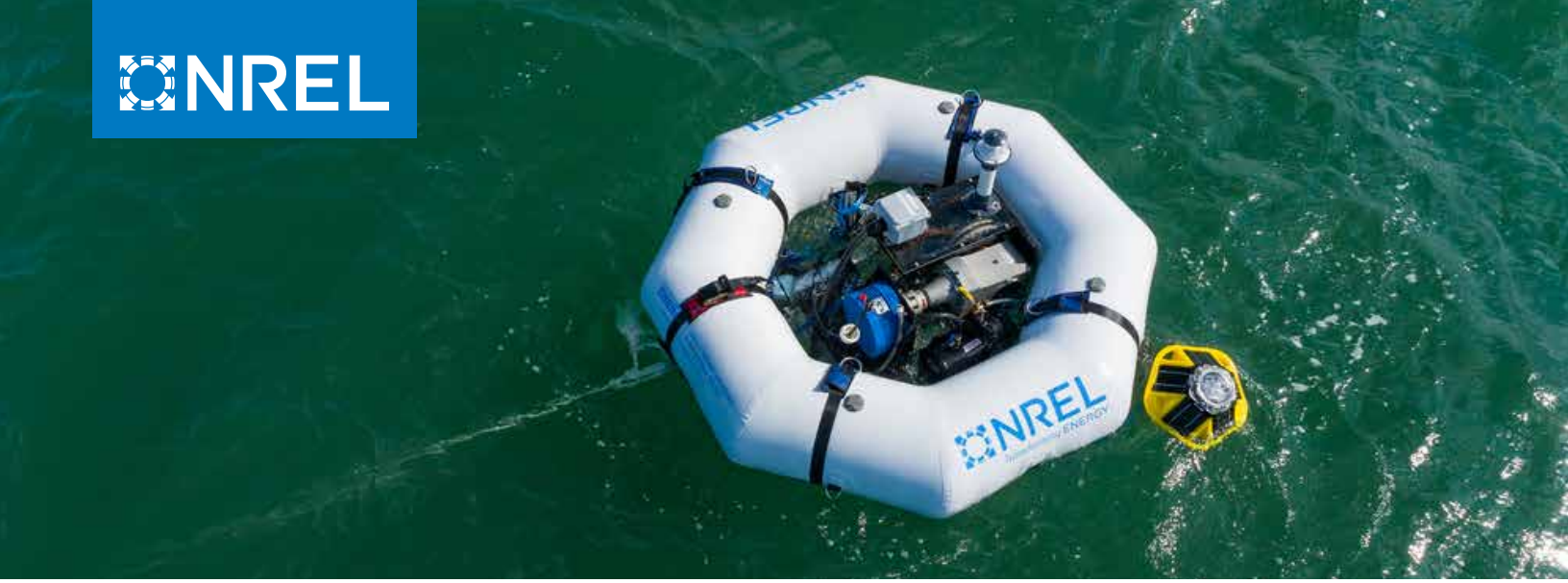

Unlocking America's Abundant Marine Energy Resources

NREL experts are driving innovation in marine energy technologies through cutting-edge design tools, state-of-the-art facilities, and strategic collaborations

The United States has vast wave, tidal, river and ocean current, and ocean thermal energy resources. Tapping into even a fraction of this available energy could significantly contribute to achieving a secure and independent energy future.

With more than 40 years of experience, NREL is at the forefront of advancing marine energy technologies. Through foundational research and development (R&D), state-of-the-art facilities, and deep technical expertise, NREL helps move technologies toward commercialization—both through independent research and collaborations with industry and academic partners. For more information, visit nrel.gov/water/marine-energy.

Driving Design Innovation Through Simulation and Analytical Tools

NREL developed a suite of publicly available simulation tools that help streamline R&D, reduce testing barriers, accelerate deployment, and foster expert collaboration.

- Leveraging advanced facilities, NREL offers a wide range of models and simulation tools, like WEC-Sim, OpenFAST, and the System Advisor Model™ (SAM), which can mimic how various device designs will operate in different ocean locations and conditions. Such tools are critical to help decrease the cost and time associated with technology development, increase investor confidence, and accelerate the commercialization of marine energy technologies.
- NREL's energy and economic analysis capabilities for water power technologies leverage decades of experience in system performance modeling, cost estimation, and tool building throughout the energy sector. NREL's SAM can be used to investigate questions about the technical, economic, and financial feasibility of marine energy projects, ultimately enhancing cost-effectiveness.
- As part of the Portal and Repository for Information on Marine Renewable Energy (PRIMRE)—developed in collaboration with the U.S. Department of Energy and other national labs—the Marine Energy Atlas is a free, interactive mapping tool that quantifies the power of marine energy resources across the United States, offering valuable resource characterization for project planning.

