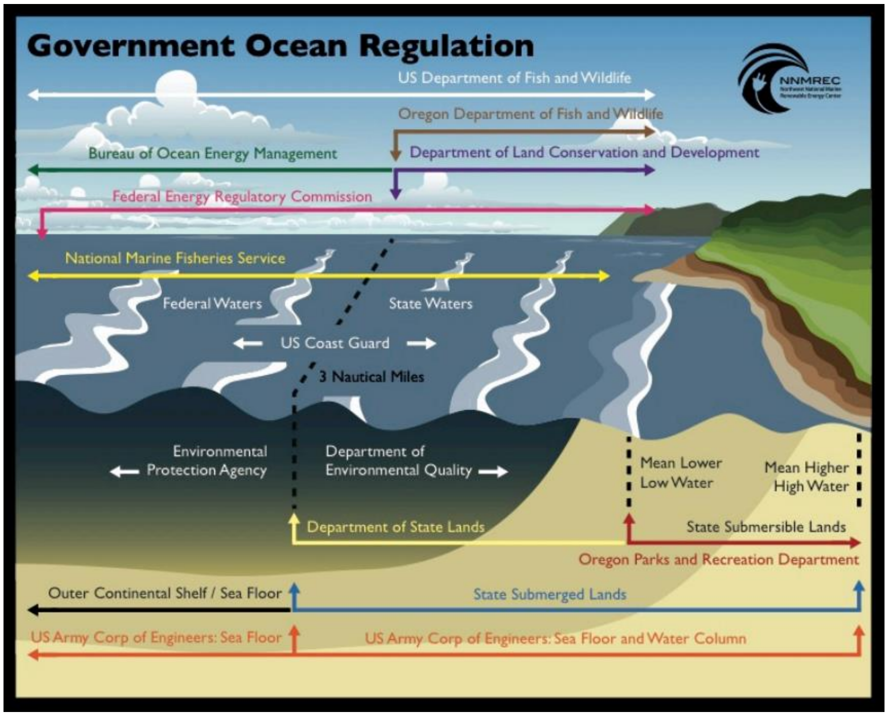
ENERGY AND TRANSMISSION NEEDS

Most of Oregon's electricity demand is west of the Cascades, while electricity generation is east of the Cascades. Transmission lines that cross the Coast Range are all owned by Bonneville Power Administration and transfer power east-to-west. There is no significant power generation on the coast. Local generating resources could safeguard the system against problems such as outages and overloads and preserve a local utility's ability to deliver electricity to its customers.

Experts note that marine renewable energy projects can provide a more constant power production than solar or wind because they are relatively constant and change seasonally. Wind patterns over the ocean are typically stronger and more consistent than wind patterns on land. These stronger and more consistent offshore winds have the potential of producing steady energy and significantly larger amounts of electricity than land-based wind installations, even with increased wind speeds of only a few miles per hour.

Regulation

Within three nautical miles of the state coastline is the Oregon Territorial Sea, which is under state jurisdiction. Beyond the Territorial Sea boundary is the Outer Continental Shelf, which is under federal jurisdiction. If a marine energy project is located in Oregon's Territorial Sea, it must follow the regulatory structure laid out in Part 5 of the Territorial Sea Plan, adopted by the state in January 2013, in addition to meeting other standards and obtaining other state permits. If a project is in federal waters, it must receive a lease from the federal Bureau of Ocean Energy Management.



Source: Bureau of Ocean Energy Management[1]

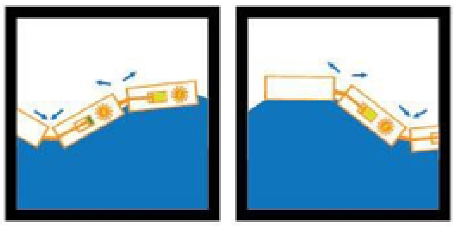
Examples of Marine Energy Devices

Marine energy projects would be zero-carbon emitting resources and have a low lifecycle carbon footprint associated primarily with the embedded greenhouse gas emissions from manufacturing and construction. Devices in development come in various shapes and sizes and can be fully or partially submerged, anchored or float, or affixed to a dock or jetty. They can also be integrated into the natural landscape in order

[1] https://www.boem.gov/NREL-Development-Testing-Program/

to avoid causing a negative visual effect from shore. Ongoing research is conducted to evaluate the potential impacts on marine life from the operation of these devices.

