MARINE Renewable Energy

Makes Waves as an Alternative Energy Source

OCEAN WAVES CAN CARRY a tremendous amount of energy. But is it sufficient to extract and provide electrical grid power on land? The answer is a resounding "Yes."

Although usable wave energy varies throughout the world, the wind blows consistently and with enough force in many areas to provide continuous waves; this is especially true off the western coasts of Scotland, northern Canada, southern Africa, Australia, and the north-western coasts of the United States. And the potential of these energy sources has not been lost, as companies are actively developing systems that harness renewable marine energy and efficiently convert it to electricity for use on land.

HOW IT ALL BEGAN

The Carbon Trust is an independent company that was established by the British government in 2001 to accelerate the move to a low carbon economy. In 2004, the Trust began a year-and-a-half long Marine Energy Challenge ("the Challenge") to provide engineering support for developers of marine renewable energy technologies.

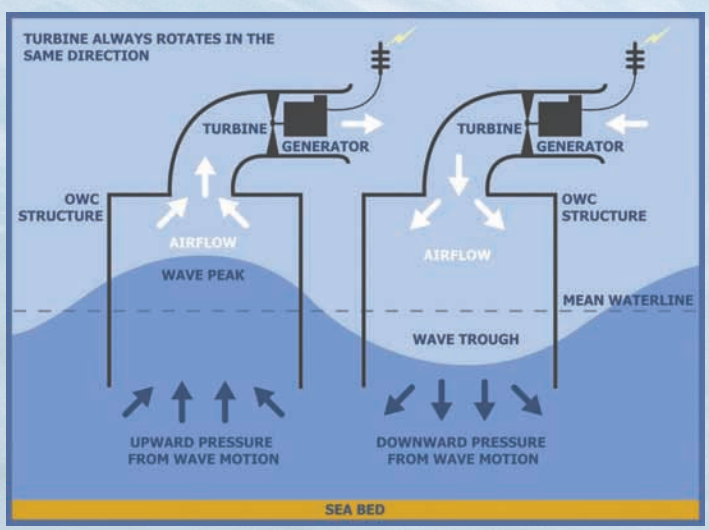
Because of its impressive experience and expertise in the marine steam turbine industry, Peter Brotherhood Ltd. was selected to participate in the Challenge. (Dresser-Rand Company Ltd is carrying forward with this participation after its purchase of certain assets of Peter Brotherhood Ltd in 2008.) Participants focused on potential areas for cost reduction and performance improvement, tidal stream resources in the UK, application of engineering standards to marine energy devices, and the viability of wave and tidal stream energy.

Following completion of the Challenge in mid-2005, the Carbon Trust initiated a detailed study to assess the cost-effectiveness and potential growth opportunity of wave and tidal stream energy as a marine renewable.

That same year, Dresser-Rand assembled a team to develop a bi-directional air turbine to use in oscillating water column (OWC) devices to generate electricity from wave energy. The result: the HydroAir™ turbine. The HydroAir turbine is a variable radius turbine (VRT) with a modular design that facilitates rapid maintenance turnarounds, and it can be customized for each OWC technology application.

OWC TECHNOLOGY

OWC remains the most successful and extensively studied technology for extracting energy from ocean waves. It works on the following principle: Approaching wave swells force the water surface in the chamber to move up and down. This causes an oscillation of the air pressure inside the chamber which, in turn, forces the air backwards and forwards through an air turbine installed in a duct connecting the chamber to the atmosphere. The turbine converts this air movement into electrical energy.



Oscillating water column device.

