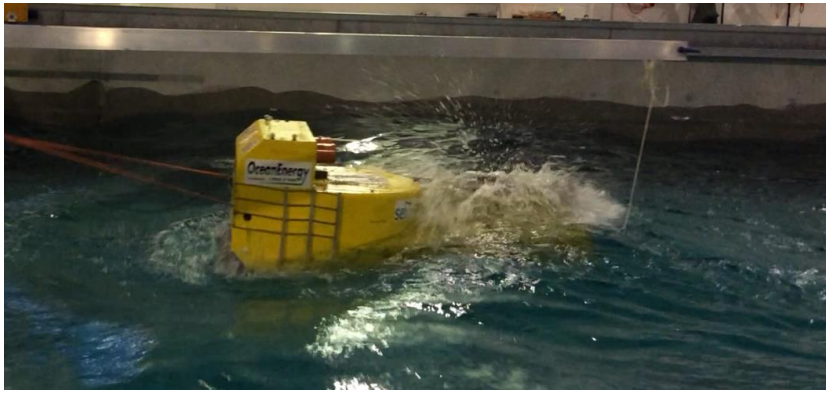

OCEAN ENERGY
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Demonstration of the Ocean Energy (OE) Buoy at U.S. Navy's Wave Energy Test Site

Tony Lewis - CTO

Ocean Energy USA LLC +353 (0) 21 481 6779
tl@oceanenergy.ie

Project Overview

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

Scope:

- Demonstrate the Ocean Energy (OE) Buoy technology at near-full-scale at an open sea test site

The Challenge:

- Reliability of near-full-scale wave energy converters (WECs) needs to be demonstrated
- Near-full-scale ocean test data is needed to validate performance predictions, reliability, and levelized cost of energy (LCOE) estimates

Partners:

- **Ocean Energy USA:** Business and Technical Project Management
- **Re Vision Consulting:** Real Time Wave Measurement System
- **Tritec Marine USA:** Structural and Mooring System Design
- **HydroGroup:** Umbilical System Design
- **Dresser Rand (Siemens):** HydroAir Turbine System Integration
- **U.S. Navy:** Wave Energy Test Site (WETS) Operator
- **RG Consulting:** Marine Operations
- **Black & Veatch:** Third Party Validation and Technical Support

Program Strategic Priorities

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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

Increase MHK deployment in opportune markets

Technology Maturity

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The Impact

- Demonstrate the full-scale OE Buoy technology
- Rated capacity of 500kW
- Target average annual pneumatic performance of 131kW
- Target power take-off efficiency of 70%
- Large scale deployments of wave energy technology is possible in United States
- Grid connection of large-scale wave energy devices is possible in United States

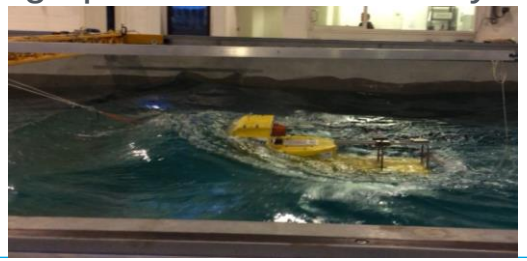
Technical Approach

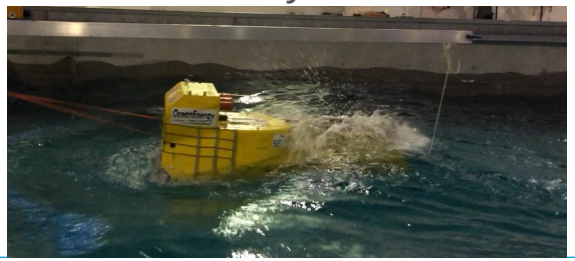
Detailed Design of System Components

- Design of large-scale wave energy structure completed using standard ship construction techniques
- Mooring system design completed to interface with WETS pre-installed system
- HydroAir turbine integration progressing—critical interface for both hull and turbine systems

Risk Reduction Strategies

- Use of recognized and competent contractors for large-scale system designs
- Third Party Validation carried out by independent entity to cross-check designs and validate approach
- Use of industry codes and standards throughout the design process
- Failure Modes, Effects and Criticality Analysis process adopted throughout design process to record key design risks and identify load cases





Technical Approach

Engagement with Component Suppliers and Supply Chain

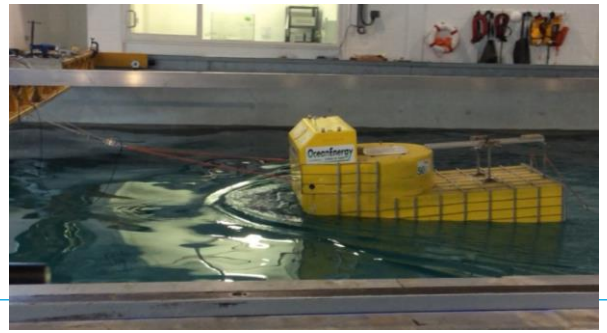
- Engagement with multiple shipyards throughout U.S. mainland and Hawaii
- Development of relationships with key suppliers to marine and hydrokinetics (MHK) market
- Engagement of supply chain in planning of novel marine operations

Advancement of State of the Art in LCOE Projections

- Completed a full bottom-up review of the power performance projections for the OE Buoy technology
- Developed methods of managing uncertainties in the combination of datasets from model tests of varying Froude scales

Development of a Novel Launch and Recovery Strategy

- Completed scale model testing of novel launching and recovery strategy to monitor stability behavior



Accomplishments and Progress

- Detailed design process nearing completion
- Preferred fabricator identified and engagement continuing on construction of hull
- Marine operations planning progressing and preferred supplier engaged for ocean towing and launching method
- Integration of HydroAir turbine nearing completion
- Financial planning to deliver Budget Period (BP) 2 being completed

Project Plan & Schedule

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- Original contract period: 8-1-15 through 2-1-19
- Go/No-Go decision point in FY16
- Proceed to BP2 in FY17

Project Budget

Budget History					
FY2014		FY2015		FY2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$0k	$0k	$45k	$11k	$456k	$114k

- The initial project plan was modified to incorporate required changes as the project evolved. These changes related primarily to sub-contractor budgets. The overall budget is unaffected.
- Additional cost share support provided by the Sustainable Energy Authority of Ireland

Research Integration & Collaboration

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Communications and Technology Transfer:

- Results will be presented at upcoming conference upon completion of project
- Many generic design-process, marine operations, and risk reduction strategies and related items will be transferrable to the wider WEC industry

Next Steps and Future Research

FY17/Current research: Initiate BP2 – Construction, System Integration, Deployment, and Operations

Proposed future research: Optimizing power performance through advanced control strategies