Hawai‘i Natural Energy Institute Research Highlights

Grid Integration & Renewable Power Generation

The Hawai‘i Wave Surge Energy Converter (HAWSEC)

OBJECTIVE AND SIGNIFICANCE: The objective of the Hawai‘i Wave Surge Energy Converter (HAWSEC) project is to mature a WEC concept developed by the HNEI led team, that could ultimately produce cost-effective renewably generated electricity for coastal communities. The project is expected to make important advances in the emerging wave energy field and has the potential to mature a technology with realizable commercial potential in the future – for Hawai‘i, the U.S., and beyond.

BACKGROUND: HNEI has been involved in supporting research and testing objectives at the U.S. Navy’s Wave Energy Test Site (WETS), off Marine Corps Base Hawai‘i, since 2010, with funds from both the U.S. Department of Energy (DOE) and the U.S. Navy (Naval Facilities Engineering Command – NAVFAC). Through this involvement, HNEI has gained valuable practical experience associated with real-world deployment and operation of WECs in this first-of-its-kind in the U.S. grid-connected test site. Additionally, through numerical modeling of WEC dynamics and mooring systems in support of WETS test objectives and WEC developers, HNEI has accumulated key design insights and numerical modeling experience related to WEC design.

The HAWSEC concept is based on the oscillating wave surge energy converter (OWSC), or flap-type, WEC. Such systems rely on the surge motion of the waves close to shorelines, where wave direction becomes more consistent than offshore. The flap moves back and forth in the waves and drives hydraulic cylinders to pump water through a hydro turbine to generate electricity. Its inherent scalability could support smaller-scale generation for isolated communities or islands, or larger-scale devices (likely deployed in arrays) to generate power to feed into coastal power grids. A rendering of our conceptual flap is shown below. We will explore both a high-head/low-flow and a low-head/high-flow hydraulic system, utilizing the same flap, in the first half of the project, ultimately settling on an optimized configuration (with a hydro turbine selected to best align with the optimized head and flow) before scaling up for additional testing in the latter stages of the project.

Figure 1. Rendering of the HNEI HAWSEC system.

HAWSEC development is proceeding along the following broad set of tasks:

1) Numerical modeling of small-scale version, nominally a 1m x 1m flap, to optimize design;
2) Fabrication and local testing of the small-scale system – both the hydraulic system and the flap itself in nearshore waters on O‘ahu;
3) Controlled tank testing of the small-scale system at Oregon State University’s (OSU) Hinsdale wave basin;
4) Validation of numerical modeling with test results from OSU;
5) Numerically scaling up to medium scale, nominally a 3m x 3m flap, and completing a buildable design of the HAWSEC at this scale;
6) Undergoing a Go/No-Go decision with DOE;
7) Fabrication of a full medium-scale system, including flap and hydraulics;
8) Controlled tank testing of the medium-scale device at the University of Maine’s test flume; and
9) Validation of medium-scale numerical models with test data from Maine, and modeling and performance prediction for a full-scale version of HAWSEC.

PROJECT STATUS/RESULTS: This nominally three-year project was initated in August 2020. Task 1 numerical modeling is complete, and the smaller-scale flap system has been designed and fabricated. A hydraulic bench test setup has been largely procured and will be set up in our lab on the UH campus in late 2021. Nearshore testing of the flap in local waters (at Makai Research Pier) has been approved and will also take place in late 2021.

Substantial procurement challenges – some associated with COVID-related supply chain issues – have delayed this timeline considerably, and we now expect to be testing in the wave basin at Oregon State University in March 2022. Results from this testing will be crucial in validating numerical models at the smaller scale and scaling these results up to a larger-scale device for subsequent testing. The first budget period in the project will conclude with a final design for the larger-scale WEC, which will be built and tested in the second budget period, subject to approval by DOE.

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