



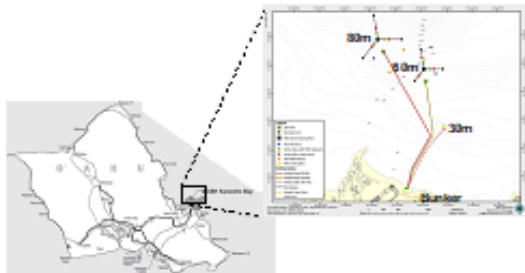
Hawai'i Natural Energy Institute Research Highlights

Ocean Energy

Research Support to the U.S. Navy Wave Energy Test Site

OBJECTIVE AND SIGNIFICANCE: Wave energy has the potential to address global renewable energy goals, yet it poses daunting challenges related to commercializing technologies that must produce cost-competitive electricity while surviving an energetic and corrosive marine environment. The nascent commercial wave energy sector is thus critically dependent on available test infrastructure to advance development of wave energy conversion (WEC) devices and related technologies. For this reason, the U.S. Navy established the Wave Energy Test Site (WETS) in the waters off Marine Corps Base Hawai'i (shown below) as the United States' first grid-connected site, completing the buildout in mid-2015. WETS consists of test berths at 30m, 60m, and 80m water depths, and can host point absorber and oscillating water column (OWC) devices to a peak power of 1 MW.

HNEI provides key research support to this national effort in the form of environmental monitoring, independent WEC device performance analysis, and critical marine logistical support. The results achieved at WETS have far reaching impacts in terms of advancing wave energy globally.



BACKGROUND: Wave energy has enormous potential to supply persistent power to these non-grid-connected applications, as well as to aquaculture, at-sea mineral scavenging, and providing renewable power to remote or island communities. Through a cooperative effort between the Navy and the U.S. Department of Energy (DOE), WETS hosts companies seeking to test their pre-commercial WEC devices in an operational setting. HNEI works with the Navy and DOE to directly support WEC testing at WETS in three key ways: 1) *environmental impact monitoring* – acoustic signature measurement and protected species monitoring; 2) *independent WEC device performance analysis*, including wave forecasting and monitoring, power matrix

development (power output versus wave height and period), numerical hydrodynamic modeling, and a regimen of regular WEC and mooring inspections; and 3) *logistics support*, in the form of past funding to modify a site-dedicated support vessel for use at WETS, through local partner Sea Engineering, Inc., assisting WEC developers with deployment planning and through funding to developers for maintenance actions during their WEC deployments at the site.

In Summer 2021, NAVFAC granted HNEI an additional \$6M to continue this core support to WETS, and to expand research related to smaller-scale WECs for offshore, non-grid-connected applications of wave energy. This includes: 1) examining the potential for existing WETS infrastructure to support the creation of an offshore test and demonstration node, including subsea power storage as well as communications and power interfaces that would allow small WECs to power applications such as autonomous undersea vehicle (AUV) recharge, environmental/environmental sensing, and navigation; 2) design of an AUV docking/charging station for WETS; 3) development of a power generation and management system for a floating OWC device of UH design for applications such as ocean observation and AUV recharge; 4) advancement of a novel breakwater system with integrated OWC power generation; and 5) concept development of a floating flap-type WEC.

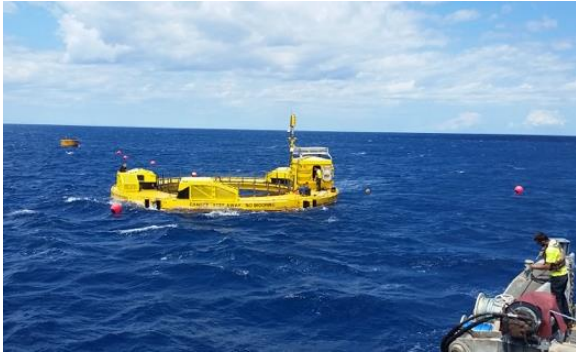
In Summer 2022, an additional \$3.6M was awarded by Navy to further extend core support to WETS, including key infrastructure upgrades/maintenance.

