University of New Orleans
ScholarWorks@UNO

Ocean Waves Workshop

Nov 17th, 10:00 AM - 11:00 AM

Development of Wave Energy Converters at Ocean Power Technologies (Extended Abstract)

Kathleen Edwards
Ocean Power Technologies, kedwards@oceanpowertech.com

James E. Eder
Ocean Power Technologies

Philip R. Hart
Ocean Power Technologies

Deborah A. Montagna
Ocean Power Technologies

Development of Wave Energy Converters at Ocean Power Technologies

Kate A. Edwards*, James E. Eder, Philip R. Hart, and Deborah A. Montagna
Ocean Power Technologies, 1590 Reed Rd, Pennington, NJ 08534 US
Phone: 609-730-0400, Fax: 609-730-0404, *Corresponding author: kedwards@oceanpowertech.com

Ocean Power Technologies (OPT) develops moored devices (‘PowerBuoys’) that convert the power in ocean waves into useful electrical power in power capacities up to 500 kW per device. Designs reflect deployment site considerations and power requirements. Development includes modeling, numerical simulation, and ocean testing. Building on a long history of previous deployments, an autonomous PowerBuoy is presently undergoing ocean operations off New Jersey. The use of wave measurements in evaluating the PowerBuoy’s performance is described.

1. Background

The PowerBuoy utilizes the vertical or heaving motion of the sea surface, acting as a point absorber of wave energy [1]. A buoyant float moves up and down along a spar (**Figure 1**), which remains relatively stationary in the water column. Inside the spar, a Power Take Off (PTO) converts the linear motion into electrical power. The on-board controller provides optimal resistance to motion so as to maximize the extracted power and also manage power flow so as to provide continuous electrical output irrespective of day to day wave variability.

Figure 1. PowerBuoy design for LEAP, consisting of float (yellow/orange), spar (gray). Spar motion is limited by heave plate at base.

2. PowerBuoy Development Process

a) Define project requirements, including incident wave power and survival conditions at the site, deployment requirements, and client power needs.

b) Initiate design spiral. For candidate designs, predict power generation across all sea states using OPT’s model of PowerBuoy motions in waves, which incorporates WAMIT (hydrodynamics model). Determine survival and fatigue loads on mooring system and structure using OrcaFlex (marine dynamics model). Find expected response of structure to loads using finite element analysis. Revise structure until it meets power and survivability goals.

c) Design mechanical and electrical subsystems that perform all required functions while meeting constraints such as system efficiency, manufacturability, and maintenance interval.

d) Advanced testing. Construct small-scale physical model for tank testing. In waves representing typical and extreme conditions at the site, record model loads and power generation. Analyze measurements; validate predictions. Update design.

e) Marine logistics. Given site survey and environmental conditions, design mooring and method of deployment.

f) Ocean testing. Deploy full-scale prototype in ocean environment. Transmit measurements to shore for monitoring and analysis. Collect wave measurements for power prediction model. Compare expected and actual power generation.

g) Final design and deployment. Based on ocean test results, finalize design. Manufacture and deploy at quantity and scale required by customer.

3. PowerBuoy Deployment off New Jersey

OPT recently developed and deployed an autonomous PowerBuoy for a U.S. Navy program. The system provides autonomous, constant power to a radar system housed within the PowerBuoy, which has been deployed off New Jersey since August 2011. The system and moorings withstood Hurricane Irene (**Figure 2**a; Hs>9m, hourly average winds>20 m/s). During the initial 6-weeks of deployment, the system has provided uninterrupted power to the payload. The system has provided nearly continuous telemetry data over a satellite network and has required little need for operator intervention. Power production typically exceeds requirements (Figure 3).

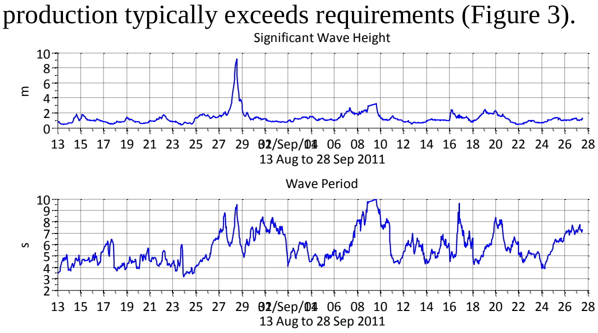

Figure 2. Significant wave height and average wave period. Hurricane Irene passes Aug 28.

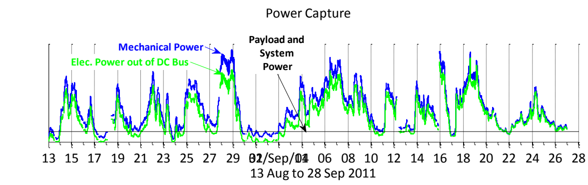

Figure 3. Power captured by LEAP PowerBuoy. Values not labeled (proprietary). Blue: mechanical power into generator. Green: electrical power out of DC bus. Black: power required by payload and system.

4. References

[1] Falnes, J. (2002). Ocean Waves and Oscillating Systems - Linear Interactions Including Wave-Energy Extraction. Cambridge University Press.