Oregon Wave Energy Trust
Utility Market Initiative

Integrating Oregon Wave Energy into the Northwest Power Grid

www.oregonwave.org

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The Utility Market Initiative was prepared by *Pacific Energy Ventures* on behalf of the Oregon Wave Energy Trust.

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About Oregon Wave Energy Trust

The Oregon Wave Energy Trust – (OWET) - with members from fishing and environmental groups, industry and government - is a nonprofit public-private partnership funded by the Oregon Innovation Council in 2007. Its mission is to serve as a connector for all stakeholders involved in wave energy project development - from research and development to early stage community engagement and final deployment and energy generation - positioning Oregon as the North America leader in this nascent industry and delivering its full economic and environmental potential for the state. OWET's goal is to have ocean wave energy producing 2 megawatts of power - enough to power about 800 homes - by 2010 and 500 megawatts of power by 2025.

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Project Background

Wave energy has the potential to play a significant role in growing Oregon's economic and energy landscape. New jobs and clean energy will result from this emerging industry. Over the past several years, great strides have been made to encourage wave energy development in Oregon. In order for the wave energy industry to successfully transition from pilot to commercial scale projects, technical and market challenges must be addressed, which will require close collaboration between the utility and wave energy industries. To date, Oregon utilities have been interested in wave energy, and some have invested resources to explore its potential; however, more work is needed to elevate wave energy as a viable resource for Oregon utility companies.

In February 2009, the Oregon Wave Energy Trust kicked off a project titled the Utility Market Initiative (UMI). The purpose of the project was to initiate a process to align the needs of the regional electric utilities with the resource potential of the wave energy industry. Pacific Energy Ventures' proposal, which included a broad multi-disciplinary teamed, was selected and the effort began in May 2009.

Benefits of Wave Energy

The benefits of wave energy are similar to that of other forms renewable energy. However, wave energy offers unique benefits to consumers and utilities compared to other renewables. In addition to providing the opportunity for economic development and new job growth as an emerging industry, the actual resource itself is extremely attractive to utility planners based on the fact it is consistent and predictable.

Economic Development
Based on the fact that wave energy requires significant capital outlay and manufacturing, new jobs and intellectual property will be gained from wave energy development. The majority of these jobs will most likely be located in coastal communities and will consist of device construction, deployment, and operations and maintenance. The Oregon Wave Energy Trust has conducted various studies forecasting the economic benefits of wave energy.

Resource Characterization
Waves off the Oregon coast track the current load requirements of coastal population centers. For example, waves are more powerful during the winter months when demand for electricity is its highest.

Clean Resource
Beyond the energy most likely used (fossil energy based utility power) for the construction of these devices, the actual energy generated from waves produces no carbon dioxide or other pollutants.

Close to Load
In the Northwest United States, the majority of the energy is generated along the eastern side of the Cascade Range and transmitted to population centers in the west. Wave energy offers the opportunity to generate power very close to load base, increasing efficiency and alleviating transmission congestion.

Scalability
Capital costs associated with energy development are extremely high. In most case, large facilities are

required to justify economic investment, even if all the energy capacity is not required in the marketplace. Wave energy projects can be easily expanded to meet flexible load growth.

Reliable and Predictable
Waves are active around the clock and during all times of the year. Although the wave resource is greater in the winter months, it can also produce significant amount of energy in the summertime. In addition, waves are predictable as far out as 2 days in advance, providing a premium value to the utilities.

Diversified Portfolio
Wave energy has unique characteristics and attributes. And combined with conventional resources and other renewable energy projects, can provide utilities with a diversified portfolio required to meet ever changing load and demand criteria.

Project Overview

The UMI program establishes useful tools and effective strategies to address the technical and business issues currently facing both the utility companies and wave energy industry. A summary of the project tasks are outlined below:

***Task 1*- Utility Engagement:** This task includes establishing a Wave Energy Utility Advisory Committee that guides and oversees efforts of the project. Committee members provide direction for areas of focus and provide feedback on project deliverables.

