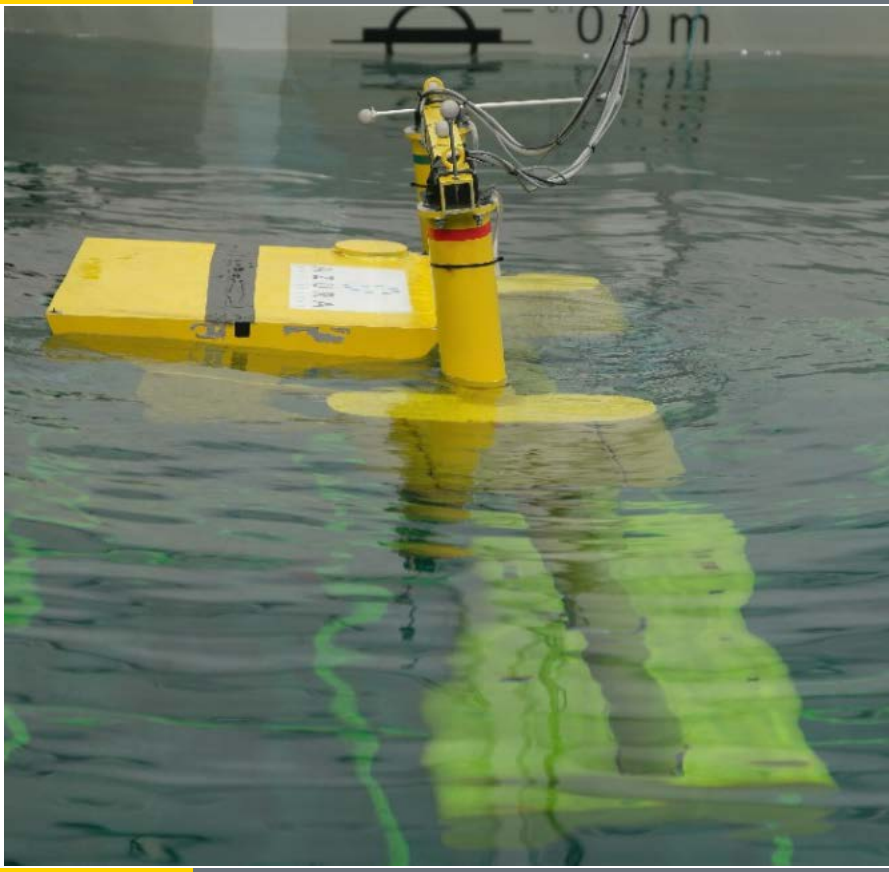
Azura Demonstration at the Navy's Wave Energy Test Site



DE-EE0006923

Marine and Hydrokinetics Program

October 9th, 2019

PI: Steven Kopf

Presenter: Bradley Ling

Northwest Energy Innovations

Project Overview

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

Project Summary

The objective of the project is to **design**, **fabricate**, **deploy** and **test** a full-scale 250 kW Azura wave energy device at the Navy's Wave Energy Test Site site located at Kaneohe Bay in Hawaii.
The goal is to demonstrate a pathway to commercial viability by demonstrating performance, reliability, and levelized cost of energy (LCOE).

Project Objective & Impact

The project objectives is to **design**, **fabricate**, **deploy**, and **test** a full-scale 250 kW Azura wave energy device at the US Navy's Wave Energy Test Site in Hawaii. The target LCOE of the prototype is $500/MWhr, and the target test duration is 12 months. The goal of this project is to demonstrate a pathway towards commercial viability of the Azura Wave technology.

Project Information

Project Principal Investigator(s)

Steven Kopf

WPTO Lead

Lauren Moraski

Project Partners/Subs

Energy Hydraulics Ltd.
Pacific Energy Ventures
Williwaw Engineering
NREL
DNV-GL

Project Duration

- July 2015
- September 2022

Alignment with the Program

Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

- Foundational and Crosscutting R&D
- **Technology-Specific Design and Validation**
- Reducing Barriers to Testing

Alignment with the MHK Program

Technology-Specific Design and Validation

- **Validate performance and reliability of systems by conducting in-water tests of industry-designed prototypes at multiple relevant scales**
- Improve methods for safe and cost efficient installation, grid integration, operations, monitoring, maintenance, and decommissioning of MHK technologies
- Support the development and adoption of international standards for device performance and insurance certification
- Evaluate current and potential future needs for MHK-specific IO&M infrastructure (vessels, port facilities, etc.) and possible approaches to bridge gaps

This program develops a full-scale prototype design of the Azura technology.

