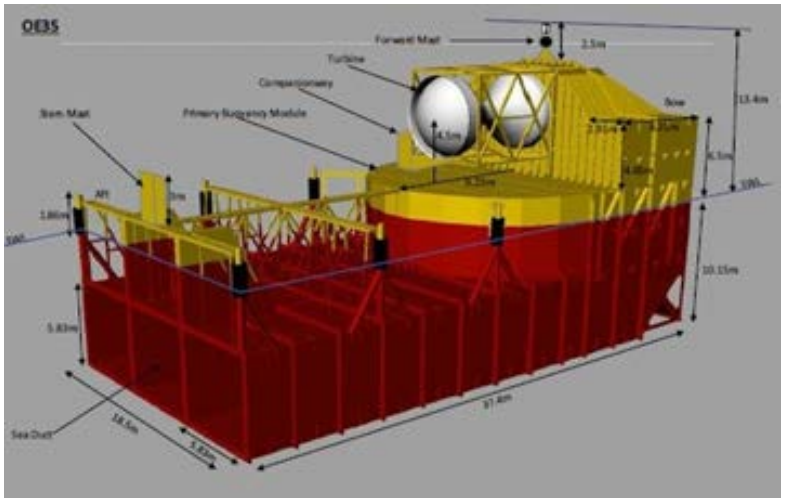


Demonstration of the Ocean Energy (OE) Buoy at US Navy's Wave Energy Test Site

CID -EE0006924

Marine and Hydrokinetics Program

Wednesday 9th October 2019

Principal Investigator

Prof. Tony Lewis CTO

Organization

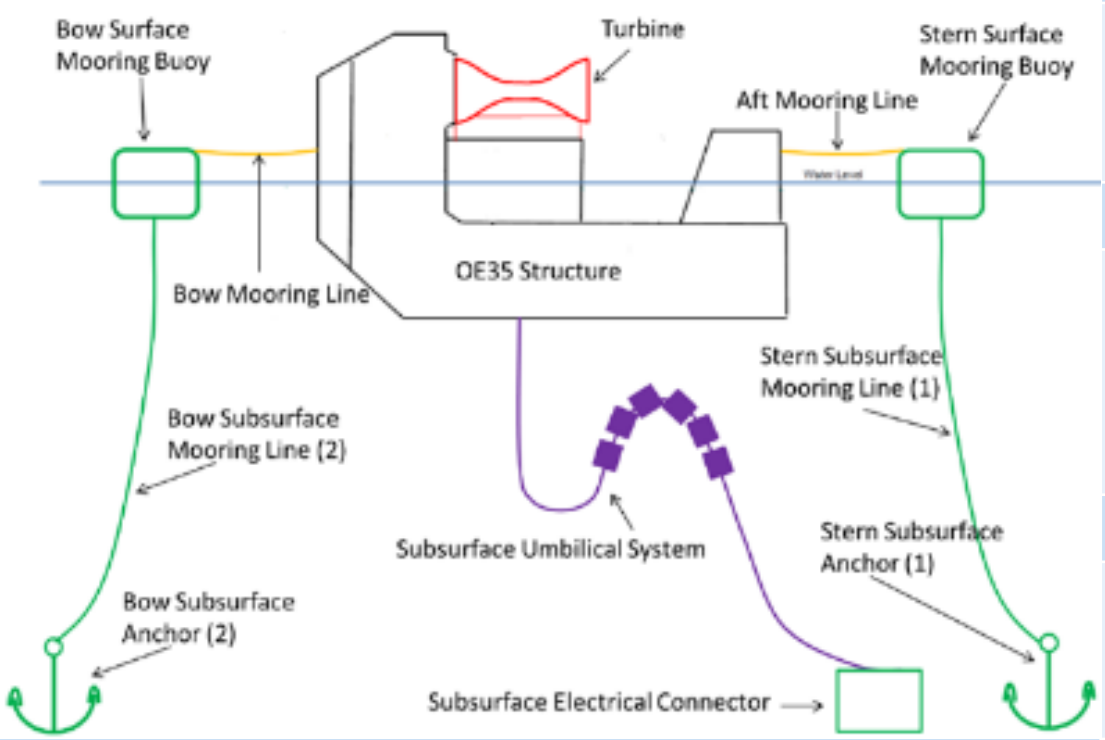
Ocean Energy USA LLC.