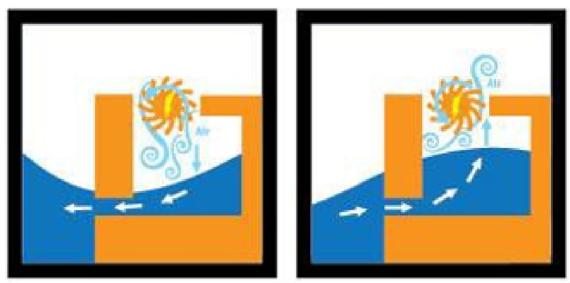
More than 100 conceptual designs of marine energy conversion devices have been developed over time, but only a few have been built as full-scale prototypes or tested. Currently, oscillating water column, attenuator, overtopping and point absorbers are the main types of devices that generate or convert energy from waves. Offshore wind turbines can have ocean-floor mounted turbines or floating platforms. Oregon has a deep seafloor, which means offshore wind installations will likely need to be platform-based. Examples of the different technologies are included below.



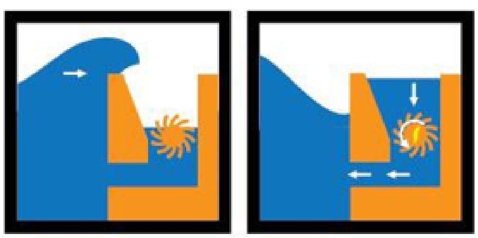
(Northwest National Marine Renewable Energy Center)

Attenuator: These devices are oriented in the direction of incoming waves, which cause articulated components to bend and drive generators. Appearing like semi- submerged "train cars," they are typically moored to the ocean floor on one end. This device is around 390 feet long and 11 feet wide, with about seven feet above the surface of the water.

Oscillating Water Column: These devices generate power when waves push against a horizontally-hinged flap, or are funneled into a structure that causes a water column to rise and fall. These devices may be fixed to the ocean floor, hung from a floating or shoreline structure, or built into harbor jetties. These devices could be put into 20 to 100 foot depths and be as much as 65 feet wide.



(Northwest National Marine Renewable Energy Center)



(Northwest National Marine Renewable Energy Center)

Point Absorber: A device that captures energy from the vertical motion of the waves; it can be floating on the surface or attached to the ocean floor.

(Principal Power)

Platform-based offshore wind turbine: Offshore wind turbines are placed on a floating support structure to dampen wave and turbine induced motion, enabling wind turbines to be sited in previously inaccessible locations where water depth exceeds 50 meters.

INDUSTRY ACTIVITY

While wave energy has great potential both off the northwest coast of the United States and worldwide, the wave energy industry is in early stages of development. Industry challenges include difficulty capturing the energy in a usable form, the harsh marine environment, deployment costs, and competing uses of sea space.

Oregon State University's (**OSU**) Northwest National Marine Renewable Energy Center (Center) has become the primary testing center for wave energy device development in the U.S. In 2012, the U.S. Department of Energy (**DOE**) awarded OSU $4 million to establish two test sites as part of the Pacific Marine Energy Center. In January 2013, the Center selected Newport as the "South Energy Test Site" (**SETS**) of the Pacific Marine Energy Center. SETS is located about five miles from shore and is the second facility in the world where full-scale devices can plug into the electricity grid.

