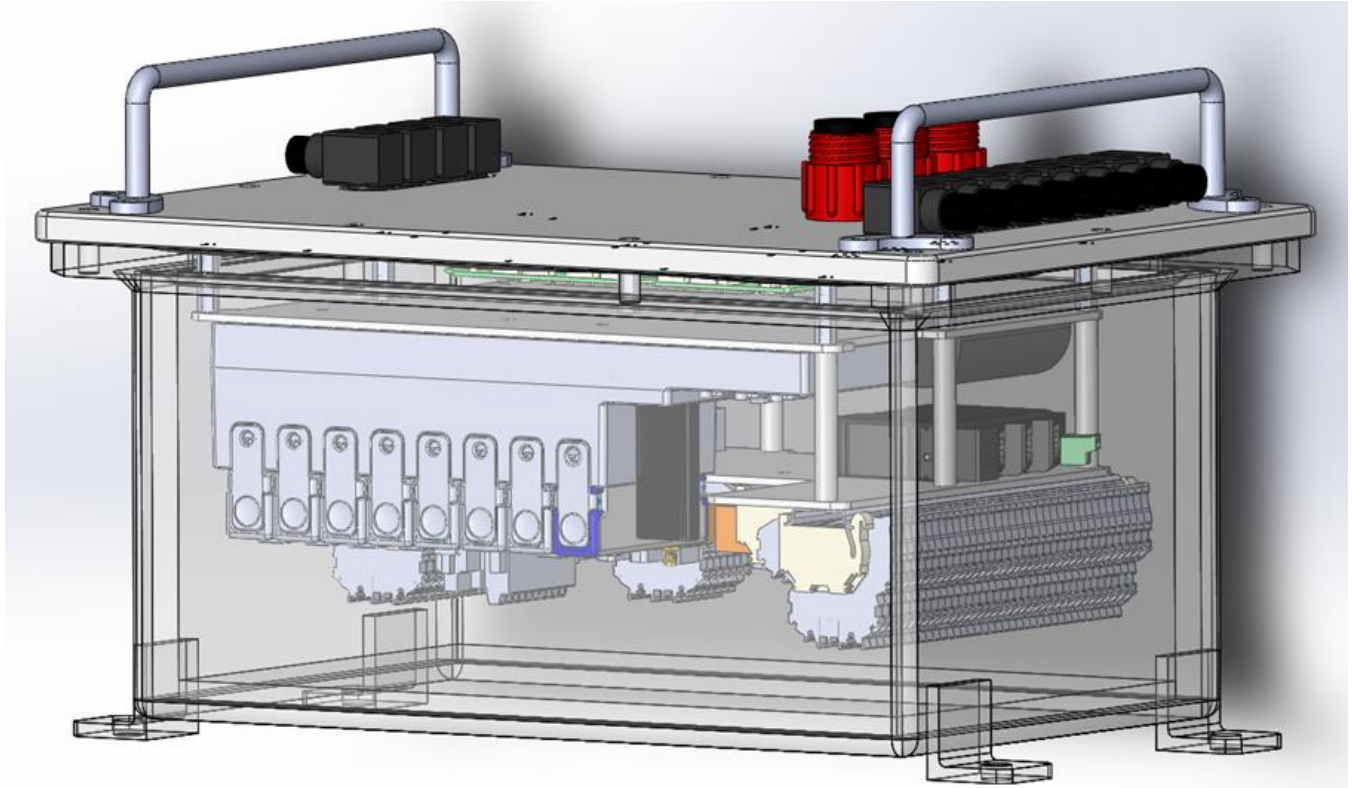


Modular Ocean Instrumentation System, third-generation system

Modular Ocean Instrumentation System (MOIS)

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Project Overview

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

Modular Ocean Instrumentation System (MOIS) Goals:

Develop or purchase an instrumentation package for on-device testing of MHK renewable energy devices, including tidal and wave energy devices. System should collect measurement data to characterize device performance, validate model and analysis codes, assess and improve IEC technical specifications, and develop MHK device testing methodology.