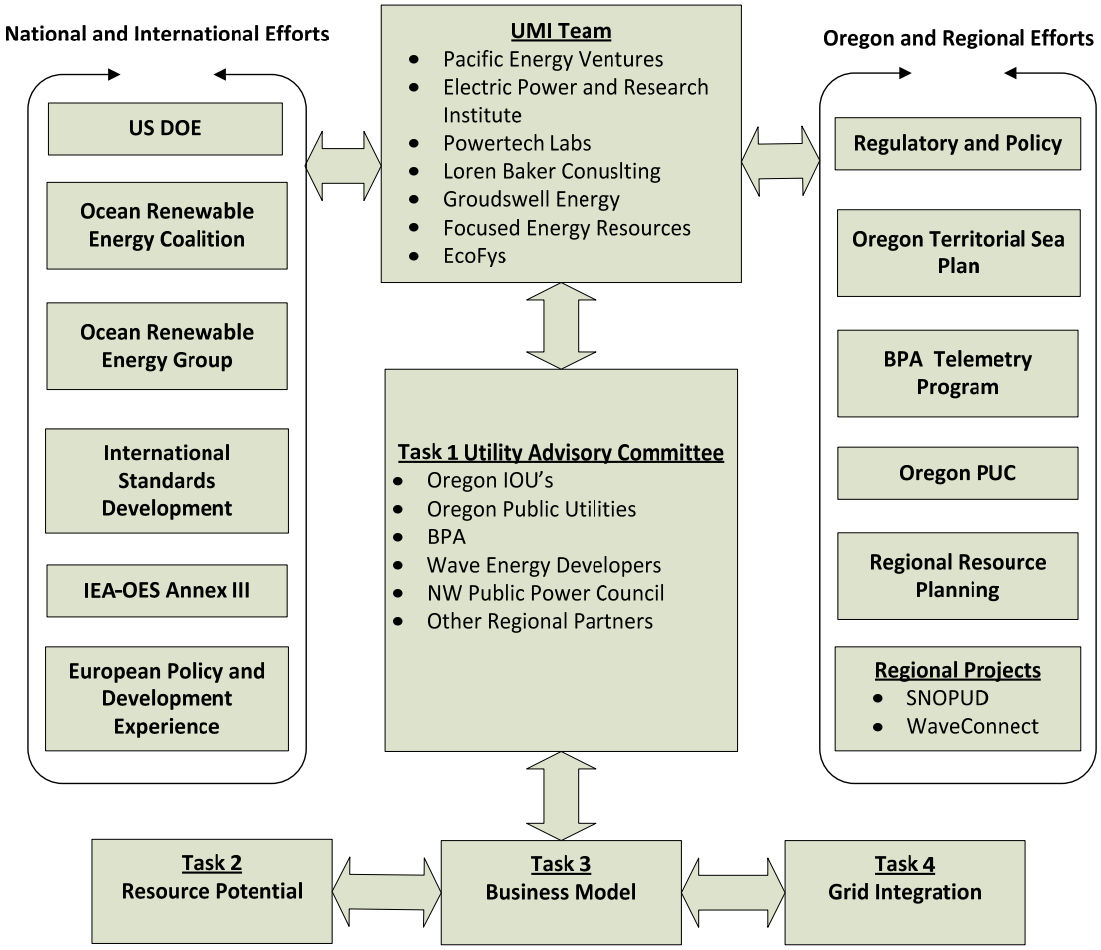
***Task 2*- Resource Potential:** A comprehensive examination of the wave resource and existing wave energy conversation technologies. In addition, this task provides an estimate of potential installed megawatts, timing and locations for wave energy in Oregon's power supply portfolio.

***Task 3*- Business Model:** This task provides an overview of the wave energy industry, including the current estimated cost and value of wave energy and a review of alternative price support mechanisms. In addition, there is a review of the risks associated with wave energy and the different business protocols to be contemplated to address risk.

***Task 4*- Grid Integration Tools**: This task identifies the existing transmission capability of the system with an integrated systems analysis. In addition, this task summarizes key technical and operation information: interconnections requirements, scheduling parameters, and other operational considerations. A review of a wave forecasting tool is also provided.

