



Seeking Public Support for a Wave Energy Power Plant Offshore Douglas County, Oregon

Justin Klure
Oregon DOE

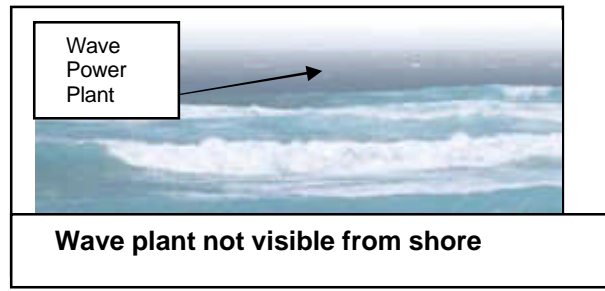
Annette von Jouanne
Alan Wallace
Oregon State University

Roger Bedard
Omar Siddiqui
EPRI/EPRI Solutions

May 20, 2005

Purpose of This Paper

To inform Oregon electricity stakeholders about a proposed wave power plant offshore Douglas County, Oregon and to get public support for this project.



Have you ever watched the swell of an ocean wave surging towards the shore, perhaps carrying a surfer, and pondered its enormous strength? The power of ocean waves is truly awesome. Aside from thrilling surfing enthusiasts and enthralling beachgoers, their destructive potential has long earned the respect of generations of fishermen, boaters, and other mariners who encounter the forces of the sea.

Now consider today's rising fuel prices, at home and at the pump. Think about the all too familiar headlines you read every day about our country's dependence on fossil fuel, including foreign oil, and its implications for the environment and our national security. Wouldn't it be wonderful if the power of ocean waves could somehow be harnessed into useful energy to reduce our dependence on fossil fuel? Instead of burning depleting fossil fuel reserves that pollute the air and water, wouldn't it be wonderful to obtain energy from a resource as clean, pollution free, and abundant as ocean waves? Is this idea the stuff of science fiction? Hardly, the technology, though young, *exists* to convert the power of ocean waves into electricity.

Oregon, in particular, is blessed with very powerful waves. The total wave energy resource potential off the coast of Oregon is enough to supply about 20% of the state's total electrical demand.

So what is needed to make the dream of wave energy a reality in Oregon? The authors advocate the establishment of a pilot-scale wave power plant off the Oregon coast as a first step towards a commercial scale facility, which would be the first of its kind in the US. With enough public will and cooperation between government agencies and other stakeholders, Oregon can add the renewable resource of wave energy to its mix of energy resources.

The Benefits to Oregon

Using wave energy to generate electricity would provide many far-reaching benefits to the state of Oregon and its citizens. The construction, operation, and maintenance of wave power plants would create jobs, promote economic development, and improve the state's energy self-sufficiency.

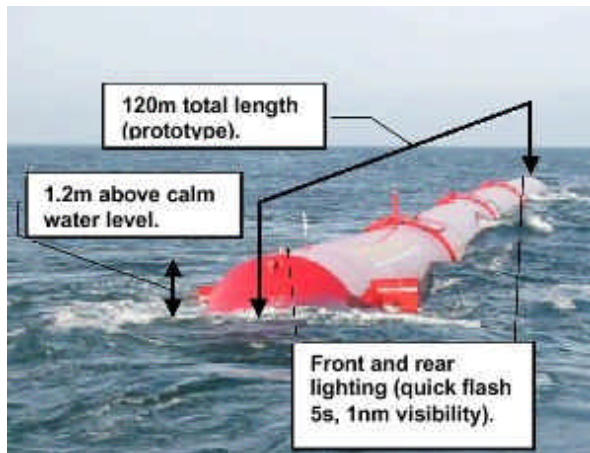
There are other compelling arguments for offshore wave energy technology in Oregon.

First, with proper siting, converting ocean wave energy to electricity is believed to be one of the most environmentally benign ways to generate electricity. Second, offshore wave energy offers a way to minimize the 'Not In My Ocean' (NIMO) issues that plague many energy infrastructure projects, from nuclear to coal and to wind generation. Since wave energy conversion

devices have a very low profile and are located at a distance from the shore, they are generally not visible. In addition, wave energy is more predictable than direct solar or wind energy, and therefore can be more easily integrated into the overall electricity grid for providing reliable power. Lastly, since a diversity of energy sources is the bedrock of a robust electricity system, wave energy is consistent with Oregon's needs and goals. Wave energy is an energy source too important to overlook.