The Challenge: In-water deployments of MHK devices is expensive and time consuming. Device testing/validation should be rigorous, learning as much as possible during the time at sea.

Partners: Northwest Energy Innovations, wave energy converter (WEC) developers, testing partners for MOIS

Increase MHK Deployment in Opportune Markets

Technology Maturity

- **Test and demonstrate prototypes**
- Develop cost-effective approaches for installation, grid integration, and operations and maintenance
- Conduct R&D for innovative MHK systems & components
- Develop tools to optimize device and array performance and reliability
- Develop and apply quantitative metrics to advance MHK technologies

Deployment Barriers

- Identify potential improvements to regulatory processes and requirements
- Support research focused on retiring or mitigating environmental risks and reducing costs
- Build awareness of MHK technologies
- Ensure MHK interests are considered in coastal and marine planning processes
- Evaluate deployment infrastructure needs and possible approaches to bridge gaps

Market Development

- Support project demonstrations to reduce risk and build investor confidence
- Assess and communicate potential MHK market opportunities, including off-grid and non-electric
- Inform incentives and policy measures
- Develop, maintain, and communicate our national strategy
- Support development of standards
- Expand MHK technical and research community

Crosscutting Approaches

- Enable access to testing facilities that help accelerate the pace of technology development
- Improve resource characterization to optimize technologies, reduce deployment risks, and identify promising markets
- Exchange data information and expertise

Increase MHK Deployment in Opportune Markets

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The Impact

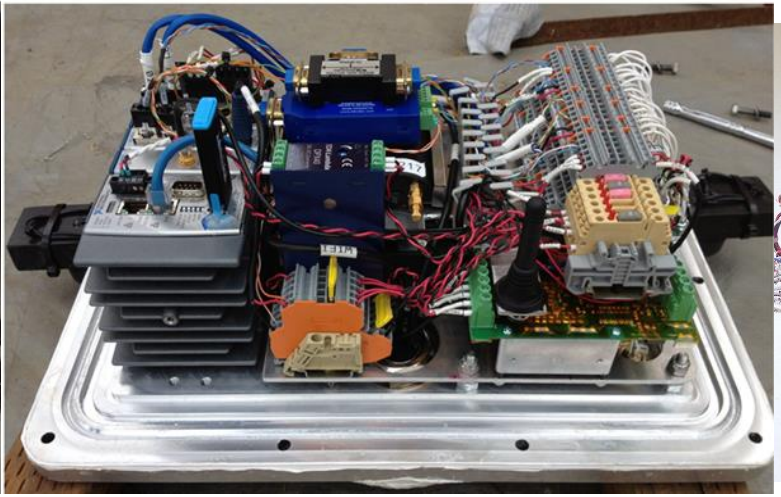
- Develop/purchase instrumentation packages that are readily fitted to MHK devices, including wave and tidal
- Evaluate MHK devices using common instrumentation suite, regardless of technology
- Characterize MHK device performance
- Validate modeling and analysis codes
- Test devices to IEC technical specifications
- Develop and refine testing methodologies for MHK devices

Technical Approach

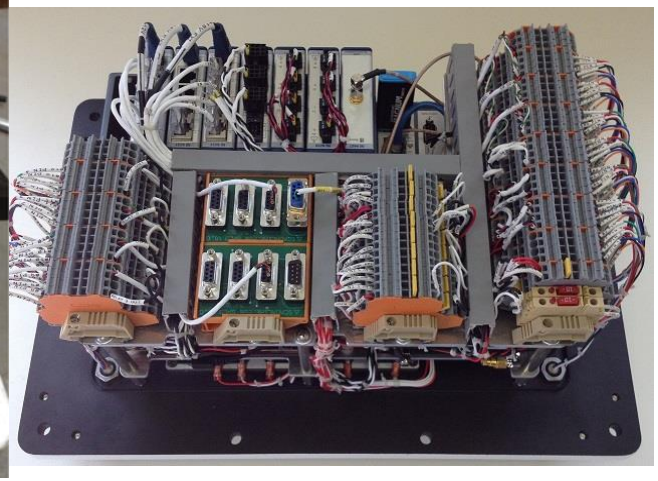
MOIS's capabilities for testing MHK devices has evolved by using at-sea deployments for development feedback and system readiness checks.



