AN INTERNATIONAL PERSPECTIVE ON MARINE RENEWABLE ENERGY

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Abstract – Climate change and increasing dependency on imported energy by many countries require an ambitious development of renewable energy sources. The marine environment represents a huge potential for harnessing different renewable energy resources. There is a wide range of marine renewable technologies being developed and deployed worldwide.

The most advanced technology is offshore wind with around 3GW of installed power in Europe at the end of 2010 and increasing annual rates of growth. At present the deployment of offshore wind parks are based on large wind turbines fixed structures such as monopiles, tripod and jackets in shallow water up to around 50 m water depth. In many parts of Europe such as France, Spain, Portugal and Norway, there are significantly larger offshore wind resources available in waters deeper than 50 m but still relatively near to the shore. In other relevant markets worldwide such as the US, Canada and future markets on the Southern hemisphere, the continental shelf is
even smaller and floating technology is the key to the offshore wind market takeoff.

Wave power captures kinetic and potential energy from ocean waves to generate electricity. Wave energy converters (WECs) are intended to be modular and deployed in arrays. At present there is little design consensus for wave energy devices with no industry standard device concept. Due to the diverse nature of the wave resource it appears unlikely that there will be one single device concept that is used, rather a small number of device types that exploit different regions of this vast resource. There are no commercial wave power plants to date but several prototypes at different stages of development. These prototypes are based on different concepts which can be classified into the following types:

- Attenuator devices are generally long floating structures aligned in parallel with wave direction, which then absorb the waves. Its motion can be selectively damped to produce energy.
- Overtopping devices are wave surge/focusing system, and contain a ramp over which waves travel into a raised storage reservoir.
- OWC (Oscillating Water Column) devices, in which a column of water moves up and down with the wave motion, acting as a piston, compressing and decompressing the air. This air is ducted through an air turbine.
- Point absorbers are floating structures absorbing energy from all directions of wave action due to their small size compared to the wavelength.
- Oscillating Wave Surge Converters extract energy from the surge motion in the waves. They are generally seabed mounted devices located in nearshore sites.

Tidal Current power captures the kinetic energy of the moving water of the tide. Several different tidal current energy converter device technology concepts have been proposed and developed in recent years. The main differences between concepts relate to the method of securing the turbine in position, the number of blades and how the pitch of the blades is controlled. Tidal current devices are generally modular and intended for deployment in 'arrays' for commercial use in order to obtain a significant combined energy output (similar to the onshore wind approach). There are no commercial plants with tidal current devices so far, however the technology has converged more than for wave energy with several full scale prototypes installed, most of them based on horizontal axis turbines.

Tidal Range (or Tidal Rise and Fall): Tidal energy can also be captured based on the potential energy of the difference in the height of water at high and low tides. Technologies such as tidal barrages are used to convert this energy into electricity. The largest ocean energy installation in the world, with a power of 240MW, is based on this technology and it is located in La Rance, France.

Ocean Currents are the constant flows of water around the oceans. These currents always flow in one direction and are driven by wind, water temperature, water salinity and density amongst other factors. They are part of the thermohaline convection system which moves water around the world. Ocean current energy technologies are being developed to capture the kinetic energy carried in this constant flow of water. The primary design concepts for ocean current energy are based on water turbines.

Ocean Thermal Energy Conversion (OTEC) is a technology to draw thermal energy from the deep ocean and convert it to electricity or commodities. This technology requires a temperature difference of 20ºC between the warm surface water and cold deep water and as such is only possible in certain areas of the world; the tropics are the key area for this technology. The key uses for OTEC are to generate electricity, desalinate water, provide refrigeration, and support mariculture.

Salinity Gradient power is energy from the difference in salt concentration between fresh water and salt water. As such, this can be exploited at the mouth of rivers where fresh water meets the saline water. There are two technologies being developed to convert this energy into electricity: pressure-retarded osmosis and reverse electrodialysis.

If costs can be reduced to a competitive level, the potential for marine renewable energy in deep waters is huge. One way of reducing costs is to exploit synergies between different technologies. One effective choice is to combine offshore wind with wave energy or ocean/tidal currents at sites where these resources are concentrated. Because of the different characteristics of these resources, they offer substantial additional benefits compared to the simple addition of more wind capacity. These benefits could be even bigger if other uses such as aquaculture are also considered, establishing a new concept of multiuse offshore platforms.