

Inventing a New Way to Capture the Energy of Waves

Highlights in
Research & Development

Innovative NREL wave energy conversion technology enables greater control of wave loads to create a more economical source of renewable energy

The simplest way to convert wave energy is with a buoy that is tethered to a generator resting on the sea floor. As waves heave the buoy back and forth and up and down, the movement pulls on the tether, creating forces that drive the electrical generator and produce pulsating electrical energy in harmony with the waves.

This works fine until a storm creates very large waves. If the generator is too small to handle the power surges and too weak to accommodate extreme tether motions without damage, it will be overwhelmed. Furthermore, generators robust enough to handle storms are also prohibitively expensive.

To find a cost-effective solution, the National Renewable Energy Laboratory's ocean energy research team, led by Research Fellow Bob Thresher, did some brainstorming. With broad expertise in ocean engineering, structural dynamics, fluid mechanics, and control systems, the team put their minds to work imagining a wave converter that could handle highly energetic seas and storms.

They came up with an invention (see figure) that resembles a venetian blind structure pivoted at its base. Each of the blind's flaps is individually controlled and can open and close depending on wave conditions.



NREL's "Wave Energy Conversion Devices with Actuated Geometry" record of invention features individually controlled flaps that open and close depending on wave conditions. This results in improved energy capture without overloading the generator and could cut the cost of wave energy in half. Illustration by Joshua Bauer, NREL.

"When waves are small to moderate, you can close all the flaps to maximize the wave forces and generate more power. As the wave height increases, you can sequentially open flaps to reduce the driving force and let some of the energy pass through," Thresher said. "This allows you to operate over a wide set of wave conditions, resulting in improved energy capture while minimizing the loads, limiting the generator output."

The invention yielded Thresher and his team—Nathan Tom, Michael Lawson, Yi-Hsiang Yu, Jason Cotrell, and Alan Wright—a record of invention titled, "Wave Energy Conversion Devices with Actuated Geometry."

"Actuated geometry wave converters using advanced control strategies can easily cut the cost of wave energy in half by enabling improved load control and power generation in a wider spectrum of sea states," said Tom, a postdoctoral researcher who is the lead researcher on the laboratory-directed research and development wave energy project.

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References: Tom, N. M., M. J. Lawson, Y. H. Yu, A. D. Wright. 2016. "Development of a nearshore oscillating surge wave energy converter with variable geometry." *Renewable Energy* 96: 410–424.

Tom, N. M., M. J. Lawson, Y. H. Yu, A. D. Wright. 2016. "Spectral modeling of an oscillating surge wave energy converter with control surfaces." *Applied Ocean Research* 56: 143–156.

Key Research Results

Achievement

NREL's ocean energy research team's efforts to develop more robust and cost-effective wave energy converters have yielded a record of invention titled, "Wave Energy Conversion Devices with Actuated Geometry."

Key Result

This innovative wave device features a wave converter with controlled geometry that increases energy capture and prevents large waves from overloading the generator. The invention's control system actuates flaps that open and close depending on wave conditions.

Potential Impact

Greater control of the wave forces acting on wave energy conversion devices provides a solution to one of wave energy's biggest challenges—and could cut the cost of wave energy in half. This technology will be made available to companies interested in developing the system further.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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