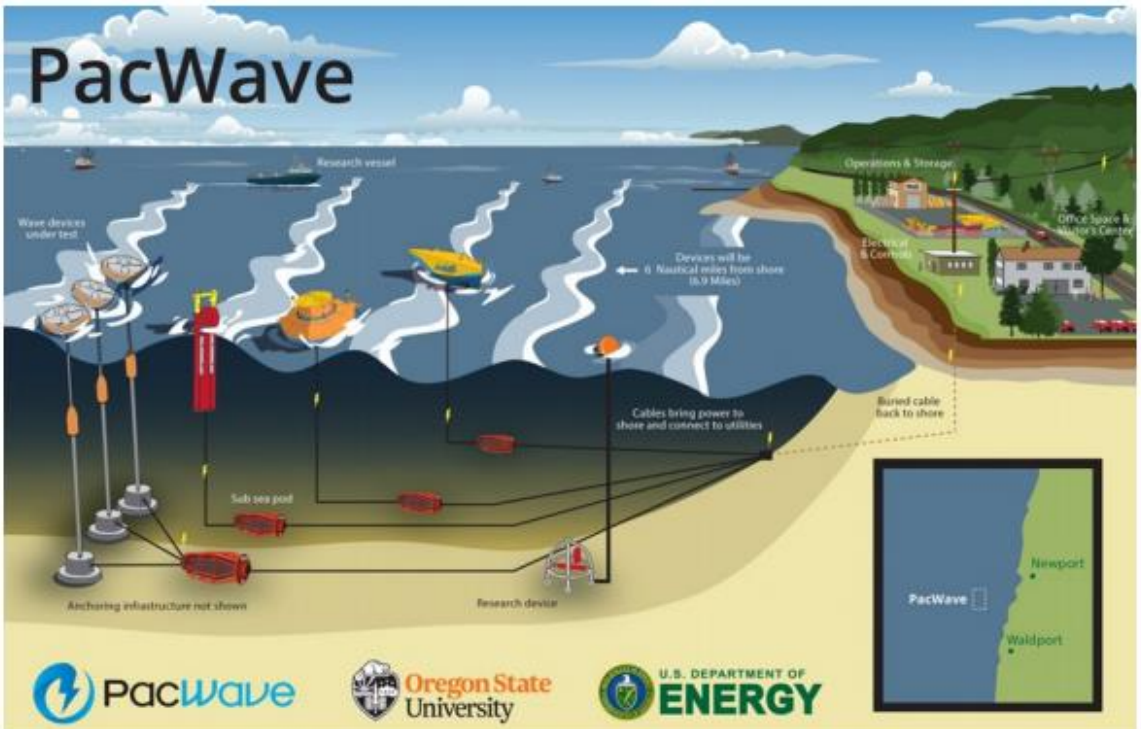
Source: Bureau of Ocean Energy Management[2]

In 2014, the Bureau of Ocean Energy Management (**BOEM**), a federal agency charged with managing development of the United States Outer Continental Shelf's energy and mineral resources in an environmentally and economically responsible way, gave Principle Power, Inc. approval to submit a formal plan to build five, 6 MW floating wind turbine devices about 13 miles off the shore of Coos Bay. Known as the WindFloat Pacific project, the 15-square mile proposed lease area was one of a series of leasing efforts being pursued by BOEM.

[2] https://www.boem.gov/NREL-Development-Testing-Program/

In 2016, the legislature approved an $800,000 appropriation for another Oregon marine energy project to OSU and the Northwest National Marine Renewable Energy Center. The legislature also approved an increase of $200,000 for the Oregon Wave Energy Trust. Also, the U.S. DOE awarded OSU $40 million to develop a utility-scale, grid-connected marine energy test site.

In September 2018, SETS rebranded as PacWave. It is currently under development as the first grid-connected wave energy test site in the U.S. OSU submitted a draft license application and preliminary draft environmental assessment for the site to the Federal Energy Regulatory Commission in April 2018. PacWave is expected to be operational by 2020, pending approval of U.S. DOE funding from Congress, and will be able to test utility-scale wave energy devices in the ocean. PacWave will enable four separate wave energy devices to be tested simultaneously, and the wave generators will be connected by subsea cable to the Central Lincoln PUD electric grid.



Source: Bureau of Ocean Energy Management[3]

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[3] https://www.boem.gov/NREL-Development-Testing-Program/