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Office of
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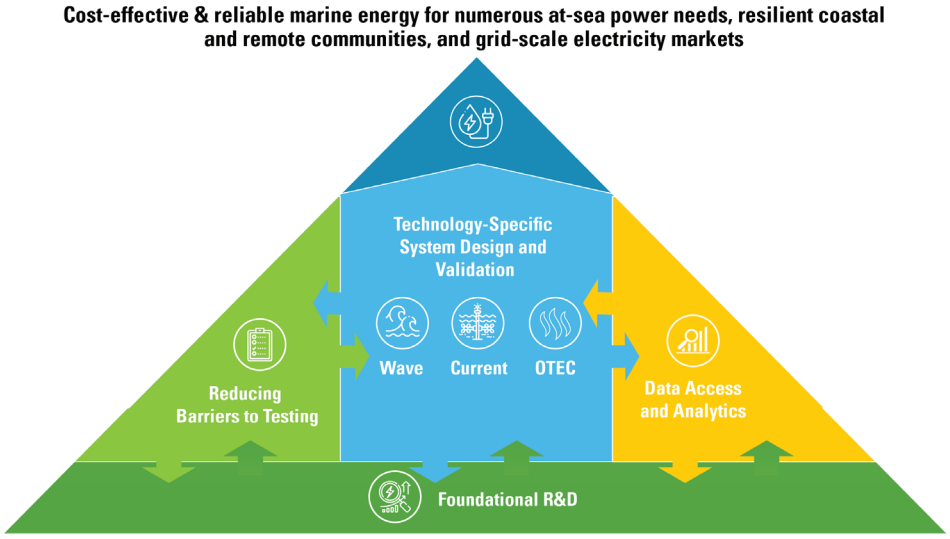
RENEWABLE ENERGY

Marine and Hydrokinetics Program's 2019–2020 Accomplishments Overview

Marine energy technologies are at an early stage of development because of the fundamental challenges of generating power from a dynamic, low-velocity, and high-density resource while withstanding corrosive marine environments. These challenges are intensified by high costs and lengthy permitting processes associated with in-water testing.

The vision of the Water Power Technologies Office's (WPTO) Marine and Hydrokinetics (MHK) Program is a U.S. MHK industry that expands and diversifies the nation's energy portfolio by responsibly delivering power from ocean and river resources. To help realize this vision, the MHK Program conducts transformative early-stage research that advances the development of reliable, cost-competitive MHK technologies and reduces barriers to testing.

This document highlights MHK Program successes, organized by activity area, from 2019–2020. To learn more about these projects and their accomplishments, please see the full WPTO 2019–2020 Accomplishments report[1]. For more information on WPTO's MHK Program, visit the WPTO website[2] and subscribe to the office's Water Wire newsletter[3].



WPTO Marine and Hydrokinetics Program Strategic Organization.
Source: Water Power Technologies Office

Activity Areas Overview

The MHK Program comprises four core research and development (R&D) activity areas and one initiative that represent the program's strategic approaches to addressing the challenges faced by the U.S. MHK community.

Powering the Blue Economy™: WPTO formally launched the Powering the Blue Economy™ initiative in 2019 following an analytically-driven process focused on near-term end-user needs to understand the potential for using marine energy within the blue economy. The program is strategically growing a portfolio of investments to accelerate development and deployment of marine energy technologies, which includes supporting foundational research; providing access and upgrades to testing assets; developing an entrepreneurial ecosystem; and fostering partnerships with government and private sector end-users.

Reducing Barriers to Testing: Enable access to open-water, grid-connected, and non-grid connected testing facilities; support environmental monitoring technologies, tools, and data collection to understand potential environmental risks and reduce costs.

Foundational Research and Development: Drive early-stage R&D on components, controls, manufacturing, and materials; develop numerical modeling tools; improve resource assessments and characterizations; develop quantitative metrics to evaluate devices' potential.

Technology-Specific System Design and Validation: Validate performance and reliability of marine energy systems through prototype and in-water testing; improve cost-effective methods for installation, operations, and maintenance; and support development and adoption of international standards for device performance and insurance certification.

Data Access and Analytics: Improve access to and use of data, tools, and science, technology, engineering, and mathematics (STEM) resources to increase awareness of MHK technology advances and lessons learned; reduce cost, time, and uncertainty for marine energy permitting; and develop a skilled marine energy workforce.

