Nathan Tom, Thanh Toan Tran, and David Ogden helped create an award-winning simulation software for technology developers to quickly improve and validate their wave energy device designs. *Photo by Werner Slocum, NREL 66214*

Three Modeling Tools Accelerate the Development of Marine Energy Technologies

Enough power flows through U.S. rivers and oceans to meet up to 60% of the country's electricity needs. But before today's early-stage marine energy technologies can harness some of that power, they need to overcome a few challenges, such as a volatile ocean and high development costs. And to do that, technology developers need reliable tools to understand and overcome the challenges they face.

That's why researchers at the National Renewable Energy Laboratory (NREL) have developed several open-source, validated, and customizable numerical tools for technology developers. With these tools, the marine energy community can assess their devices' potential power output, predict how their technologies might handle extreme loads (like extreme waves), and learn how changing one component might affect their device's performance.

The lab's models generate highly accurate, reliable, robust data that can help marine energy devices leap from the computer screen to the ocean and, eventually, the power grid.

Wave Energy Simulation Software Earns R&D 100 Award

Today, wave energy developers can bring the ocean to the computer thanks to a tool built by researchers at NREL and Sandia National Laboratories. Called the Wave Energy Converter SIMulator (or WEC-Sim for short), this first-of-its-kind, open-source code allows developers to simulate how much electricity their theoretical device could produce and how well it could handle the open ocean. WEC-Sim, which just won a prestigious R&D 100 award (also known as the "Oscars of Innovation") can forecast outcomes for a broad range of wave energy converters. And in May 2022, the WEC-Sim team released version 5.0, which includes refactoring of classes and properties, updates to the power take-off simulation library, and other code changes to improve usability.

Marine energy developers can also access WEC-Sim through the U.S. Department of Energy's U.S. Testing Expertise and Access to Marine Energy Research (TEAMER) program. The TEAMER program pairs developers with the nation's best facilities and expertise, and WEC-Sim is considered one of those top-tier facilities. One of TEAMER's most requested facilities, WEC-Sim has supported more than 16 projects so far.

OpenFAST Opens Up to Tidal Energy

Although NREL's OpenFAST software was originally designed to simulate wind turbines, the tool has grown to include underwater tidal energy devices, which share similar properties with their above-water cousins. Both wind and water are fluids, but water is a thousand times denser than air. So, in 2021 and 2022, NREL's experts worked on adapting OpenFAST to account for these physical differences and provide marine energy developers with accurate simulations of how different designs might perform in the real world.

New Control Co-Design Tool Provides Holistic Analysis

The latest modeling tool to join NREL's team is the first open-source tool to holistically assess novel marine energy turbine designs. Using control co-design, the tool blends technology design, optimization, and control (the ability to manipulate the device's energy production from afar) into one streamlined—and therefore faster and more cost-effective—approach.

Currently under development thanks to a collaboration between researchers at NREL, Colorado State University, and Design Impact, the control co-design modeling tool allows simultaneous design of each of a device's different components. For example, if a developer wants to add bigger blades to their underwater turbines, they can use the software to learn how that change might impact their technology's cost, energy output, and robustness. And the tool can provide both lower-fidelity simulations, which take seconds, and higher-fidelity simulations, which take just minutes to hours.

Broader Role in Advancing Marine Energy

NREL's validated, open-source simulation tools could help the marine energy industry more rapidly converge on the most robust, cost-effective marine energy technology designs. NREL's experts will continue to add new features and capabilities to these tools so developers can access the data they need to achieve commercial success.

Contact

Michael Lawson
Michael.Lawson@nrel.gov