# Oregon Wave Energy Trust
# Utility Market Initiative

## Task 4.5.2: Integration and Balancing of Wave Energy


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

Task 4.5.2 was completed by Ecofys.

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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.

ECOFYS

Report for:
Oregon Wave Energy Trust – Utility Market Initiative
Integration and Balancing of Wave Energy

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**Wave Integration and Balancing**

Wave power naturally varies on many levels. On the order of seconds, voltage flicker or power quality effects may occur, which is an issue that the technology and correcting devices will be required to correct. Variation on the order of minutes and hours affects the scheduling of power. This intermittent nature of wave power is shared by wind generation, a more mature technology. The tools used for integrating wind power into the electric grid can be used as a model for wave power.

Bonneville Power Administration, the region's largest supplier of electricity, launched two wind integration services in 2004: a network wind integration service and a storage and shaping service. The network service utilized the flexibility of the hydro system. BPA would meet and follow the customer's load at all times, with no regard to wind output. The customer was charged a fee of $4.50/MWh, at the onset of the service, for all scheduled energy integrated into the BPA system. The BPA storage and shaping service would take the hourly output of the wind projects, integrate and store the energy in the Federal hydro system, and redeliver it later in blocks to the customer. The base charge for the storage and shaping service was $6/MWh.

These BPA balancing services were discontinued in 2008, lasting only 4 years. BPA determined that the federal power system may not have the capacity to provide the services. In part, court decisions had reduced the flexibility of the hydro system. And while natural gas is used for balancing in some regions, it was not considered due to its carbon footprint. The hourly schedules being predicted by wind operators were deemed by BPA to be not sufficiently accurate. Particularly problematic were large ramp events that would occur, both up and down, but were not shown in the schedules. The size of the wind fleet together with the large ramps required a larger reserve from the hydro system than was forecasted.

Currently BPA requires a Wind Balancing Service rate for all wind plants (excluding those 20MW and less until late 2010). Initially BPA proposed a rate of $12/MWh, but eventually dropped it to $5.70/MWh. The wind integration rate represents a 5-10%

adder to the delivered cost of wind on BPA's system. This rate compensates for regulating reserves (moment-to-moment generation-load differences), following reserves (larger differences occurring over longer periods of time during the hour), and imbalance reserves (differences between the generator's schedule and the actual generation during an hour) distinctly. Wind plants that have implemented their own balancing may be exempted from the rate. An excerpt from the Rate Adjustment Proceeding, regarding the Wind Balancing Service, is included as an appendix.

The implementation of balancing and integration for wind power in the region could be a predictor for wave power, as they are both renewable resources with inherent variability. However, if it is possible to provide more accurate forecasts for wave power than for wind power, then fewer resources will be needed for balancing wave energy. The most expensive aspect of wind balancing, approximately 60% to 75% of the cost, is the hour-to-hour scheduling inaccuracy. While both wind and wave resources are variable, waves are believed to be more predictable. Further research and validation regarding forecasting are ongoing by EPRI, NOAA and the wave-power industry.

Questions pertinent to wave-energy producers, and in some cases to all market participants, include:

1) How accurate will the wave forecasts be? Over what time periods? Is overall accuracy the most important, or is it the ability to predict ramps and other extreme events (e.g., cutout due to storm conditions)?
2) Will there be geographic diversity of installed wave-power plants, enough to effect some smoothing of the variability of individual projects?
3) Will the Northwest continue to have many balancing areas, with limited trading, or will there be consolidation? If there is consolidation, will it be physical or "virtual" consolidation?
4) Will the scheduling requirements remain the same, or will there be shorter scheduling periods and more ability to adjust schedules before the next sale period?
5) Will there be integration costs assessed specifically to wave-energy producers? In order to do so, research must be done to quantify:
    a. Required operating reserves necessary only because of wave energy
    b. Cost due to uncertainty (imperfect forecasts)
    c. Costs due to variability (natural variation in the resource)
6) Will there be wide-spread deployment of flexible, controllable loads in the grid, such as smart appliances and electric vehicles, which can assist system operators to accommodate ramping and cycling of variable resources like wave energy?