Gen 1



Gen 2



Gen 3

Photos Eric Nelson, NREL

- Utilized at-sea testing to gain feedback for subsequent MOIS designs
- Improved capabilities on each generation: channel count, sample rate, remote administration, and self monitoring
- Deployed MOIS Gen 2 system at sea in May 2015 on the WEC Azura; still deployed presently and continuously collecting measurement data
- Completed MOIS Gen 3 system in FY15 with designs and manuals uploaded to the MHK Data Repository

Open Ocean Testing of WEC Azura at U.S. Navy's WETS Facility

Northwest Energy Innovations tests and evaluates the half-scale WEC Azura, 30-m test site. Gen 2 MOIS hardware was deployed on May 31, 2015. On-device measurements are compared to WEC-Sim device model results in plots.

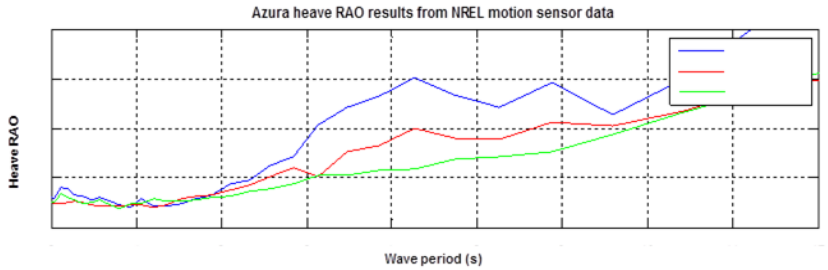


Image Brad Ling, NWEI

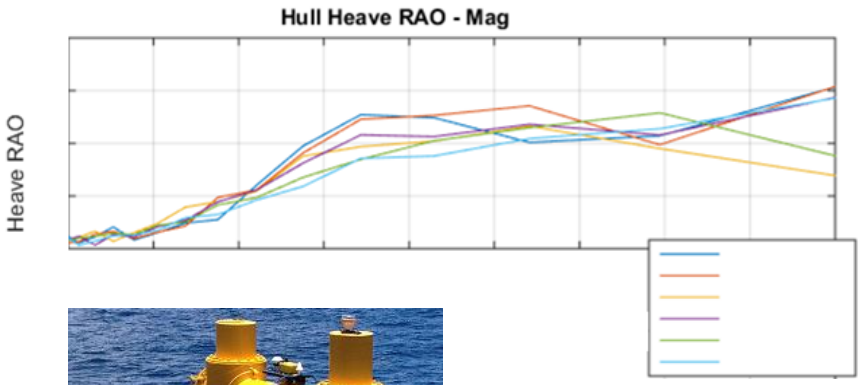
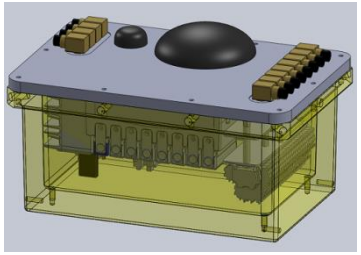