Project Overview (1)

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

Project Summary

The Ocean Energy (OE) Buoy is based on the floating oscillating water column which uses variability in wave height to move air through an air turbine. The turbine rotates in a single direction using high-speed air flow to generate electricity. The OE Buoy has previously been tested at 1/4 scale in real sea conditions for over 3 years. The 500kW system will be demonstrated for 12 months at near full-scale at the US Navy's Wave Energy Test Site (WETS), Hawaii.



Project Information

Project Principal Investigator(s)

Prof. Tony Lewis
Chief Technical Officer
Ocean Energy USA LLC.

WPTO Lead

Erik Mauer
Rajesh Dham

Project Partners/Subs

Siemens Government Technologies (SGT)
US Navy
Vigor
NREL

Project Duration

- Project Start Date : December 2014
- Project End Date : March 2021

Project Overview (2)

Project Objective & Impact

The key project objectives are to :

- Perform the detailed engineering
- Fabricate and test OE35 wave energy converter including Hydro-Air Turbine
- The end-product is a grid connected, large-scale, OE 35m Buoy fitted with a 500kW Siemens Government Technologies Hydro-Air turbine power take-off and electrical generation system
- Deploy & test a near full-scale deep-water floating Wave Energy Converter (WEC) at WETS to collect useful data to inform the larger MHK industry

This project will demonstrate a grid connected near full-scale WECs can be constructed using the existing supply chain in the USA.

- This machine will be the largest WEC deployed and grid connected to date in the USA and one of the largest worldwide thus demonstrating the significant progress of the USA in the Global MHK sector.
- The overall test results will confirm the commercial viability of the OE Buoy technology at a large scale and provide confidence for commercialization efforts.
- The estimated annual average pneumatic power output of 131kW and a power take-off efficiency of 70%.

The goal for this project is to collect 12 months of data from testing a near full-scale device.

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 (1)

Conduct in-water tests of near full-scale prototypes to validate performance and reliability of systems

- Demonstrate the OE buoy technology which has been validated, tested, and benchmarked against other MHK devices and has proven to be competitive with other WEC devices under development.
- Ocean Energy USA is collaborating with major industrial and research partners for construction, deployment, testing, and operations.
- The project will significantly improve stakeholder confidence in the wave energy sector in the USA.

Improve methods for safe and cost-efficient installation, grid integration, operations, monitoring, maintenance, and decommissioning of MHK technologies

Testing a near full-scale device at WETS will:

- Demonstrate safe installation, grid integration, and operations through detailed planning
- Result in significant learnings from Operation and Maintenance (O&M) for a 12-month deployment period encompassing a full range of sea state conditions at the WETS will reduce risk,
- Facilitate the collection of useful data from extensive instrumentation for O&M and effective monitoring of WEC devices.
- Improve methodology reduce risk based on experience with deployment and decommissioning.

Alignment with the MHK Program

Technology-Specific Design and Validation (2)

Support the development and adoption of international standards for device performance and insurance certification

- The monitoring system installed on the WEC is fully compliant with the requirements of the IEC Technical Specifications for Marine Renewable Energy Systems.
  - The data produced will allow provision of useful feedback for continual updating of these Specifications.
- The successful implementation of insurance coverage for the delivery and deployment of the WEC at the WETS site represents significant advancement of MHK technologies.
  - Approvals by a Marine Warranty Surveyor (MWS) will contribute to insurance certification for future MHK devices.

