U.S. Navy Wave Energy Test Site (WETS)

Projects to Date

NWEI Azura
6/15 – 12/16

Modified Azura
2/18 – 8/18

Fred. Olsen
Lifesaver
3/16 – 4/17

Lifesaver w/UW AMP Integration
10/18 – 3/19

Intro for National Shipbuilding Research Program

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Projects Ahead

Oscilla Power
C Power
Aquaharmonics
NWEI Grid Scale

Up Next – Ocean Energy
In Hawaii – to WETS in Spring
Wave Energy Intro

• “Recoverable” resource is vast
  • 1170 TWh/year nationally*
  • 80 TWh/year in Hawaii*

• Challenges abound
  • Large devices/deployment challenges
  • Marine environment/survivability/serviceability
  • Cabling to shore
  • Cost of energy (LCOE) numbers remain daunting

• At-sea testing is essential, but costly, with limited permitted, grid-connected venues in the world
  • European Marine Energy Center in Orkney Islands, Scotland
  • Navy’s Wave Energy Test Site (WETS) in Hawaii – first grid-connected site in US

• Not yet close to commercialization
  ➢ Efforts at WETS of high interest globally

* EPRI Report
What does a wave energy conversion (WEC) device look like?
Wave Energy – An Opportunity for the Shipbuilding Industry?
WETS Layout

Cable Capacity
30m Berth – 250kW
60/80m Berths – 1MW
HNEI Core Research Support to WETS

Wave Measurement

Performance assessed in accordance with IEC Technical Specification 62600-100

Power Matrix Development

Device and Mooring Numerical Modeling

Global to Local Wave Modeling/Hindcasting

100m Grid
Acoustic Data Collection

- Device acoustic signatures
  - Bottom-mounted and drifting hydrophone systems
- Sediment transport
- Ecological surveys
- Protected marine species monitoring

![Image of acoustic data collection](image)

![Graph showing PSD vs frequency](graph)

- Low-frequency limit (~ 20 Hz)
- High-frequency limit (~ 3 kHz)

- 20 m stand-off
- 100 m stand-off
- 800 m stand-off (equal depth)
- 100 m stand-off

PSD [dB re 1/µPa²/Hz]

Frequency [Hz]
WETS Support Vessel – Kupa’a
(Sea Engineering, Inc.)

- 85 foot LOA
- 4-point mooring capability
- 10-ton A-frame lift capacity
- Knuckle-boom crane
- Deepwater dive spread
- ROV launch capability
- Reconfiguring w/adder beam
- To be kept at boat harbor ~ 1hr away

Super Mohawk ROV
Added heave plate at base of device

Device motions (relative between spar and float) matched numerical predictions well, but PTO was unable to respond to the higher torque, high frequency oscillations.
Fred. Olsen Lifesaver – 2\textsuperscript{nd} Deployment at WETS

Motivations
- Address mooring issues from 1\textsuperscript{st} deployment
  - PTO riser elasticity
  - Storm mooring hawser tension
- Use WEC electricity to power UW AMP and WiBotic subsea charging capability
Deep Berth Mooring Upgrades

Installed 2014

Installed 2019
Surface Float Hardware

Customized padeye/weld

U-link to address bending stresses
60m Berth Repairs – May/June 2019

Crane Barge – Healy Tibbits

Pull Test

No-WEC Hawser Install
WEC Development Projects at UH/HNEI

**Hawaii Wave Surge Energy Converter**
- OWSC (flap) WEC with novel electric PTO
- DOE-funded FOA award
- Will test at 2 scales

**Nalu e Wai (waves into fresh water)**
- Concept and Design winner in DOE Waves to Water competition
- OWSC-based desalination
- Compact (ships in 1m³ container), rapidly deployable
- Seeking funds to develop and test prototype

**Halona**
- Free-floating or fixed OWC
- Intended for recharge of AUVs
- Tank testing of 1/10-scale at OSU just completed
## WETS Testing Summary

<table>
<thead>
<tr>
<th>Project</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Fred. Olsen Bolt Lifesaver (60m)</td>
<td>Mar 2016 – Apr 2017</td>
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<tr>
<td>Modified NWEI Azura (30m)</td>
<td>Feb – Aug 2018</td>
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<tr>
<td>Bolt Lifesaver Redeployment (30m)</td>
<td>Oct 2018 – Mar 2019</td>
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<tr>
<td>C-Power SeaRay</td>
<td>~ Nov 2021 (6 months)</td>
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<tr>
<td>Oscilla Power (30m)</td>
<td>~ Nov 2021 (1 year)</td>
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<tr>
<td>Ocean Energy OE-35 (60m)</td>
<td>~ Apr 2022 (1 year)</td>
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<tr>
<td>C-Power StingRay</td>
<td>~ Fall 2022 (1 year)</td>
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<tr>
<td>AquaHarmonics (30m)</td>
<td>~ Fall 2022 (1 year)</td>
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<tr>
<td>NWEI grid-scale Azura (60m)</td>
<td>~ Apr 2023 (1 year)</td>
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</tbody>
</table>
Upcoming Deployments at WETS

Oscilla Power

C-Power SeaRay, powering Biosonics acoustic Package and SAAB Sabertooth charging station

Ocean Energy

OE35 in Hawaii
Questions?

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