# Oregon Wave Energy Trust
# Utility Market Initiative

## Task 3.3.1: Value of Wave Power – Summary of Results

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.

Task 3.3.1 was completed by Energy Focused Resources.

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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.

# Value of Wave Energy - Summary of Results

## Project Goals

The purpose of this economic analysis is to demonstrate a reasonable approach to determine the value and cost of wave power by publishing a working, open model that parties can craft to their own needs. The main value of this work is to identify items that must be considered by utilities, policy-makers and developers to bridge the gap between market prices and anticipated costs, and to provide a rudimentary framework for detecting, categorizing, and managing financial business drivers and risks.

This model's actual outputs for value and cost are of secondary importance because they are assumption driven and much of the information is speculative (e.g. machine performance), considered proprietary (e.g. technology), and/or will change over time (e.g. market price assumptions). It is expected that users of this tool will modify assumptions based on their unique understanding of technology, tariffs, politics and/or markets.

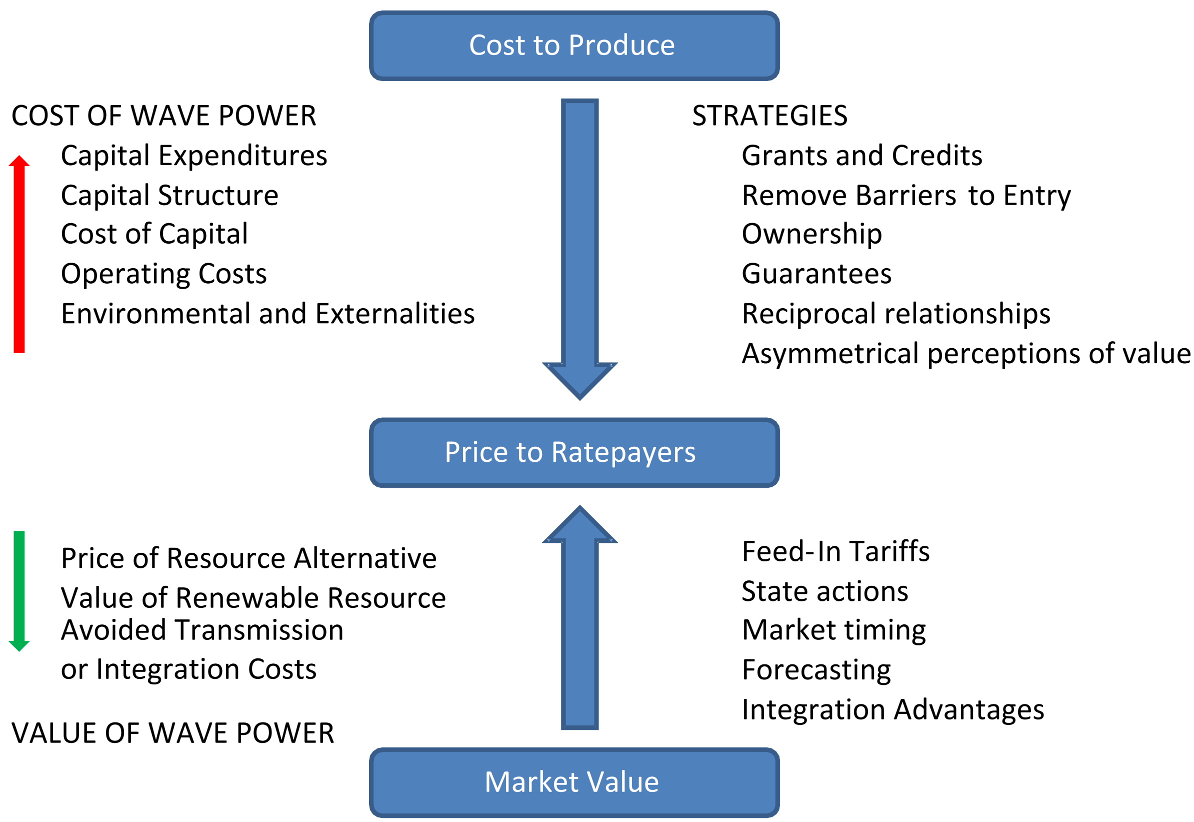


**Figure 1-- A sample analytic framework**

This work is intended to be used as a framework for discussing cost and value between technology companies, developers, and governmental bodies. Effort is best spent understanding the values and costs assumed in the model and then researching and/or adjusting values and the model to match a more specific circumstance based on the technology, site and other factors being pursued.

## Definitions of Value and Cost

Value in this work is defined from the perspectives of both developers and utilities.