Implementation Approach

The UMI program prioritized the use of existing workgroups, tools, and expertise, where appropriate. PEV assembled a multi-disciplinary team with broad expertise in both the wave energy and utility industries to execute this comprehensive program. Our approach leveraged the UMI project efforts with the existing activities detailed below:



Task 1.0 Utility Engagement

Objective

Establish effective mechanisms to engage utility planners and industry to identify and address issues in order to accelerate market growth.

Background

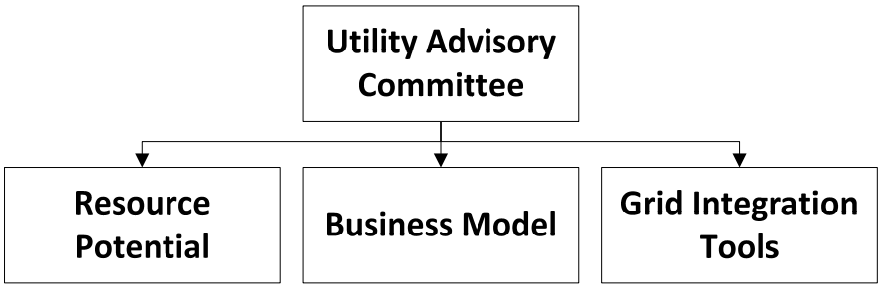
In the last three years, Oregon has experienced firsthand the rapid emergence of the wave energy industry, with two demonstration projects and eight preliminary permit applications for commercial scale wave projects. While the wave energy industry is still in the early stages of development, renewable portfolio standards, interest in carbon management, and government financial incentives have and will continue to support the acceleration of renewable energy. Recent advances by the wind energy industry in the Northwest have had significant impacts to the management of the regional power system, resulting in considerable direct and indirect costs to regional utilities. Regional utilities are currently establishing integration requirements, allocating costs, and scheduling procedures for variable/intermittent power generation projects. These circumstances present a valuable opportunity for early engagement between utilities and developers to work together to determine the optimal approach to integrating these resources into the power system.

Information Gaps

Because most utilities and power system planners neither know the resource potential nor understand the technologies, wave energy is currently not being contemplated in regional power planning efforts. Further, there is little understanding of the resource characteristics and how that translates into technical integration requirements or business arrangements.

Approach

The PEV team established a **Utility Advisory Committee** to engage the wave energy industry and utility community at a policy and leadership level. This Utility Advisory Committee guides and oversees efforts in three key areas necessary for successful integration of wave energy into the electric grid; resource potential, business model, and integration requirements.



TASK 2.0 RESOURCE POTENTIAL

Objective

Provide concise, comprehensive information to the marine energy industry in a format that will allow them to better understand the viability of wave energy in Oregon's power supply portfolio.

Background

In 2006, the Oregon Wave Energy Trust asserted that there is 500 MW of wave energy development potential over the next 15 years of the coast of Oregon. This assertion was based on early technology and wave resource information developed by EPRI. Since that time, there have been technology developments that could be updated. Further, with strong Oregon's interest in wave energy development, it is appropriate to invest in more detailed evaluation of the readiness of the technology, the potential and characteristics of the resource, and the existing infrastructure.

Approach

Provide up-to-date information about the capability of wave energy in formats that are easy to understand, yet specific enough for utility planners to assess the impacts to the regional system.

Sub-Tasks	Summary of Deliverables
2.1 Technology Assessment	2.1.1 EPRI Wave Energy Technology Assessment 2.1.2 Garrad Hassan Wave Energy Technology Review 2.1.3 Oregon Wave Project Database
2.2 Wave Resource Assessment	2.2 Wave Resource Assessment *EPRI review analysis to be completed in June 2010*
2.3 Wave Energy Capacity Profile	2.3 Forecast of Potential Wave Energy in Oregon
2.4 Resource and Interconnection Maps	2.4 Oregon Coastal Transmission Map and Substations

Task 3.0 Business Model

Objective

- Utilities and planning agencies understand the value and system effects of wave energy.
- The wave energy industry appreciates the value and costs of the resource viewed by utility.
- Effective business protocols are established between the utilities and wave energy industry.
- Innovative policy recommendations are developed to remove financial barriers and costs.

