Predicting wave power could double marine-based energy

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In the search for alternative energy, scientists have focused on the sun and the wind. There is also tremendous potential in harnessing the power of the ocean's waves, but marine energy presents specific challenges that have made it a less promising resource.

It's a challenge to tune Wave Energy Converters (WECs) so that they are able to harvest the maximum energy from waves, which differ in terms of their size and force. This unpredictability leads to intermittent energy collection. WECs also need to withstand the harsh winds and storms to which they are subjected in the open sea—storms which can destroy the devices.

Now, working with a team at the University of Exeter in the UK, Prof. George Weiss of Tel Aviv University's School of Electrical Engineering and Center for Renewable Energy has developed a control algorithm that, when used in conjunction with previously-developed wave prediction technology, helps WECs calculate the correct amount of force needed to collect the maximum energy possible, allowing the device to respond to each wave individually. The system, which was recently published in the journal *Renewable Energy*, doubles the energy previously collected by WECs.

Calculating force

WECs, Prof. Weiss explains, have two parts—a fixed or weighted lower part, possibly attached to the ocean floor, and an upper section that moves up and down based on the motion of the water. The device collects energy generated by the resistance force between the parts. Unlike wind turbines or solar panels, which collect as much or as little energy as comes their way, WECs need to adjust themselves to each oncoming wave to function properly, which requires knowledge of the characteristics of the incoming wave.

If there is zero resistance between the two parts of the WEC, the upper part moves freely with the waves, and no electricity is generated, Prof. Weiss explains. On the other hand, where there is so much resistance that it suppresses movement, the device turns rigid. At both of these extremes, no energy is produced. The ideal is a happy medium based on measurements of the incoming wave.

Prof. Weiss and his fellow researchers developed a control algorithm that is responsible for setting the correct resistance force for the WEC based on the predicted wave information. A processor attached to the WEC runs the algorithm five times per second in order to determine and then implement an optimal mechanical response to the coming waves.

In the lab, the researchers have run simulations using wave data gathered from the ocean. Combining prediction technology with their new algorithm, energy collection was improved by 100 percent —double the amount of energy that WECs had collected previously.

One second warning

The most important piece of information is the height of the wave, says Prof. Weiss, which the WEC needs to know in advance in order to prepare. "You would think that the longer the WEC knows the wave height in advance, the better, but in a surprising finding, it turns out that a one-second prediction horizon is enough," he says, noting that a longer prediction time does not actually improve the energy harvest.

Their findings could not only help to improve the functioning of the WECs that are already in use in places such as the East Coast of the US and the Atlantic Coast of Spain, but could help the technology become more competitive. Currently, marine energy is fifty times more expensive to collect than the market price for the energy itself—as solar and wind energy were in their infancy, says Prof. Weiss. But with the improvement of WEC structure, performance, and mass production, it could become commercially viable. "There is a lot of untapped energy in the ocean," he adds.

Provided by Tel Aviv University

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