[1]https://www.energy.gov/eere/water/water-power-technologies-office-accomplishments-2020
[2]https://www.energy.gov/eere/water/marine-energy-program
[3]https://www.energy.gov/eere/water/water-wire

PROJECT HIGHLIGHTS

Powering the Blue Economy

WPTO Prize Unveils 17 Promising Wave-Powered Desalination Designs: The first prize to launch under WPTO's Powering the Blue Economy initiative, the Waves to Water prize is a five-stage prize to accelerate the development of small, modular, wave-powered desalination systems capable of providing potable drinking water in disaster relief scenarios and remote coastal locations. Since its launch in 2019, the prize has attracted more than 120 submissions from teams across the nation—with the DESIGN stage supporting winning concepts such as modular systems pairing reverse osmosis technology with wave-energy harvesting solutions, and double moored point absorber wave energy converters to drive onboard desalination devices.

First Round of WPTO-NOAA Prize Engages over 60 Teams, Challenges Competitors To Improve Hurricane Monitoring Technology: The Ocean Observing Prize was designed to incentivize the development of marine energy powered, self-charging ocean observing platforms and has thus far seen idea submissions from 55 teams across academia and the private sector. A range of innovations have been identified, such as a self-charging light-weight power, data, and sensor node for buoys used in both ocean observing and aquaculture applications, a mobile wave energy platform that provides power for oceanographic sensors, and autonomous underwater vehicles.

New WPTO-Led Initiative Drives Marine Energy as a Future Enabler of Growth in the Blue Economy, New Scientific Discovery, and Resilient Communities: Representing the suite of sustainable ocean-based economic opportunities that can lead to commercial growth, improved livelihoods, and new jobs while preserving the health of ocean ecosystems, the blue economy is a space of increasing focus for WPTO. Launched in 2019, WPTO's Powering the Blue Economy initiative has since made more than 85 awards to industry and academia and built new partnerships to catalyze innovation in marine energy and connect more closely with future customers and end-users in the blue economy.

First-Ever Marine Energy Collegiate Competition Engaged 100+ Students across Diverse Disciplines: In its inaugural year, the 2020 Marine Energy Collegiate Competition challenged university students from across the country to propose technical solutions and business cases for marine energy to serve the blue economy and with potential real-world applications in the not-so-distant future. Winners were announced in the summer of 2020, with the team from the University of Hawaii at Manoa crowned the overall winner; other teams secured honors in categories for Best Plan, Best Pitch, and the 'Rising Star' and 'Moonshot' awards. A second iteration of the competition is already underway.

Reducing Barriers to Testing

First-Ever U.S. Accredited, Grid-Connected Wave Energy Test Site Makes Critical Advances Toward 2022 Commissioning: Oregon State University (OSU) has completed the design phase of PacWave South, the first accredited, grid-connected, and pre-permitted wave energy test facility in the United States. Funded by WPTO, OSU submitted a Final License Application and an Applicant Prepared Environmental Assessment to the Federal Energy Regulatory Commission in May 2019 to secure a 25-year license authorizing construction and operation of the 20 megawatt facility. As the test site gears up for construction, the PacWave team is working with developers to secure spots before the facility opens for business.

Critical Field Tests Demonstrate Performance of Newly Developed Environmental Monitoring Technologies: The Pacific Northwest National Laboratory (PNNL)-led Triton Initiative, initiated to support the development and testing of more precise and cost-effective environmental monitoring technologies for marine energy, provided critical technical support for a number of privately designed monitoring systems. The projects leveraged PNNL's Marine and Coastal Research Laboratory to conduct several iterative phases of testing. University of Washington's DAISY system and 3G-AMP were primary beneficiaries of the testing supported by Triton, with DAISY successfully demonstrating system functionality, ease of deployment and recovery, and integration of all sensors, while the efficacy of the 3G-AMP's sensor suite was verified over the course of a 5-month long deployment.

U.S. Leads Development of the Third International State of the Science Report, Providing the Latest Information on Potential Environmental Impacts of Marine Energy: In September 2020, on behalf of the International Energy Agency's Ocean Energy Systems collaborative, PNNL released the 2020 State of the Science Report. With more than a dozen authors across as many countries, the report summarizes the latest science on marine energy devices and their potential interactions with the environment, including marine animals and the habitats that support them. While more research is needed to ensure impacts are avoided, the results of the report suggest the impact of single devices and small arrays on marine life is likely minimal. Continued research is helping to inform the design of robust monitoring programs to help grow the industry while protecting ocean resources.

Sandia Develops Sophisticated, Accurate Method for Quantifying Marine Energy Noise in Complex Environments: Sandia National Laboratories published several model-based reports, open-source codes, and various training materials to be used by regulators, project developers, environmental consultants, and other scientists to quantify marine renewable energy device interactions and noise in marine environments.