Project Budget

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

Total Project Budget – Award Information			
DOE	**Cost-share**	**Total**	
$10,572k	$5,934k	$16,506k	
FY17	**FY18**	**FY19 (Q1 & Q2 Only)**	**Total Actual Costs FY17–FY19 Q1 & Q2 (October 2016 – March 2019)**
Costed	**Costed**	**Costed**	**Total**
$3,357k	$3,489k	$1,743k	$8,589k

- The initial project plan was modified to incorporate required changes as the Project evolved and to facilitate a further deployment at larger capacity.
- Cost share support provided by the Irish Government through the Sustainable Energy Authority of Ireland (SEAI).

Management and Technical Approach (1)

The components of the project program cover the wide range of technical issues that are required for the successful delivery of this project. These include :

- Permitting
- Final design of OE35 Structure / Interface to SGT Hydro-Air Turbine
- Fabrication, Fitting out and Commissioning of OE35
- Moorings and Umbilical Systems Design and Fabrication
- Deployment & Installation Planning
- Operations, Monitoring and Maintenance Planning
- Deployment for 1 year at the US Navy Wave Energy Test Site, Kaneohe Bay, Oahu, Hawaii
- Data Analysis and IEC Compliance

Management and Technical Approach (2)

- The metrics used to measure progress will be based on the success of the different phases of the projects – device design, device fabrication and fit-out, deployment at the WETS site, operations for 12 months at the site, data analysis and transfer to the MHK Data Repository.

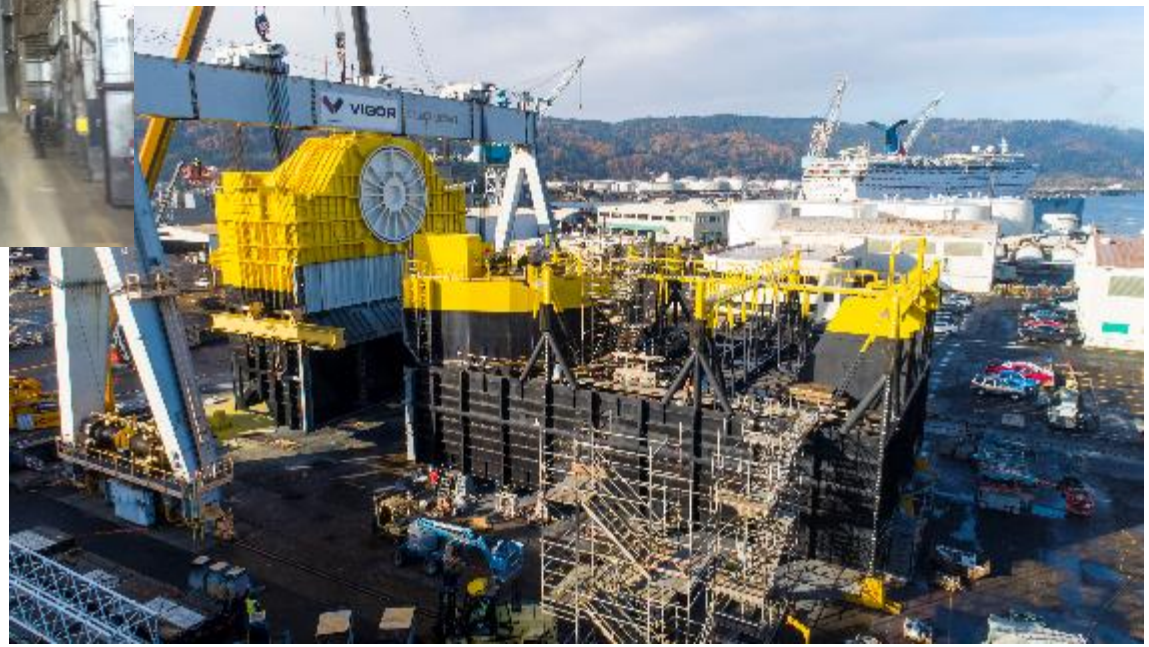
- The economic and technical metrics to be used in assessing the success at the conclusion of the project will be as follows
  - State of the art probabilistic assessment of the LCOE for the OE Buoy technology will be undertaken based on the learnings from the project operation and the data outcomes.;
  - Comprehensive bottom-up review of the performance projections for the OE Buoy undertaken at the conclusion of the project based on the recorded performance data.
  - Advanced understanding of the cost drivers for the technology of this project will follow from detailed engagement with the supply chain during the project