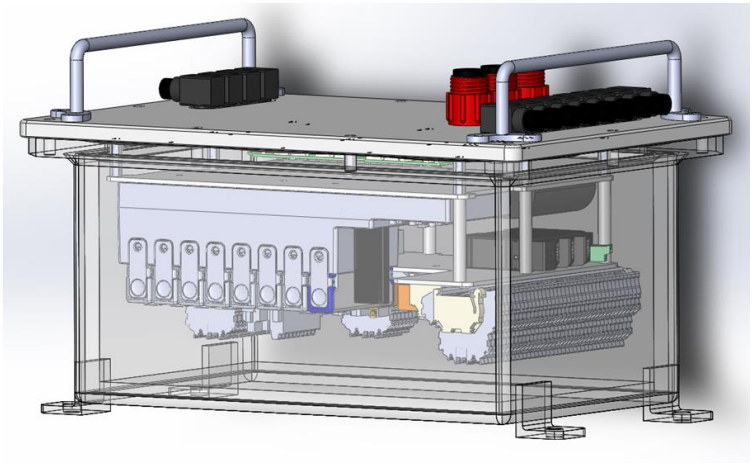
Photo Steve Kopf, NWEI



Photo Steve Kopf, NWEI



MOIS Gen 3 System Completed



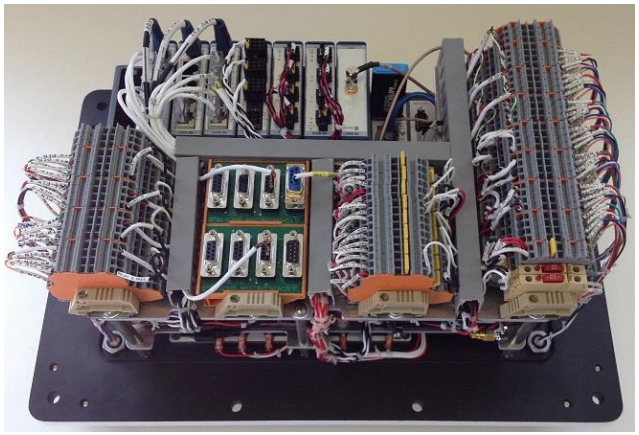


Photo Eric Nelson, NREL

- Increased channel count, sample rate, and measurement types are supported
- Has less power consumption compared to earlier generations
- Can be submerged more than 80-m deep
- Has remote antennae ports for GPS, Cell, and WIFI communications
- Can store up to 500 GB of data onboard
- User and software manuals are available

Project Plan and Schedule

- FY14: MOIS Gen 2 preparation for deployment at sea
- Go/no-go FY14: schedule delays for WEC Azura, given a go
- FY15: MOIS Gen 2 installed on WEC Azura (at sea May 2015)
- FY15: MOIS Gen 3 completed, built, and documented
- FY16: Azura deployment planned to end in FY16 but was extended due to ongoing deployment of WEC Azura at the U.S. Navy's WETS facility in Hawaii
- January 2017: WEC Azura retrofit with next generation float and other hardware at WETS is scheduled

Project Budget

Budget History					
FY2014		FY2015		FY2016	
DOE	Cost Share	DOE	Cost Share	DOE	Cost Share
$101K	N/A	$186K	N/A	$36K	N/A

- Project spending was slowed in Q3 FY14 due to schedule delays in the deployment of WEC Azura at WETS (MOIS Gen 2 equipment on WEC)
- Finalized build of Gen 3 MOIS system in Q2 FY15
- WEC Azura installed at WETS in May 2015
- WEC Azura deployment was extended, resulting in funds that were originally planned for decommissioning to be used for ongoing testing operations
- All funds for project have been spent

Research Integration & Collaboration

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Partners, Subcontractors, and Collaborators:

- Northwest Energy Innovations is using MOIS's measurements for model validation analysis on their Azura WEC device.
- Hawaii Natural Energy Institute (University of Hawaii) is using data from MOIS for real-time location monitoring of the Azura WEC and also helping with data management of MOIS.
- Columbia Power Technologies and Big Moon Power are utilizing MOIS components for their tests.

Communications and Technology Transfer:

- MOIS design documents have been uploaded to the DOE MHK Data Repository for public use.
- The MOIS CAD models and software have been uploaded.
- The user manual and software development manuals are included.
- Project CAD and software are at https://mhkdr.openei.org/submissions/64.
- **Outcome:** Project documents downloaded 250+ times.

Next Steps and Future Research

FY17/Current Research:

- The MOIS project transitioned in FY16 from a development to a mission-readiness effort. The remaining funds were moved to Testing Facilities and Capabilities at NWTC in FY17.
- MOIS will remain on WEC Azura with measurements for evaluating updated device performance in FY17 at WETS

Proposed Future Research:

- Maintain equipment and instrumentation for use in testing MHK devices in the water
- Support DOE demonstrations of full-scale devices at sea