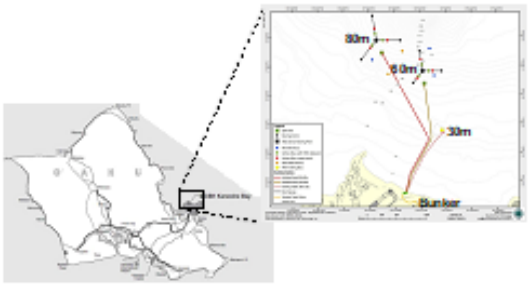
Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

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

OBJECTIVE AND SIGNIFICANCE: Wave energy has potential to address global renewable energy goals, yet it poses daunting challenges related to commercializing technologies that must produce cost-competitive electricity while surviving the 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: 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 $6 million 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 will include: 1) an examination of 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 and data upload, environmental sensing systems, ocean observation, and navigation; 2) design of an AUV docking and 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, navigation, and AUV recharge; 4) advancement of a novel breakwater system with integrated OWC power generation; and 5) concept development of a nearshore, small-scale, rapidly deployable WEC for power generation and/or seawater desalination. 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.

PROJECT STATUS/RESULTS: Since mid-2015, the following major activities have occurred at WETS, with HNEI in both supporting and leading roles. Photos depicting the events are provided under each bullet:

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

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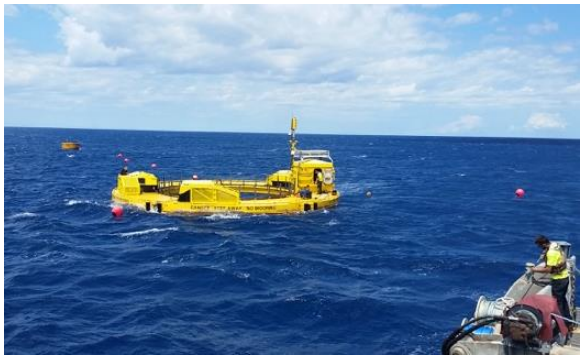
- Sound and Sea Technology deployed Fred. Olsen Lifesaver at 60m berth – Mar 2016 to Apr 2017. This project was not grid-connected.



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

- 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 – Oct 2018 to Mar 2019. This use of wave energy to power an offshore sensing suite was an important national first.

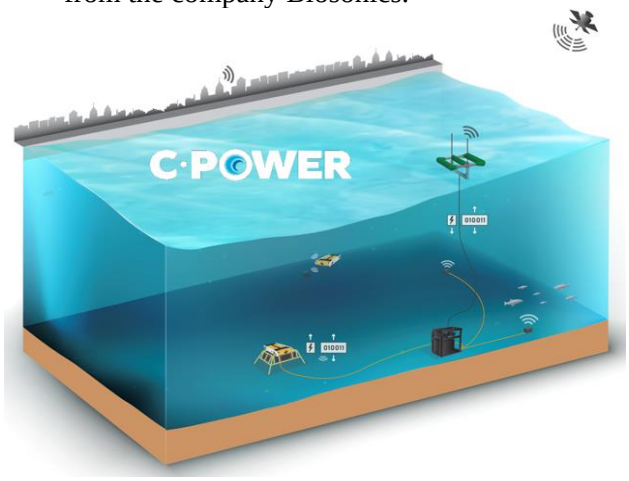
- Completion of site-dedicated support vessel Kupa‘a , by research partner Sea Engineering, Inc. – November 2019. This vessel adds significantly to our ability to perform various functions at WETS.

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

Several activities are 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, and will be deployed to WETS upon completion of site upgrades, including the installation of new anchors and a new electrical/data junction box. Pending weather availability for these operations and for the deployment itself, the Triton-C should deploy in early spring 2022.

2) Deployment of the C-Power SeaRay WEC. This will be a stand-alone (not grid-connected) deployment of a small, 1kW, device that will feed power to a subsea acoustic sensing system from the company Biosonics.



3) Deployment of the Ocean Energy (Ireland) OE35 WEC at the 60m berth. This device has been in Hawai‘i since December 2019, but must undergo repairs in drydock prior to deployment. These repairs have been delayed by various issues, including travel restrictions related to COVID-19.

Looking ahead, we expect WEC deployments from C-Power (a larger device called StingRay), Northwest Energy Innovations (a much larger version of Azura), and Oregon-based Aquaharmonics – in the 2023-2025 timeframe.

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

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