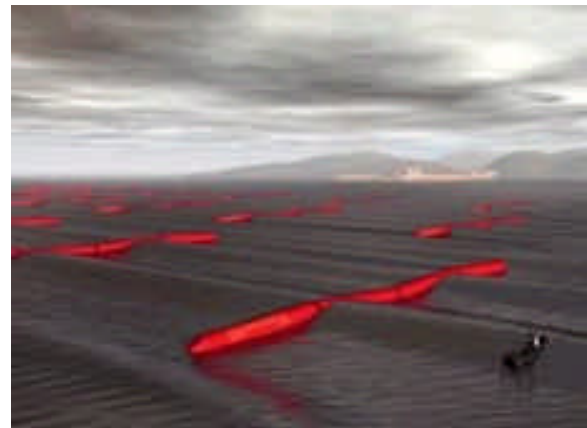
Description of Typical Wave Energy Conversion Device

The Ocean Power Delivery (OPD) Pelamis wave energy conversion device, shown below, is in our opinion, the most technologically mature device available today. It consists of 4 cylindrical steel sections that are connected by 3 joints. The total length of the device is about 400 ft (120m) and the device diameter is about 15 ft (4.6m). The wave-induced motion of these joints is resisted by hydraulic rams which pump high-pressure oil through hydraulic motors via smoothing accumulators. The hydraulic motors drive electrical generators to produce electricity. Power from all 3 joints is fed down a single umbilical cable to a junction on the sea bed.



Fabrication of the devices would be performed in Coos Bay, Gardiner or Reedsport. In addition, local resources will be used for assembly at the dock, installation of the mooring equipment and sub sea cabling, deployment of the devices and continuing operation and maintenance activities.

Several devices can be connected together and linked to shore through a single submarine cable as illustrated in the following figure.



The Proposed Plant

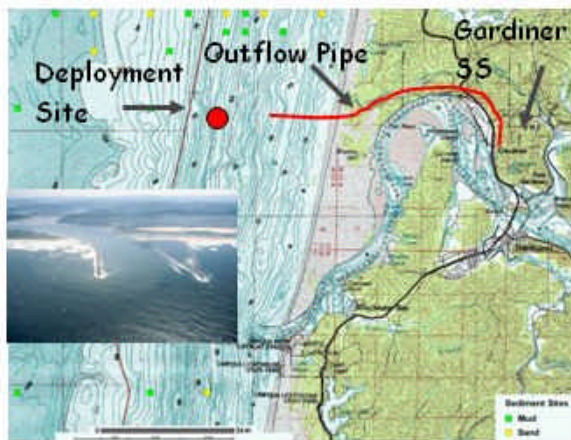
The Electric Power Research Institute (EPRI) conducted a feasibility definition study in 2004 which resulted in a compelling case for an offshore wave power plant in Oregon¹. Bonneville Power Authority (BPA) (the EPRI Oregon client) selected the Douglas County area as the plant site and the Pelamis as the representative wave energy conversion device because:

- Douglas County¹ meets all required site attributes. In addition, it has an existing outflow pipe which offers a unique opportunity for reducing the cost of this plant.
- The OPD Pelamis wave energy device² is a technologically mature device that is the result of six years of testing and development, including one year of successful full-scale testing at sea.

Pilot and commercial scale plants were designed by the EPRI team for the Douglas County, Oregon site³. The following map shows the deployment site; the location of the Gardiner substation and the existing outflow pipe. A submarine cable would be buried in the seafloor sediments from the deployment site until it enters the outflow pipe, and then would run inside the pipe until it is connected to the grid at the Gardiner Substation. The deployment site would be at the 60m water depth contour line.

The Tahkenitch substation, also in Douglas County, has sufficient capacity to handle the additional load. Bonneville Power Administration (BPA) carried out a preliminary power flow study indicating that the transmission in the vicinity of Gardiner should be able to handle up to 100 MW from a commercial scale wave power plant.

A paper mill owned by International Paper, which is now closed and for sale, is located next to the Gardiner substation and has an outflow pipe going from the paper mill out into the ocean. This presents a unique easement and substantially reduces the cost of this project. This 30 inch diameter pipe could be used to house the power cable from the substation into the ocean thus eliminating many of the landfall and grid interconnection issues. An agreement with International Paper, which will not affect their ability to sell the assets of the plant, will be needed to use the pipe for this purpose.



A nominal 90 MW commercial scale offshore wave energy plant will provide 300,000 MWh per year of energy (an average power output of 34,000 kW or enough power for 34,000 homes). This plant will use an area of about 2.25 miles long by 1.8 miles wide and will be 3.5 miles from the shore.