The design will be fabricated and tested in a 12-month open-ocean deployment at WETS in Hawaii.

Data collected during the deployment:

- Power Performance
- Device motions and loads
- PTO Performance
- Cost Data

Project Budget

Total Project Budget – Award Information		
DOE	Cost-share	Total
[$5,250,000]	[$4,312,500]	[$9,622,500]

DOE and Total values include FFRDC Budget

FY17	FY18	FY19 (Q1 & Q2 Only)	Total Actual Costs FY17–FY19 Q1 & Q2 (October 2016 – March 2019)
Costed	Costed	Costed	Total
[$1,475,697]	[$***]	[$***]	[$1,475,697]

FY17 numbers include cost-share spending.

At the time of this draft, NWEI is still under negotiation with DOE regarding its Go/No-Go from BP1 to BP2. Costs have been incurred in FY18 and FY 19 for BP2 tasks but have not yet been reimbursed.

Management and Technical Approach

BP1

- Preliminary Design
- Wave Tank Testing
- Key Milestones:
- CDR #1
- Wave Tank Testing
- Go/No-Go #1

July 2015 - July 2019

BP2

- Detailed Design:
- Structural, IO&M, Instrumentation, mooring, grid interface
- Key Milestones:
- CDR#2

August 2019 -July 2020

BP3

- Fabrication, Assembly, Deployment, and Testing
- Key Milestones:
- Installation Readiness Review
- Test Readiness Review
- Data Acquisition Reports
- Final Reporting

August 2020 - July 2022

Management and Technical Approach

Approach:

- Work Breakdown Structure to manage project tasks
- Develop confidence in design from:
  - model validation of Azura Scaled Prototype Deployment Data
  - 1/15th scaled testing.
- Engage partners for specialized expertise:

NWEI	Project Management, Hydrodynamic Design, Project management, Manufacturing Engineering
Pacific Energy Ventures	Permitting, Compliance
Energy Hydraulics Ltd.	PTO Design, Structural design
Williwaw Engineering	Test Engineering, Grid Interface Design
NREL	Structural Loading Estimates, Instrumentation and Test Engineering

Critical Success Factors:

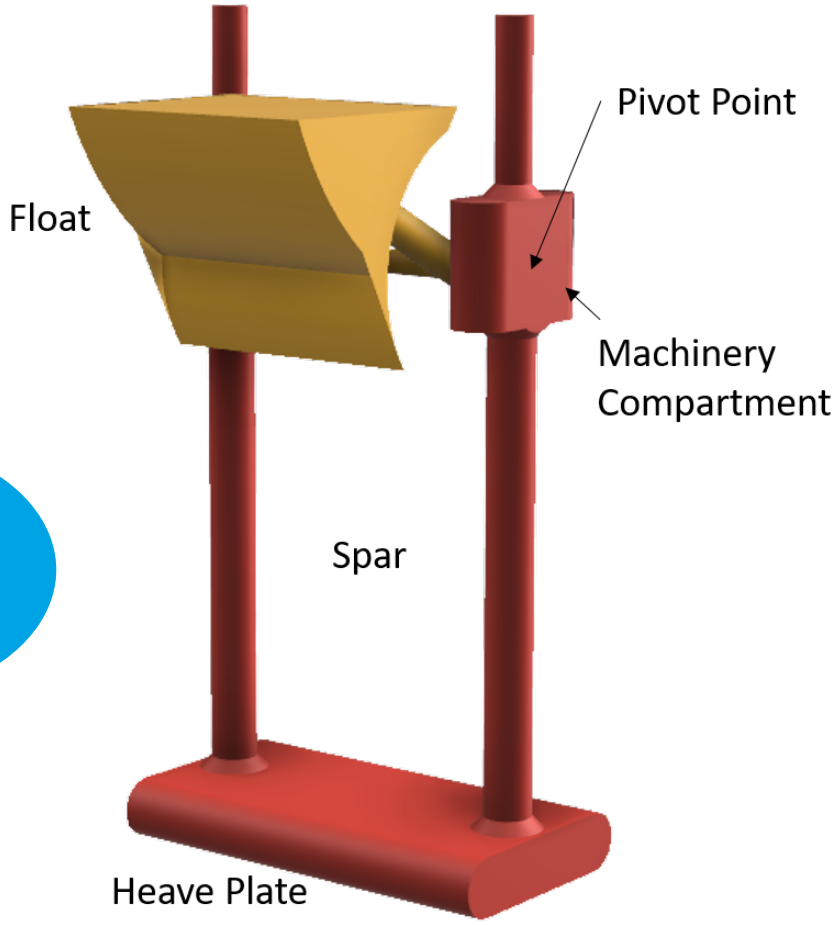
- Developing cost-effective, robust, and reliable structural design
- Accurately estimating commercially realistic LCOE from a single prototype deployment