A significant component of Re Vision's controls testing with developers involved open-ocean deployments, such as the one shown here, captured off the shore of Santa Cruz, California. *Source: Re Vision*

Foundational Research and Development

Co-Design Is Key: Different Approaches to System Controls Research Arrive at Similar Conclusions on the Future of Wave Energy System Design: Advanced controls techniques can result in massive improvements to wave energy devices' efficiency. From 2014 to 2020, WPTO supported projects with Sandia and marine renewable energy developer Re Vision Consulting to investigate philosophically different approaches to controls theory. Both projects arrived at similar conclusions: the controls system, the power takeoff system, and the basic structure of the device must all be co-designed from the start, and additional research and tools are needed to support this process.

Resource Mapping Greatly Expands U.S. Wave Energy Estimates, Charts the Course for Industry Technology Development: In 2020, DOE released new models and characterization data on the U.S. wave energy resource, representing the highest resolution, most comprehensive wave dataset publicly available. Created by WPTO's multi-lab resource characterization project, new estimates show a U.S. wave energy resource potential 30% larger than previous calculations, due to an improved resource accounting methodology that provides a more complete accounting of how wave energy totals are estimated.

NREL researcher Levi Kilcher, wearing the white hard hat, works with a team to deploy tidal energy resource characterization instruments. Resource characterization work like this lays the groundwork for industry to design and develop systems capable of efficiently extracting marine energy resources and delivering power to communities. *Source: NREL*

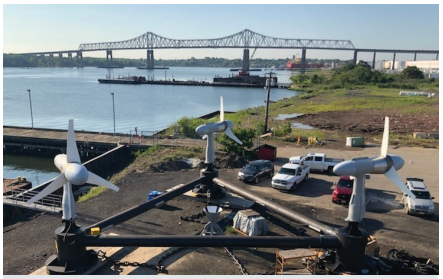
Technology-Specific System Design and Validation

River Hydrokinetics Reduce Dependence on Diesel in Alaska: In 2019, the Alaskan village of Igiugig worked with Ocean Renewable Power Company (ORPC) to deploy the RivGen® Power System, a 35-kilowatt (kW) system that utilizes the free-flowing current of the river to generate power. After a full year of operation in the Kvichak River, more than 8 megawatt-hours of power was transmitted into the Igiugig grid—at many points providing over half of the village's peak electricity needs. The local workforce was also able to deploy and retrieve the device for inspections and maintenance, enhancing the system's cost effectiveness and long-term community resilience. Additionally, after rigorous environmental monitoring of the device, no negative interactions were observed with migrating local salmon populations—an indispensable economic and cultural resource for the community.

The ORPC RivGen Power System prior to installation on the Kvichak River in Igiugig, Alaska. *Source: ORPC*

Innovative, Economical Test of a Wave Energy Converter Using Land-Based Lab System Provides Promising Results: In 2019, the National Renewable Energy Laboratory (NREL) and developer Columbia Power Technologies demonstrated the feasibility of safely conducting low-speed reciprocating tests of the company's wave energy converter generator using a traditional onshore wind turbine dynamometer, presenting a new avenue for validating performance and reducing risks prior to in-water testing.

Tidal Testing Underway in New York's East River: In 2020, Verdant Power deployed the company's fifth generation Free Flow System (FFS) turbines with their new TriFrame™ mount in New York's East River. With support from WPTO, NREL, and the New York State Energy Research and Development Authority, Verdant is scheduled to test throughout the duration of 2021, aiming to demonstrate streamlined installation procedures and long-term system reliability. Verdant's mounting system, a single triangular frame mount that holds three FFS turbines, is rated at 100 kW and is designed to simplify deployment and retrieval during installation and maintenance.



Verdant's Free Flow System turbines positioned on the TriFrame mount. *Source: Verdant Power*

Data Access and Analytics

Multi-Lab Partnership Launches New, Centralized Portal for Marine Energy Information Sharing: WPTO supported the creation of the Portal and Repository for Information on Marine Renewable Energy (PRIMRE), a central home for federally-funded tools, research, and analysis that can be used to advance marine renewable energy technologies now and in the future.

WPTO Creates New STEM Hub to Inspire the Future Workforce, Reaches Visitors to the Northeast's Largest Aquarium: In 2020, NREL released new STEM and workforce development portals for both marine energy and hydropower. Some of the resources featured are already being used, including as part of a public energy exhibit at Mystic Aquarium in Connecticut.

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