Oregon Wave Energy Trust
Utility Market Initiative

Task 4.4: Scheduling Requirements and Challenges

www.oregonwave.org

www.peventuresllc.com

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

Task 4.4 was completed by Ecofys.

December 2009

This work was funded by the Oregon Wave Energy Trust (OWET).

OWET was funded in part with Oregon State Lottery Funds administered by the Oregon Business Development Department. It is one of six Oregon Innovation Council initiatives supporting job creation and long term economic growth.

This Utility Market Initiative was prepared by Pacific Energy Ventures on behalf of the Oregon Wave Energy Trust. Task 4.4 was completed by the Ecofys.

For information about this project, please contact Justin Klure at Pacific Energy Ventures:

Phone: (503) 475-2999

Email: jklure@peventuresllc.com

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.

Report for:
Oregon Wave Energy Trust – Utility Market Initiative
Scheduling Requirements and Challenges

18 November 2009

Authored by:
Diane Broad, P.E., Sr. Consultant
Ecofys US

Overview of Scheduling

Electric utilities have control, directly or indirectly, over a wide variety of generation resources at any moment in time. Balancing Authorities and utility power managers must receive regular schedules from each of the generation resources to determine which resources are available, and what the expected power output is from each.

In the Northwest each Balancing Authority schedules power on an hourly basis. The power output schedules are submitted on a day-ahead basis (also referred to as a preschedules), with the opportunity to adjust the schedule at a specified time interval (e.g., 30 minutes) in advance of any given hour.

Utility power managers require preschedules in order to determine what resources will be available to meet load and optimize the operation of their resource portfolio. Depending on how and to whom the wave energy is being sold, the project operator may be asked to submit a schedule to a scheduling agent, the utility, or directly to the Balancing Authority.

The table below outlines the two major types of schedules and how they are used.

Type	To Whom	When	Purpose
Preschedule	Utility power manager and/or Balancing Authority	Day prior	Allow for resource optimization and system planning
Hourly Schedule	Balancing Authority	30 minutes prior to hour	Manage electrical reliability of the system

The purpose of this report is to identify the typical scheduling methodology of the Northwest utilities, and what the expectations may be for scheduling wave energy resources both at the pilot stage and at full commercial-scale operation. Challenges in scheduling that are specific to wave energy will be identified. The report concludes with a brief discussion of possible changes in the Northwest electricity

market and associated requirements for scheduling generation, and how these changes could affect implementation of wave energy.

Project Size and Scheduling

Given both the size and the expected power sales arrangements for wave energy, the preschedule requirements will likely be the most important for wave energy. The details of what information to be provided, to whom, and under what timelines will be defined in the power sales agreement.

Small generators are not of significant concern to the control center operators, because they are seen essentially as negative load. In the past, the hour-by-hour operation of generators below 10 MW has been ignored by the control center operators. However, with more small generators (renewable and non-renewable) expected to come online in the coming decades, the balancing authorities are concerned that the aggregate effects could become significant enough to affect the economic and reliable operation of their portion of the grid.

In Oregon, the Public Utility Commission recently approved AR 521, Small Generator Interconnection Rules. These rules require that any generator 3MW or larger have real-time telemetry to communicate the operational status and power output to the appropriate control center. The OPUC Rules govern only the investor-owned utilities, but Bonneville Power Administration (BPA) has also adopted the 3MW minimum for telemetry requirements. With telemetry installed, it is expected that the control center operators will require scheduling from these small generators.

The wave energy industry in the United States is still in the technology development phase. Individual wave energy converters are being tested and improved. We will likely see the first pilot-scale projects in the waters off the Oregon Coast in the next two years. The pilot-scale projects are expected to be less than 3 MW. If this is the case, no scheduling would be required. If the pilot-scale projects are 3MW or larger, then hourly schedules will most likely be required to be submitted to the appropriate balancing authority.

When wave energy projects grow to the scale of “large generators”, defined by the FERC as greater than 20 MW, scheduling will certainly be a requirement.

Project Location and Scheduling Procedures

The designated balancing authority is determined by both the point of interconnection and the purchaser of the power from the wave energy project.

Option 1: Interconnection Directly to BPA

BPA has significant transmission resources along the Oregon Coast, and several points of interconnection that look highly desirable for wave energy development. If a wave energy project were to interconnect directly to BPA’s transmission system, the day-ahead schedule, and any necessary hour-ahead adjustments, would be delivered to the BPA control center.

Option 2: Interconnection Directly to PacifiCorp

PacifiCorp also has areas of load served on the Oregon Coast, and a 115-kV transmission network to reach these loads. If a wave energy project were to interconnect directly to PacifiCorp's transmission system, the day-ahead schedule, and any necessary hour-ahead adjustments, must be delivered to the PacifiCorp control center.

One aspect to be considered, as wave projects grow in size, is that PacifiCorp's transmission system exists in pockets that are in all cases interconnected to BPA's transmission system. PacifiCorp has indicated that its largest load served along the Oregon Coast is in the Coos Bay area, and it is 30 MW. To take this area as an example, if wave energy interconnected to PacifiCorp reached a level nearing or exceeding 30 MW, PacifiCorp would at times need to export this power across BPA's transmission system. A schedule might need to be submitted to BPA's control center as well, in this case.