The outcomes of these various developments will determine the relative ease and cost of integrating and balancing wave power.

**APPENDIX:**

**Excerpt from**

2010 Wholesale Power and Transmission Rate Adjustment Proceeding (BPA -10)
Administrator's Final Record of Decision
Appendix C
*2010 Transmission, Ancillary Service and Control Area Service Rate Schedules (FY 2010-2011)*

*(Pages 65-67)*

E. WIND BALANCING SERVICE

The rate below applies to all wind plants in the BPA Control Area except as provided in sections III.E.3 and III.E.4. Wind Balancing Service is comprised of three components: regulating reserves (which compensate for moment-to-moment differences between generation and load), following reserves (which compensate for larger differences occurring over longer periods of time during the hour), and imbalance reserves (which compensate for differences between the generator's schedule and the actual generation during an hour). Wind Balancing Service is required to help maintain the power system frequency at 60 Hz and to conform to NERC and WECC reliability standards.

1. RATE

Except as provided in section III.E.4.ii, the total rate shall not exceed $1.29 per kilowatt per month. Each component of the rate shall not exceed the following:

(i) Regulating Reserves $0.05 per kilowatt per month

(ii) Following Reserves $0.26 per kilowatt per month

(iii) Imbalance Reserves $0.98 per kilowatt per month

2. BILLING FACTOR

The Billing Factor is as follows:

(i) For each wind plant, or phase of a wind plant, that has completed

installation of all units no later than the 15th of the month prior to the billing month the billing factor will be the nameplate of the plant in kW. A unit has completed installation when it has generated and delivered power to the BPA system.

(ii) For each wind plant, or phase of a wind plant, for which some but not all units have been installed by the 15th day of the month prior to the billing month, the billing factor will be the maximum measured hourly output of the plant through the 15th day of the prior month in kW.

3. EXCEPTIONS

(i) This rate will not apply to a wind plant, or portion of a wind plant, that, in BPA's determination, has put in place, tested, and successfully implemented no later than the 15th day of the month prior to the billing month, the dynamic transfer of plant output out of BPA's Balancing Authority Area to another Balancing Authority Area.

(ii) Any component of this rate will not apply to a wind plant, or portion of a wind plant, that, in BPA's determination, has put in place, tested, and successfully implemented in conformance to criteria specified in BPA-TS business practices, no later than the 15th day of the month prior to the billing month, self-supply of that component of balancing, including by contractual arrangements for third-party supply.

(iii) Through September 30, 2010, this rate will not apply to any wind plant with a nameplate capacity of 20,000 kW or less.

4. RATE ADJUSTMENT

(i) On 30 days' written notice posted on BPA-TS's OASIS, BPA may increase the rate as set forth in section III.E.4.ii, with a commensurate increase in the amount of balancing reserves set aside for Wind Balancing Service, if

a. one or more participants in the Pacific Northwest utility industry, including regional organizations, asks the Administrator to increase the amount of balancing reserves set aside for Wind Balancing Service in order to reduce the frequency or magnitude of BPA's implementation of Dispatcher Standing Order (DSO) 216; or

b. because of a legal challenge to DSO 216, BPA is prevented from implementing DSO 216 or is required to amend it materially.

(ii) The new total rate shall not exceed $1.58 per kilowatt per month. Each component of the rate shall not exceed the following:

a. Regulating Reserves $0.05 per kilowatt per month

b. Following Reserves $0.27 per kilowatt per month

c. Imbalance Reserves $1.26 per kilowatt per month

ci.

SECTION IV. ADJUSTMENTS, CHARGES, AND OTHER RATE PROVISIONS

A. RATE ADJUSTMENT DUE TO FERC ORDER UNDER FPA § 212

Customers taking service under this rate schedule are subject to the Rate Adjustment Due to FERC Order under FPA § 212 specified in section II.D of the GRSPs.