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Unbridled power

REF Contributor George Marsh looks at the various systems that harness the enourmous power contained in sea waves, as well as the ingenious means being developed (and proposed) to exploit this tantalisingly abundant source of renewable energy.

WIND AND solar power are well established and, as their commercialisation continues apace, there is a degree of technology convergence in each case. This is not the case with wave and tidal power, where the field for fundamental innovation is still wide open. Ideas range from the straightforward to the fanciful and, although several concepts are in pilot and demonstration phases, commercialisation is still some way off for most. Wave power, in particular, is still characterised by diversity and experimentation. Here we outline some of the prevailing concepts and give an example of each.

Online: renewableenergyfocus.com

Nass&Wind Offshore launches floating platform
http://ow.ly/2D0tdk

Ocean Power Technologies forms new offshore wind power funding agreement with Australian Government
http://ow.ly/2D0eHB

Surface point absorber (buoy)

Buoy-based solutions, also called "surface point absorbers," come in several guises and rely on the differential motion between a floating buoy (which rises and falls with the passage of waves) and a base resting on the sea bed. The two elements are joined by a mechanism that converts the kinetic energy due to the buoy's motion into electrical energy.

A notable example of this approach is the PowerBuoy® system from **Ocean Power Technologies**, which utilises a sliding spar and power take-off approach. As the buoy contours the waves, it rises and falls inside a cylindrical tube which terminates in a weighted element on the sea bed. In doing so, it causes electricity to be generated via a power take-off and generator.

In ocean trials carried out off Scotland in 2011, an OPT Mk3 system incorporating a simulated grid connection proved able to maintain generation, averaging over 400kW, in waves ranging from slight to very high in storm sea states. A peak capacity of 866kW was recorded.

This ocean test run of a third-generation system followed previous trials of earlier models. A prototype utility PowerBuoy deployed at a US Marine Corps base in Hawaii was the first grid-connected wave energy device in US territory. Another prototype, developed with support from the US Navy and utilities in New Jersey, was trialled in the period 2005-08; yet another trial took place off Spain. Results from these early deployments led to the OPT Mk3 that featured in the arduous Scottish evaluation.

Surface point absorbers have been a strong development focus, and other devices include **CETO Wave Power's** Aqua buoy (Australia), the **Flansea** (Flanders Electricity from the Sea) device (Belgium), the **SE Sea Waves Power Plant** (Israel), the **OE Buoy** from Ocean Energy (Ireland), the **Wavebob** (Ireland), **Sea Raser** (UK) and Upsala University's Lysekit Project (Sweden). Differences between these lie mainly in the way kinetic energy is converted to electricity, with various arrangements of piston pumps, linear generators, turbines, etc.

Multi-point absorber

As the name suggests, a multi-point absorber uses multiple floats instead of a single buoy. These are attached to a fixed platform that is standing on the sea bed via legs. Wave-induced up-and-down motion of the floats is converted to angular motion in the arms that connect to the floats to the platform and thence (via power take-offs) into hydraulic power which drives a generator. Advantages over a single point device include smoother power delivery, since the spaced floats experience passage of a wave at different times, higher aggregate power and redundancy in case of failure at any given float. In addition, the platform can be used to support a wind turbine so that combined wave and wind power generation is possible.

A two-float prototype Wave Star machine from **Wave Star Energy A/S** in Denmark has exported electricity to the grid since September 2009. Currently the device is being extended so that more power can be generated when it is redeployed. A much larger machine with up to 20 floats is planned. Wave Star incorporates a storm protection system under which floats are automatically raised out of the water in high sea states.

Attenuator

An attenuator comprises two or more floating elements that are hinged together in a "chain" which is aligned at right angles to the waves. As a wave passes beneath and along the chain, the elements move in the vertical plane such that their hinged joints rise and fall creating a constantly varying angle between each pair of elements. This angular motion is captured by power take-off struts