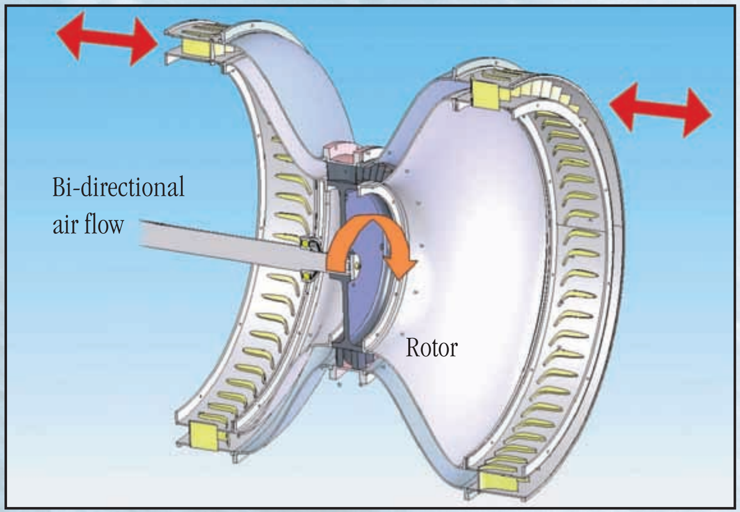
An OWC can take on various forms and can be located on the shoreline, nearshore or offshore. Although many early OWCs were shoreline-based, there are several projects underway around the world to incorporate OWCs into breakwaters. And several companies are developing floating devices moored out to sea.

The simplicity of OWC technology (water moving up and down driving a column of air) has long made it a favored solution for wave energy conversion applications. The challenge with OWC technology is to achieve satisfactory efficiency over a wide operational band, considering that the airflow not only varies between zero and maximum, but also flows in both directions. Shaft rotation must also be maintained in the same direction. (Turbines are typically used in steady, uni-directional applications and achieve very high efficiencies.)

The patented HydroAir variable radius turbine (VRT) provides an innovative, unique solution for OWC turbine applications. The turbine is constructed to withstand the rigors of a marine environment and uses a combination of protective coatings, stainless steel, marine grade aluminium, and reinforced composite components to resist corrosion. In addition, it offers the following benefits when compared to other turbines being used for wave energy capture:

- High efficiency (approximately 70 percent, which is considered above average for these types of applications)
- No moving parts (other than the rotor)
- Lower rotational speed (300 – 600 rpm) than competitive turbines
- Suitable for applications up to 500 kW
- Wide operational bandwidth
- Self-starting
- Low noise
- Bi-directional airflow to produce uni-directional shaft rotation.

The VRT design comprises two sets of static guide vanes located on either side and at a larger diameter than that of the rotor. These vanes are connected by a shaped duct to provide a route for the (inlet/outlet) airflow. Air enters the duct at a relatively low velocity and acquires a swirl motion as it passes through the inlet guide vanes. The air then accelerates as it passes down the narrowing duct toward the turbine rotor. The air drives the rotor, then decelerates as it travels back through the expanding duct before passing over the outlet guide vanes. The process is repeated (in reverse) for the next wave cycle.



Variable radius turbine principle.

PROVIDING CLIENTS WITH TOTAL OWC-BASED SOLUTIONS

Last year, a group of UK-based companies comprising Orecon Ltd (a wave energy device developer), (then) Peter Brotherhood Ltd, Converteam Group (a supplier of electrical systems to the renewable market), and Cranfield University collaborated on a study to develop OWC technology used in Orecon's wave energy buoys.

A land-based test facility was designed in the gas turbine engineering laboratories at Cranfield University. The laboratories presented an ideal site for the project because they enabled the testing of large-scale OWC turbine models and could replicate the oscillating airflows that the turbines would experience in oscillating water column applications.

"This project was a perfect opportunity to bring together industry and academia. It provided complementary skills in both steam and gas turbine technology, and the ability to apply fresh ideas to the development of an effective OWC turbine," said Russell Hall, senior mechanical engineer for the HydroAir turbine team.

Earlier this year, Dresser-Rand and Orecon Ltd signed a memorandum of understanding to optimize the chamber and turbine design for their 1.5 MW multi-resonant chamber (MRC) wave energy conversion device. Orecon's MRC device (designed to address the efficiency challenge that accompanies wave energy capture technology) combines OWC technology with Dresser-Rand's HydroAir bi-directional air impulse turbine technology. The HydroAir package can include the turbine with the generator and power conditioning equipment to provide a complete power take-off (PTO) solution for some OWC installations.

By combining their powerful technologies and expertise, Dresser-Rand and Orecon will provide total OWC-based solutions backed by Dresser-Rand's global service network. Together they will be able to provide clients with a high level of confidence in the emerging wave energy market. ■