*Utility's Value:* The utility perspective takes the current forecasted market value of the energy and Renewable Energy Certificates (RECs) being delivered to a western Oregon delivery point. It takes into consideration when the energy is delivered by month and how much is delivered on heavy load hours (HLH) or light load hours (LLH). This represents the price that the utility should be willing to pay regardless of the source for the assumed energy and REC profile. Value is expressed in dollars per megawatt-hour (MWh).

*Developer's Value:* The developer's value is the utilities' value less direct external costs to deliver the energy to the buyer. Direct external costs are those inputs provided by third parties to integrate and deliver the power to the buyer on the grid, namely ancillary services and transmission costs. Value is expressed in dollars per MWh.

*Cost:* Cost is expressed as the price of energy (including RECs) in dollars per MWh necessary to fully fund all aspects of the project under a specific set of assumptions. This includes capital investments, expenses (including integration and transmission), investment cost of capital, and retirement of debt and equity. This is accomplished by calculating the level-cost contract price that results in a balance sheet value of zero in year 20, indicating that all investors are paid and the resource has been retired. Two reference scenarios are provided to demonstrate the sensitivity of cost to large variables but they should not be considered a full range of potential outcomes.

## Major Assumptions

The value and cost scenarios share some base assumptions. The model assumes:

- A 100MW wave farm with two hundred 500 kilowatt units deployed over two consecutive summers. The project is stand-alone with a company life of 20 years and an asset life of 15 years.
- Construction and installation occurs in the middle of years three and four and the assets are removed in year 19.
- The technology has an average 35% capacity factor, annually each unit has a 10 day planned outage, a forced outage rate of seven percent in winter months, and no diurnal shape.
- Integration and Transmission rates and costs are all based on Bonneville Power Administration practices and rate schedules. A wind balancing rate analog is modeled but not applied.
- Return on Equity is assumed to be paid as a dividend and the company returns all capital invested to shareholders and debt holders at the termination of the project.

- The dividend assumption is designed to provide an economic assessment of costs of a stand-alone project; it is not an operational representation as to how value will actually accrue to equity investors.

The *valuation work* assumes the same Pacific Northwest Westside delivered forecasted prices as used in the Draft Northwest Sixth Power Plan, published by the Northwest Power and Conservation Council with Year One in the model corresponding to 2011 prices. Renewable Energy Certificate (REC) prices are assumed to rise from $7.50 to $25.00 per MWh over the life of the project.

*Cost scenario one* assumes an installed cost of approximately $3,650 per kilowatt of nameplate capacity, and no federal incentives, a 60% equity capital structure, and a cost of equity of 19.54%. The cost of equity was established at 19.54% based on wind manufacturers (closest comparables) betas.

*Cost scenario two* assumes a per kilowatt nameplate capacity installed cost of $2,650, a 30% federal grant, a 25% equity structure, and a cost of equity of 14%.

These assumptions can all be changed in the model to accommodate specific circumstances and user-defined scenarios.

## Results and Comments[1]

*The flat price, 15-year value of wave power to the utility is $124.05.* This figure assumes an escalating energy and REC price forecast throughout the project term. It also includes a 4.54% energy premium due to the higher volumes of wave energy delivery in higher priced months versus a flat energy block price. Odd-lot effects are not considered.

*The value to the developers is $114.46* which indicates an average $9.59 per MWh cost to integrate and deliver energy. These costs include one point-to-point (PTP) transmission leg and the following ancillary services:

- Scheduling, System Control and Dispatch
- Reactive Supply and Voltage Control from Generation Sources
- Operating Reserve - Spinning Reserve Requirement
- Operating Reserve - Supplemental
- Generation Imbalance

Costs may be lower if developers can self-supply ancillary services economically, can forecast generation well, or can avoid PTP charges. Costs may be higher if forecasting is poor or the equivalent of a Wind Balancing Service is applied to wave projects.

*The Scenario One cost is $476.44 per MWh.* Bear in mind this scenario contains no federal incentives and a conservative, costly capital structure. However, given the lack of knowledge concerning the capital investment of installed capacity and operating costs it cannot be considered an upper limit to how much wave power may cost.

[1] All costs and value estimates are levelized nominal costs.

*The Scenario Two cost is $218.80 per MWh.* This scenario assumes a federal incentive, a low per kilowatt installed capital cost, an aggressive capital structure and lower cost of equity. This capital structure and cost of equity most likely would only be attainable with significant risk assumption by parties other than the developer (e.g. federal loan guarantees). Given the number and magnitude of these aggressive assumptions this is probably a low-probability scenario at this stage of technological development and practical experience. Even so, it cannot be portrayed as a lower bound to the cost of wave power as additional incentives, better operational metrics, and technology improvements could alter the calculation substantially