End-User Engagement and Dissemination Strategy

- The dissemination of the project results to date has been through presentations at industry focused Conferences both in US and Europe.
- Presentations were made in MREC in Washington in May 2017, POET in Portland in September 2017, MREC in Washington May 2018, OREC in Portland in September 2018.
- Presentations were made at MRIA in Dublin February 2017, 2018 and 2019, ICOE in Cherbourg in May 2018 & Ocean Energy Europe Industry Days in Brussels in March 2019.
- Future results will continue to be disseminated through International Conferences as well as through publications in Peer Reviewed Journals.

Technical Accomplishments (1)

- A suitable steel shipyard fabricator was identified – Vigor, Portland and a contract agreed for the construction of the OE35 device hull. The fabrication of the OE35 hull has been completed



Technical Accomplishments (2)

- The Hydro-Air turbine has been fabricated and fitted by SGT. The electrical power control and power quality conditioning system has been designed and installed by SGT to conform to the HECO grid compatibility requirements.

Technical Accomplishments (2)

- The design and fit-out of all ancillary systems – safety and alarm system, System Control and Data Acquisition (SCADA) System and the instrumentation suite electrical grid interface including 11.5kV transformer and disconnect, fiber data system for transmission of data to shore, has been completed and tested.

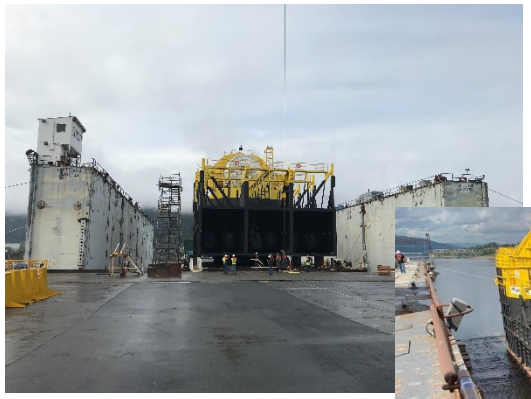
- The overall system has been End to End tested by simulating the WETS grid connection and operation and full commissioning has been completed by motoring the turbine and supplying 11.5kV through the umbilical deck cable.

- The system is now ready for load out and tow to Hawaii.

- The umbilical cable design has been completed and the umbilical has been shipped to Hawaii in advance of installation at the WETS site. The mooring system at WETS has been upgraded by the US Navy and the mooring hawser ropes for the OE35 have been procured and delivered to Hawaii.

Progress Since Project Summary Submittal

- The OE35 device - fully commissioned by 9th October
- The OE35 device was loaded out & launched on 29th September
- The device will be on tow to Hawaii on 15th October
- https://youtu.be/ZqNu69B6Sus



Future Work

• Tow to Pearl Harbor Hawaii	15th Oct. 2019
• Device preparation for deployment at WETS	10 - 15th Nov. 2019
• Device deployment at WETS (weather dependent)	16 - 19th Nov. 2019
• Operational at WETS	20th Nov. 2019 – 19th Nov. 2020
• Ongoing data collection	20th Nov. 2019 – 19th Nov. 2020
• Live operational testing to optimize control	20th Nov. 2019 – 19th Feb. 2020
• Autonomous operation	20th Feb. 2020– 19th Nov. 2020
• Device decommissioning	20th Nov. 2020
• Data Analysis and Reporting	20th Nov. 2019 - 31st Mar. 2021

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