Option 3: Interconnection to a Coastal Electric Co-op or PUD

Most of the Oregon Coast is served by electric co-ops or Public Utility Districts (PUDs). Wave energy projects interconnected to these entities are part of BPA's balancing area. Therefore, ultimately the day-ahead schedule, and any necessary hour-ahead adjustments, would be delivered to the BPA control center. Depending on the preferences of the local interconnecting utility, the schedule may go through them to BPA, or directly from the project operator.

Scheduling Requirements

As stated previously, the requirements for when and where to submit hourly generation information from a wave energy conversion device will be defined in the power sales agreement. Outlined below is a summary of requirements that typically apply to utilities that are part of BPA's Balancing Authority.

Type of Schedule	***Information Required***	***Submission Deadline***
Preschedule	Hourly Schedule for Hour Ending 1 through Hour Ending 24	NLT 2:00 pm day prior
Weekend Preschedule	Hourly Schedule for Hours Ending 1 through Hours Ending 24 for Saturday, Sunday, and Monday	NLT 2:00 pm on Friday
Adjusted Preschedule	Adjusted Hourly Schedule for next hour	NLT 30 minutes prior to the start of the hour
Hourly Schedule	Hourly Schedule for next hour	NLT 30 minutes prior to the start of the hour

Minimum Information Required For All Schedules

- *What* - MW amount of schedule.
- *When* - Starting and ending times of each schedule. Scheduled hourly values shall be referenced by the "hour ending" time on the 24-hour clock (e.g., the schedule between 2:00 p.m. and 3:00 p.m. is referred to as the schedule for the "hour ending 1500", commonly referred to as the schedule for the "1500 hour").
- *Where* - Identification of the point of receipt/delivery and the bus voltage where necessary.

Scheduling Challenges in Practice

Nothing about the scheduling of the output of wave-energy projects is fundamentally different from that of any other variable resource, such as wind or solar. A reliable forecast must be obtained. Site resource measurements must be available, in the case of wave energy from local buoys. The power output of the project as a whole, and the operational status of individual generators, must be monitored in real time. Finally, the communications systems must be in place to transmit the schedule to the relevant balancing authority's control center.

Of all these requirements, those that represent the highest risk for failure are the monitoring of the status of individual generators, and the gathering of resource data from local buoys. The data source for these is offshore, perhaps quite a long distance depending on the particular installation. Communications systems that can be deployed far from shore, in the challenging marine environment, without the benefit of a stable platform, and still reliably deliver minute-by-minute data need to be proven. The experience of BPA with integrating wind energy has shown that the most accurate forecasts are not good enough, if the real-time performance of the generating equipment and the local resource conditions are not taken into account before submitting the schedule.

Future Developments

How close to the hour the adjustments to the day-ahead schedule can be made has been shown to be a key factor influencing the economics of integrating intermittent renewable energy sources like wind energy. Compared to wind energy, wave energy is expected to be less intermittent and more predictable, but this remains to be proven as the industry gains experience with operating plants. In other regions of the US, the electricity markets operate on smaller time increments, such as 10-minute or even 5-minute markets. In general, these markets with short-time scheduling have been shown to result in more effective market participation for renewable generators, and lower system-wide costs for the necessary ancillary services.

The BPA Wind Integration Team has recognized this, and is studying the possibility of creating within-hour markets for the Northwest, initially for wind generation, possibly extending to associated ancillary services in the future. Accordingly, the current BPA Wind Integration Work Plan includes an important task: Sub-hourly Scheduling. The purpose of this pilot is to provide the ability for wind customers to submit schedules on a sub-hourly basis. BPA will implement systems and processes that will enable purchasing and selling entities to schedule excess wind generation from the BPA balancing authority area on the half-hour. The Business Practice was posted on September 8, 2009 for review, followed by a customer comment period of a few weeks. The phase 1 pilot will be implemented December 1, 2009.

If within-hour markets and sub-hourly scheduling are in place and widely accepted by the time wave energy reaches full commercial scale implementation, these will facilitate more effective participation in the electricity market for wave energy. Balancing and integration costs will be reduced. Moreover, if wave energy proves to be as easily forecasted as is currently hoped, wave-energy projects could even be suppliers of balancing reserves, adding an additional income stream for the projects.

Data Necessary for Scheduling

Although the process and techniques of wave energy forecasting are outside the scope of this report, it is wise to keep in mind what the underlying data needs are to produce a useful, reliable schedule. Typical data requirements for scheduling would include:

1. 10 minute data
2. Power Generation of the facility as a whole
3. Number of wave energy converters on line
4. Site wave resource data from local buoy
5. FTP or Secure FTP data

For other renewable energy technologies, such as wind energy, regional forecasting and scheduling providers are in operation to collect all the necessary data and submit the schedules to the appropriate balancing authorities. In the near term, this task is likely to fall to the individual operators of wave-energy projects. However, BPA is willing to discuss the merits of providing regional wave energy forecasting and scheduling. These discussions could lead to a cost-effective solution for scheduling wave energy in Oregon.