An Oregon Offshore Wave Energy Research, Development and Demonstration (RD&D) Facility

Oregon State University (OSU) proposes to leverage the infrastructure of the proposed offshore wave power plant to add a permanent RD&D facility maintained and operated by the University in Corvallis and its Hatfield Marine Center in Newport. OSU is an excellent location to conduct ocean energy wave extraction research and has an existing Motor Systems Resource Facility (MSRF) and the O.H. Hinsdale Wave Research Lab (WRL). The MSRF has the highest power rating in the nation and is a flexible test bed environment. The WRL has a 342 foot long by 12 ft wide by 15 ft deep wave tank capable of producing 5.2 ft waves and wave periods from 0.5 to 10 seconds.

Local Infrastructure Requirements

For devices such as the Pelamis, fabrication, dockside assembly, mooring and transmission cable infrastructure deployment, device deployment, operation and maintenance would all be performed by local labor. Operation and maintenance activities can be carried out at a suitable pier in Reedsport, with the device remaining in the water. For the 10-year refit, the device will need to be recovered to land onto a rail-type system on which these activities can be carried out.

Frequently Asked Questions

What is wave energy?

Waves are the movement of water near the surface of the sea. Waves are formed by winds blowing over the water surface which make the water particles adopt a circular motion. This energy of this circular motion is determined by the speed and duration of the wind, the length of sea it blows over, the water depth and the sea bed conditions. The key characteristic of wave energy that makes it especially attractive for electricity generation is its high power density compared to the power density⁴ of solar and wind energy.

Will these devices survive storms and the hostile marine environment?

Yes. The Pelamis is the result of six years of testing, modeling and development by Ocean Power Development, Ltd. of the UK. A full scale prototype has been continuously operating and providing electricity into the UK grid since the summer of 2004. The core theme of the Pelamis concept is survivability. Wave energy conversion devices absorb power from normal waves through buoyancy and static pressure. Extreme storm waves produce large inertia slamming forces. The Pelamis is very sensitive to buoyancy and static pressure forces but is not sensitive to slamming forces.

Will these devices affect the environment?

Given proper care in site planning, offshore wave power promises to be one of the most environmentally benign electrical generation technologies. We recommend that early demonstration and commercial offshore wave power plants include rigorous monitoring of the environmental effects of the plant and similarly rigorous monitoring of a nearby undeveloped site

in its natural state (before and after controlled impact studies). With proper siting, offshore wave energy power plants will not cause any permanent damage to the environment.

Will the regulatory authorities grant a permit for this offshore wave power plant?

Even though wave energy technologists may assume that there are no known environmental concerns, the novelty of the technology at the federal and state level will likely trigger conservative evaluations and extensive approval processes. The difficulty of obtaining a permit for a wave power plant presents a significant barrier to the development of wave energy technology and to commercial use of the technology. The primary reasons are:

- There is a wide variety of regulations and agencies involved with no clear jurisdictional responsibilities, therefore each state and project is unique.
- No specific “fast-track” regulations have been developed for short-term marine renewable demonstration projects.

Permitting early wave energy plants will be a challenge since there is no precedence in the US for regulatory authorities to base an approval decision. Nevertheless, we believe that, with strong public support and the positive experiences in the UK and other countries, the Federal Energy Regulatory Agency Commission (FERC) and other federal, state and local

agencies will allow this emerging technology power plant project to go forward.

Will offshore wave energy conversion technology provide reliable and cost-effective electricity?

Yes. The Pelamis uses proven technology from the offshore oil and gas industry. All hydraulic components are commercial off-the-shelf technology. Once wave energy technology is a commercial technology, it will provide a cost of electricity equivalent to that produced by existing power plant technology today.

In Conclusion

The Oregon Department of Energy is leading a working group comprised of many electricity stakeholder organizations in the State of Oregon to implement a wave energy plant offshore the coast of Douglas County, Oregon. We believe that this project serves the public good, and therefore warrants public support. For more information, please contact:

Justin Klure
Oregon Department of Energy
(503) 373-1581
justin.klure@state.or.us

Roger Bedard
EPRI
(650) 855-2131
rbedard@epri.com

References

-
- ¹ EPRI Report WP-003-OR, Oregon Site Identification and Characterization
 - ² EPRI Report WP-004-US, Wave Energy Conversion Device Assessment Report
 - ³ EPRI Report WP-006-OR, Pilot and Commercial System Level Design, Performance, Cost and Economics Assessment for Douglas County, Oregon Offshore Wave Power Plant
 - ⁴ EPRI WP-009-US, Final Summary Report