PROJECT STATUS/RESULTS: Since mid-2015, the following major activities have occurred at WETS, with HNEI in both supporting and leading roles:

- Jun 2015 to Dec 2016: Northwest Energy Innovations deployed Azura device at 30m berth.



- Mar 2016 to Apr 2017: Sound and Sea Technology deployed Fred. Olsen Lifesaver at 60m berth. This project was not grid-connected.



- May/June 2019: HNEI led a major redesign and reinstallation effort for the WETS deep berth moorings. 60m berth was reinstalled, 80m berth repairs held, subject to WEC developer demand.



- Feb to Aug 2018: HNEI led a second deployment of Azura, with modifications designed to improve power performance, including enlarging the float and adding a heave plate at the base.



- Nov 2019: Completion of site-dedicated support vessel Kupa'a by research partner Sea Engineering, Inc. This vessel adds significantly to our ability to perform various functions at WETS.



- Oct 2018 to Mar 2019: HNEI led effort to redeploy Lifesaver at 30m with modifications to moorings and integration of UW sensor package and subsea charging capability, which drew its power from the WEC itself. This use of wave energy to power an offshore sensing suite was an important national first.



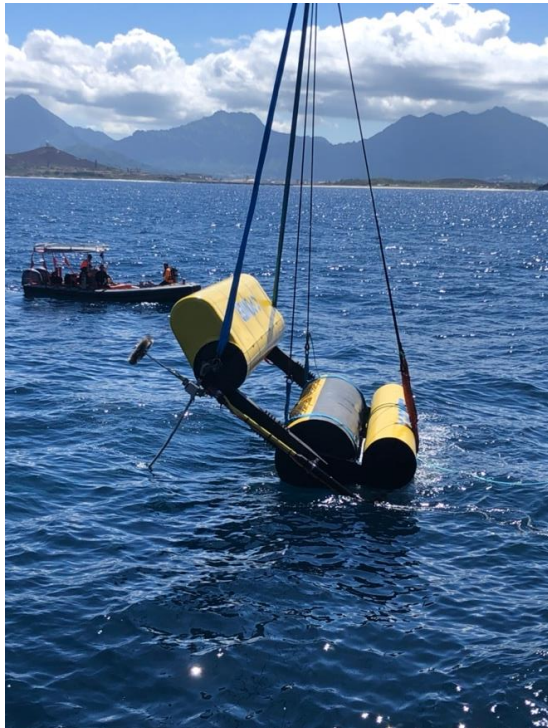
Issues stemming from COVID, funding, and technical challenges have substantially delayed planned WEC deployments over the past few years, but three deployments are currently happening, or planned in the coming year:

1. Deployment of the Oscilla Power (Seattle) Triton-C community-scale WEC at the 30m berth. This device arrived in Hawai'i in October 2021. New anchors were deployed at the WETS 30m berth in support of this project, with work complete in August 2022, and a new electrical/data junction box was installed in

September 2023. The latest expectation for deployment of the device is late fall 2023.



2. Deployment of the C-Power SeaRay WEC. This is a stand-alone (not grid-connected) deployment of a small, 1kW device that will feed power to a subsea acoustic sensing system from Biosonics, as well as other environmental sensors. The device was deployed at WETS in early October 2023, but suffered some early damage and will need to be redeployed at a future date.



3. Deployment of the Ocean Energy (Ireland) OE35 WEC at the 60m berth. This device has been in Hawai'i since December 2019, and underwent drydock repairs in Aug/Sep 2022, after extensive delays. It is currently undergoing replacement of key electrical components, and final testing, and should be ready for deployment to WETS in late 2023 or early 2024.



Funding Sources: Naval Facilities Engineering Command, Expeditionary Warfare Center; U.S. Department of Energy

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