Wave Energy Test - New Zealand Multi-Mode Technology Demonstration at the U.S. Navy's Wave Energy Test Site

Steven Kopf

Northwest Energy Innovations (NWEI)
skopf@AzuraWave.com 484.459.8200

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Project Overview

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Azura Commercial Prototype Ocean Testing: NWEI completed 18 months of ocean testing of a grid-connected 1:2 scale Azura device. High-fidelity data was collected and used to validate WEC-Sim modelling. The device was operational 98% of the time and survived 7.5 meter hurricane storm waves.

The Challenge: 1) Ocean durability needs to be demonstrated

2) Existing WETS grid interconnection insufficient for small device test.

3) Ocean data is needed to validate WEC-Sim numerical modeling.

Partners:

Energy Hydraulics Ltd – power-take-off (PTO) Design

Sea Engineering – Marine Operations

University of Hawaii/Hawaii National Marine Renewable Energy Center – Data Collection, Analysis, Reporting

Naval Facilities Engineering Command (NAVFAC) – CRADA, site management

Program Strategic Priorities

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Technology Maturity

- **Test and demonstrate prototypes**
- Develop cost effective approaches for installation, grid integration, operations and maintenance
- Conduct R&D for Innovative MHK components
- Develop tools to optimize device and array performance and reliability
- Develop and apply quantitative metrics to advance MHK technologies

Deployment Barriers

- Identify potential improvements to regulatory processes and requirements
- Support research focused on retiring or mitigating environmental risks and reducing costs
- Build awareness of MHK technologies
- Ensure MHK interests are considered in coastal and marine planning processes
- Evaluate deployment infrastructure needs and possible approaches to bridge gaps

Market Development

- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain and communicate our national strategy
- Support development of standards
- Expand MHK technical and research community

Crosscutting Approaches

- Enable access to testing facilities that help accelerate the pace of technology development
- Improve resource characterization to optimize technologies, reduce deployment risks and identify promising markets
- Exchange of data information and expertise

Project Strategic Alignment

Technology Maturity

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The Impact

Target

The objective of the project is to redeploy the Azura device at the Navy's Wave Energy Test Site (WETS) to conduct open-ocean, grid connected testing for a period of a minimum of 12 months to 1) optimize energy capture and 2) validate levelized cost of energy model.

Potential Impacts

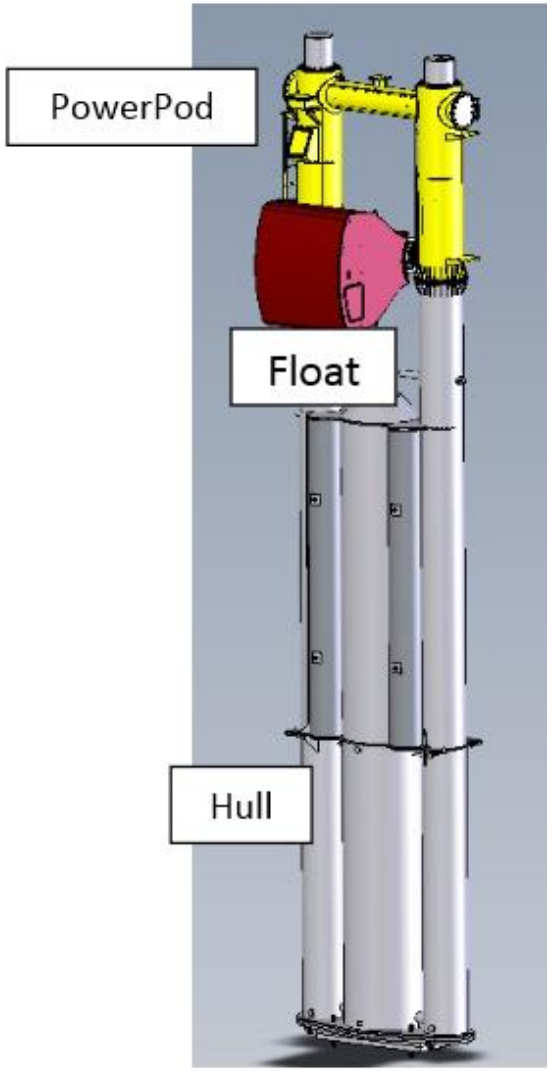
1. Advance understanding of innovative marine and hydrokinetic (MHK) technologies in the ocean environment
2. Demonstrate system durability in ocean
3. Validate numerical models to allow commercial scale design development

Final Product

A minimum of 12 months of test data correlated with WEC-Sim

Technical Approach

1. Deploy and test a 1:2 scale model of the Azura wave energy device at WETS
2. Develop a numerical model using WEC-Sim
3. Collect 12 months of ocean test data
4. Compare ocean results with WEC-Sim