End-User Engagement and Dissemination Strategy

- **End-User Engagement**
  - Our primary objective of engaging with utilities and energy investors is to demonstrate an LCOE of the Azura technology that shows a pathway to commercialization, providing confidence to secure the ongoing private investment required to advance the technology.
  - Despite many informal discussions with stakeholders, no formal engagement is planned as part of the proposed project.
- **Data Dissemination**
  - Wave tank data: uploaded to MHKDR *(5-year moratorium)*
  - Deployment data will uploaded to MHKDR *(5-year moratorium)*
  - LCOE model to MHKDR *(5-year moratorium)*
  - Numerous conference presentations, papers

Technical Accomplishments

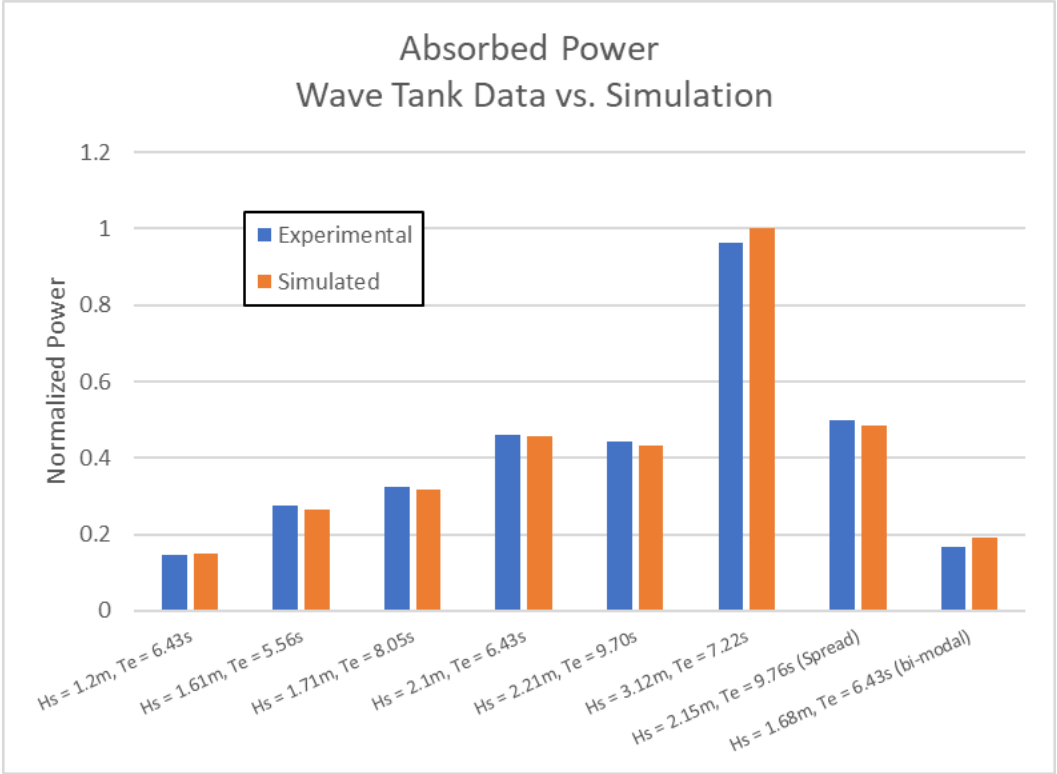
- **Completed Preliminary Design of the Azura**
  - Optimized for Hawaii Wave Climate & WETS Constraints
  - Over 700 Design Iterations



Technical Accomplishments (Cont.)