Background

The Northwest utility market, much like other parts of the nation, is extremely complex and is served by numerous utilities and policy bodies responsible for delivering reliable and cost effective electricity to consumers. Wave energy is currently a more expensive means to generate electricity than other forms of renewable energy, such as wind and biomass, and is similar in cost to solar. However, studies conducted by EPRI and estimates made by technology developers show convincing arguments that the cost of energy will decline as installed capacity increases. However, much like the early days of the wind industry and other renewable energy technologies, the wave energy will require assistance to bridge the gap from demonstration to commercialization. For this reason, more detailed review of the northwest utility market, the value of wave power in this market, and evaluation of prices support and business model alternatives is appropriate to assist developers and utilities in exploring this resource alternative.

Approach

The PEV team will provide easy to use and understand background material to facilitate collaboration among the wave energy industry and the utility community.

Sub-Tasks	Summary of Deliverables
3.1 State of the Industry Report	3.1 Utility Industry in Oregon
3.2 Price Support Mechanism	3.2.1 Market Review (International) 3.2.2 Price support Alternatives Analysis
3.3 Value of Wave Energy	3.3.1 Summary of Results 3.3.2 Model Documentation
3.4 Effective Business Models and Protocols	3.4 Business Protocols
3.5 International Standards Development	3.5.1 Overview of International Standards 3.5.2 Marine Hydrokinetics Technical Standards (TC 114)

Task 4.0 Grid Integration

Objective

The result of this task will establish a set of effective tools and guidelines that will facilitate the future integration of wave energy projects into the grid.

Background

Integrating wave energy into the regional power grid requires analysis and study. As the wind integration issues in the Northwest has highlighted, integration of a variable renewable energy resource has several considerations for the planning and operation of the electrical grid. The Northwest utility community has been responding to new issues as thousands of intermittent MWs of wind have been added to the Northwest system. These issues provide a roadmap for areas to evaluate and anticipate prior to large scale implementation of the wave energy resource. Key integration elements to be considered include the interconnection guidelines required by the jurisdictional utilities, the existing transmission capability, and the scheduling, forecasting and other operational considerations.

Approach

Using the PEV team's industry expertise, to assimilate existing information and engage with Transmission Owners and Balancing Authorities to create a comprehensive summary of Integration Tools for wave energy. The effort will focus on synthesizing existing information, working with regional partners to answer key questions related to wave energy integration, and forecasting future needs for integration of a robust wave energy industry in Oregon.

Sub-Tasks	Summary of Deliverables
4.1 Interconnection Guidelines	4.1 Interconnection Guidelines
4.2 Integrated Systems Analysis	4.2 Integrated System Analysis
4.3 Forecasting Tools	4.3.1 Forecasting Requirements 4.3.2 EPRI Review of WaveWatch III Forecast Tool *and* EPRI Recommended Implementation Plan
4.4 Scheduling Parameters	4.4 Scheduling Requirements and Challenges
4.5 Utility Considerations	4.5.1 Technical and Operational Barriers 4.5.2 Integration and Balancing of Wave Energy
4.6 Telemetry	4.6 Telemetry

Project Team:

Pacific Energy Ventures (Project Lead) – Renewable energy consulting and business development firm focused on strategic marketing, project management, governmental affairs and policy.

Ecofys – International energy and sustainability consulting firm with expertise in solar energy, wind energy, biomass, hydrogen technology, energy supply and climate policies.

Electric Power and Research Institute - EPRI provides technology, policy and economic analyses to drive research and development planning, and supports research in emerging technologies.

Energy Focused Resources - Energy consulting company serving Pacific Northwest utilities with energy trading and risk management, financial analysis, strategic marketing, and project construction.

Groundswell Energy – Consulting and development of electricity generation facilities; managing the large-scale central station generating plants, as well as small renewable energy projects.

Garrad Hassan – World's *l*eading renewable energy consultancy focused on, design and testing, project feasibility and front end engineering studies, and technical due diligence.

Loren Baker Consulting - Power management and electric utility consulting, active in the Northwest utility power market, utility power sales, and planning, and advises on renewable energy.

Powertech Labs - Delivers innovative clean power solutions to address the complex energy-related challenges, representing electrical utilities, gas companies, equipment manufacturers, and others.

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