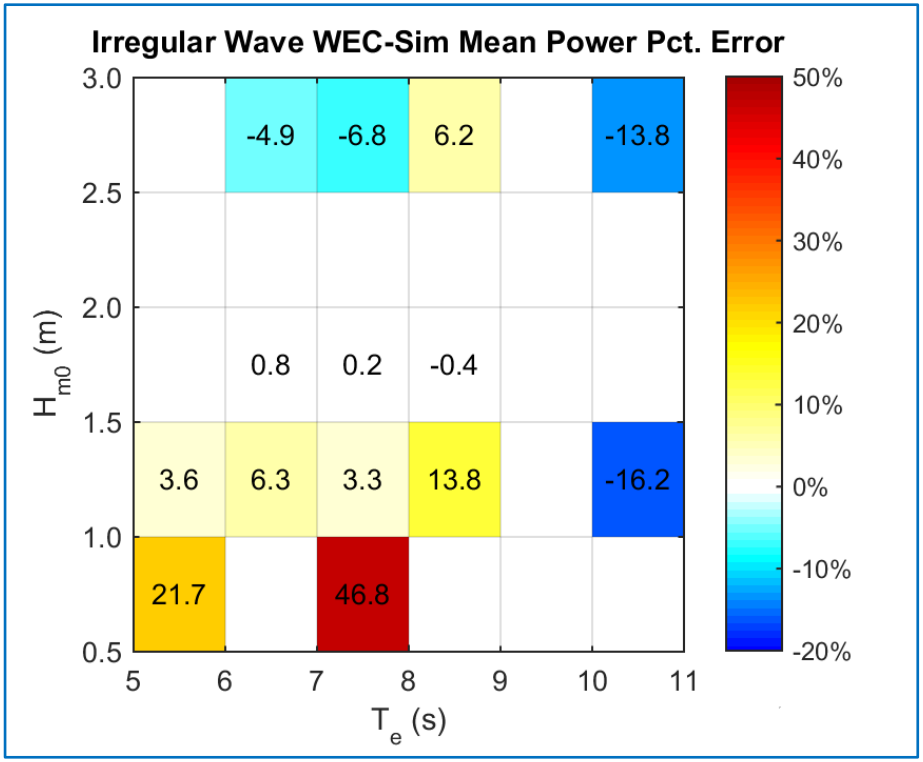
Technical Approach

Key Issues

- Interconnection
- Transportation
- Assembly
- Weather

Unique Aspects

- Only grid connected ocean testing in the US with 3rd party validation (UH)
- 18 months of ocean test data with 98% availability



Accomplishments and Progress

2014 Accomplishments

- Designed mooring system – 7/14
- Designed and installed electrical interconnection – 10/14
- Completed device shipped to HI – 10/14

2015 Accomplishments

- Assembled device – 3/15
- Deployed device – 5/15
- Survived Hurricane Ignacio – 10/15
- Completed seven months of testing – 12/15

2016 Accomplishments

- Survived Hurricane Lester (7.5m waves) – 9/16
- Completed Final Report – 7/16
- Completed 18 months of testing – 12/16

Project Plan & Schedule

- **Initial Start Date:** February 2013
- **Planned Completion Date:** February 2015
- **Actual Completion Date:** May 2016 (+15 months)
- **Schedule Slips**
  - Interconnection (+7 months) – The initial schedule assumed that the interconnection was sufficient. However, after contract award it was determined that extensive mods were required.
  - Shipping Damage (+4 months) – The device was damaged en route from NZ to HI. This resulted in a delay while repairs were completed in HI
  - Weather (+4 months) – Once the device was ready to deploy in Hawaii, we waited four months for a suitable weather window.
- **Go/No-Go Decision Points:** None

Project Budget

Budget History					
FY2014		FY2015		FY2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$167.217k	$154.234k	$0	$0	$2,472k	$0

- **Variances**: The project was completed within the allocated DOE budget.
- **Expenditure:** 100% as of July 2016
  - $529.32k DOE / $174.106k Cost Share prior to FY14
- **Other Funding Sources:**
  - UH/Applied Research Laboratory – contributed additional DOE and Navy funds to assist in the completion of the project
  - NWEI – contributed additional funds to complete the project

Research Integration & Collaboration

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Partners, Subcontractors, and Collaborators:

Energy Hydraulics Ltd – PTO development

Sea Engineering – Marine construction and operations

UH/HNMREC – Data collection, analysis, and reporting

NREL – instrumentation and data acquisition system

NAVFAC – WETS site management

Communications and Technology Transfer:

Website: www.azurawave.com

Press Coverage: Extensive list included in Final Report

You Tube Channel: https://www.youtube.com/channel/UCLcKx5dw1HVarOFkJeo1ebw

Final Report: www.osti.gov

Deliverables

Design Report
Mooring Analysis
Mooring Redesign
Design Report – interconnection

Work Plans
Safety Plan
Emergency Response Plan
Work Plan – Power Cable Fiber Training
Work Plan – Dive and Marine Ops Safety Plan
Work Plan – Installation
Work Plan – Recovery
WETS Deployment Presentation

Site and Environmental Reports
Ecological Assessment
CATEX

Test Plans
Test Plan – Full Power
Test Report – Dry Testing
Test Report – Low Power

Monthly Test Reports
June 2015 – May 2016

After Action Reports
AB Float Retrieval
AB Mooring Modification
Bend Restrictor Maintenance
Hydraulic Fluid Replacement

Final Scientific and Technical Reports
Public Report
Project Activities

Next Steps and Future Research

FY17/Current research: Project was completed in July 2016

Proposed future research:

- **New Funding** - received additional funding from UH/ARL to modify the device and continue testing
- **Heave Plate and Float** - will be modified to improve annual energy production
- **Schedule** - the modifications will occur in Q1 2017, testing will continue through Q2 2017