Verified Design Performance in a 1/15th scale wave tank test performed at the University of Maine

- Hardware-in-the-loop testing of hydraulic PTO
- High performance model and instrumentation yielded high-quality data
- Model design documented and presented at OMAE2019



Close Agreement with Experimental and Simulation Data

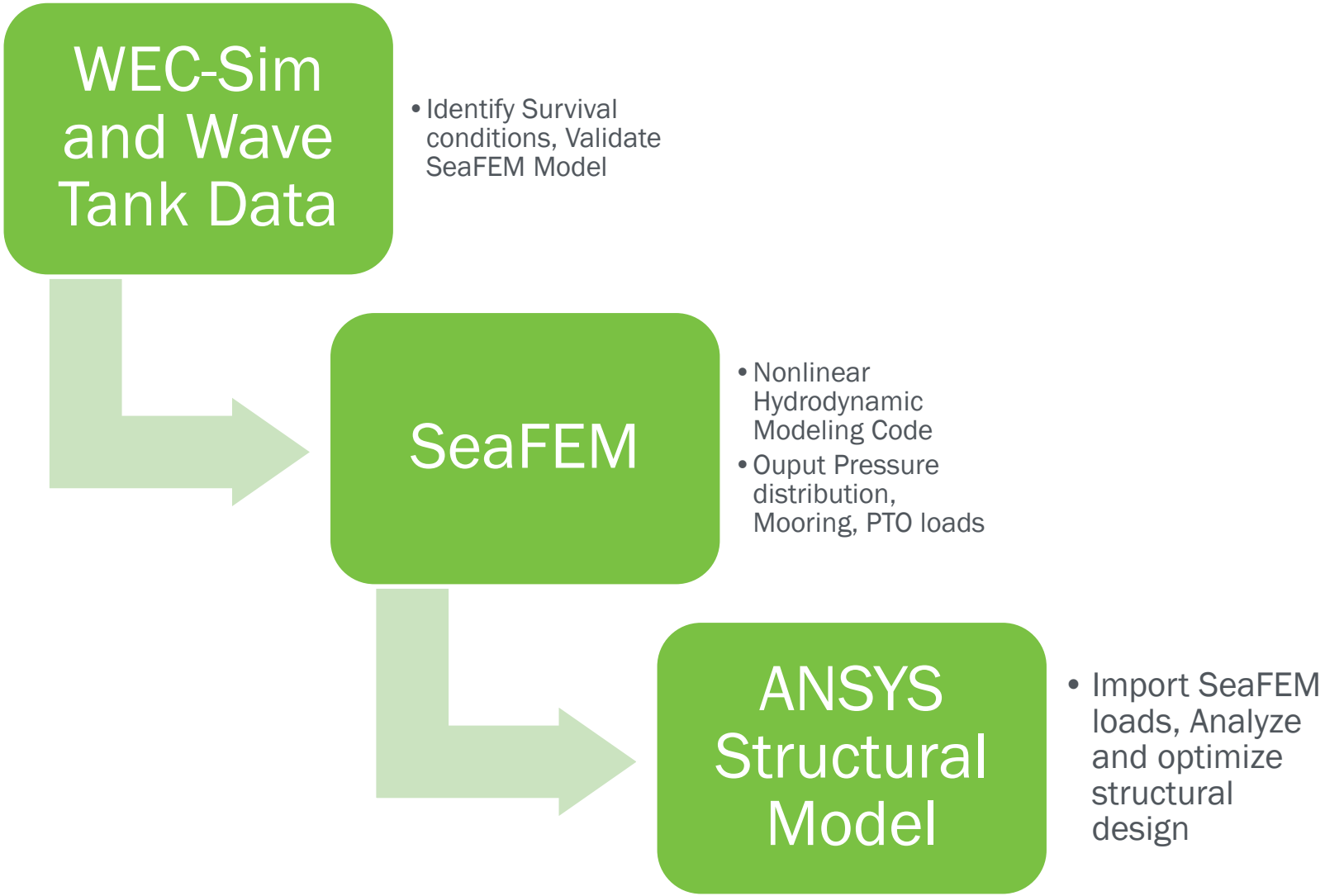
Technical Accomplishments (Cont.)

Technical Accomplishments (Cont.)

- Controls Development – Adjacent completed DOE Project
- How to implement advanced controls with hydraulic PTO
  - Power Direction Control ("bang-bang")
  - Power Magnitude Control
- Proof-of-concept tested in wave tank
- Investigating implementation in ocean deployment

Case	Pct Increase
Baseline	n/a
Hydraulic Control	11.8%
Variable Hydraulic Control*	33.0%

Progress Since Project Summary Submittal



Future Work

- ***Detailed Design (Aug 2019 – July 2020)***
  - *Structural, Mooring, and Grid Interface Design*
  - *Refined LCOE Analysis*
  - *IO&M Planning*
  - *Critical Design Review #2*
- ***Fabrication and Testing***
  - *Device Fabrication (August 2020)*
  - *Assembly, Testing, and Installation (Summer 2021)*
  - *Deployment*
  - *Data collection and analysis*
  - *Decommissioning (Summer 2022)*