Together, NREL's suite of tools provide developers with data-driven insights needed to design cost-effective, high-performing technologies. You can explore these tools at nrel.gov/water/data-tools.

NREL's R&D has resulted in patented innovations that improve energy capture, enhance materials durability in harsh ocean environments, and streamline testing—all critical for commercializing wave- and current-powered systems. For instance, FlexWEC (flexible wave energy converter) employs distributed embedded energy conversion technologies across a bendable structure, providing broad-spectrum wave energy capture, redundancy, and resilience against storm impacts.

Leveraging World-Class Facilities and Capabilities

NREL is the nation's only accredited laboratory for International Electrotechnical Commission marine energy standards compliance testing, offering an unmatched suite of integrated capabilities for system design, testing, and validation. Learn how we are actively engaged in the development of international standards for marine energy at nrel.gov/water/international-standards.

- At NREL's Flatirons Campus, the large-amplitude motion platform (LAMP) replicates real ocean wave conditions using actual sea data, simulating surge, sway, and heave motion on devices weighing up to 10,000 kilograms. This capability helps identify design challenges early in development, reducing the time, cost, and risk of open-water testing.
- Complementing LAMP, NREL's dynamometer facility uses controllable electric motors in place of water to validate power take-off systems. The dynamometers rigorously test generators, gearboxes, brakes, power electronics, and control systems under realistic conditions, supporting performance optimization, lifetime certification, and seamless grid integration.
- NREL offers nanogrid and microgrid emulation capabilities through its Advanced Research on Integrated Energy Systems (ARIES) platform, which includes testing capabilities at a variety of scales to evaluate how new technologies interact with realistic, modern grid conditions. For example, researchers can simulate how marine energy devices would perform when integrated into remote coastal microgrids or isolated island systems. Because in-water tests are often expensive and time-consuming, this kind of early-stage emulation helps technology developers reduce risk, improve system performance, and refine their devices before deploying them in the ocean. For more information, visit nrel.gov/aries
- In addition to motion and power system testing, NREL offers advanced structural validation using high-capacity load frames, multidirectional actuators, and advanced sensing technologies to simulate extreme forces and fatigue over time. Researchers push components to failure to ensure they meet strength and durability requirements in harsh marine environments.
- NREL's integrated testing ecosystem also includes a wave tank, located in the Sea Wave Environmental Lab (SWEL), which replicates ocean conditions to validate small-scale prototypes in a controlled, low-risk environment. Combined with on-site advanced manufacturing processes like 3D printing, this integrated approach enables rapid design, testing, and iteration—accelerating innovation and reducing uncertainty. Get a closer look at the our water power facilities and capabilities at nrel.gov/water/facilities

Marine Energy's Moment: Opportunities To Power Communities and Industries

Marine energy can provide reliable, utility-scale power near population centers, strengthens grid resilience, and powers offshore infrastructure such as data centers. It can play a vital role in national security by powering military bases, remote microgrids, and underwater systems while extending mission capabilities at sea. Additionally, marine energy could help grow the $3 trillion blue economy by delivering reliable and resilient power remote communities, fueling hydrogen and ammonia production, and supporting ocean science and exploration. Learn more about how we are investigating in opportunities for marine energy to enable coastal and maritime markets across the blue economy at nrel.gov/water/powering-blue-economy.

NREL is advancing early-stage wave energy converter technologies by supporting open-water testing capabilities at the PacWave facility—one of the world's few grid-connected wave energy test sites, set to open in 2025. PacWave will help technology developers advance their devices toward commercial readiness.

With NREL's groundbreaking capabilities and strategic partnerships, the United States is well poised to blaze a trail for marine energy, increasing the nation's energy resilience, making energy more affordable and independent, and ultimately positioning the United States as an innovative leader in this evolving energy sector.

Through cutting-edge research, world-class facilities, and strategic collaborations, NREL is charting the course for America's marine energy by driving innovation, strengthening resilience, and fueling opportunities across communities and industries. For more information about the NREL marine energy program, email water.power@nrel.gov and visit nrel.gov/water/marine-energy.

Stay updated with the latest NREL marine energy news at nrel.gov/water/newsletter-subscribe.

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NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated under Contract No. DE-AC36-08GO28308

NREL/FS-5700-96022 • November 2025