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An International Vision for Ocean Energy

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The oceans contain a huge amount of energy. Rapidly developing technologies, particularly in the fields of tidal current and wave energy conversion have gained significant attention throughout the world. More recently, a number of technologies are also being explored for energy uses other than electricity generation, such as, producing drinking water through desalination, supplying compressed air for aquaculture, and hydrogen production by electrolysis. John Huckerby, the Chair of the Executive Committee of Ocean Energy Systems talks about the state of the technology and the initiative's efforts to make OES an authoritative voice for ocean energy.

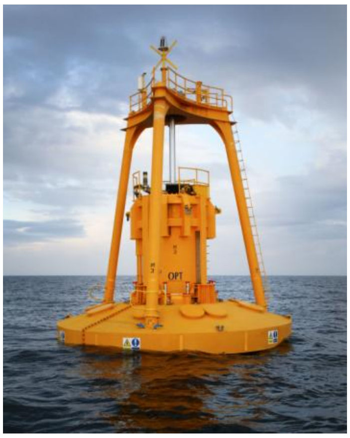

Figure 1: OPT PowerBuoy (Ocean Power Technologies)

What are the different types of ocean energy technologies?

Ocean energy resources can be divided into the following categories: ocean waves, tidal currents, tidal range (rise and fall), ocean current, ocean thermal energy and salinity gradients. Whilst these resources are vast they are not evenly distributed, although at least one form of ocean energy is available at every coast, with the potential to supply local power needs.

What is the status of the different technologies?

Wave power captures kinetic and potential energy from ocean waves to generate electricity. At present there is little design consensus for wave energy devices with no standard industry device concept. Since there are at least four different ways to extract energy from waves, it is unlikely that a single device concept will develop, rather, a small number of generic device types that will exploit different aspects of the wave energy (Figure 1).

[1] The IEA *OPEN Energy Technology Bulletin* is a free, web-based periodical newsletter published by the International Energy Agency (IEA). Views expressed in *OPEN Bulletin* articles do not necessarily reflect the views or policies of the IEA Secretariat or of all its individual member countries.

[2] The Ocean Energy Systems Implementing Agreement (OES IA) is one of 42 international energy technology collaborative programmes operating within the framework of the IEA.

Tidal range can also be captured based on the potential energy of the difference in the height of water between high and low tides. Tidal barrages utilise conventional hydroelectric technologies in estuarine settings to convert this energy into electricity. Tidal currents tend to be bi-directional during the course of each day and to flow reasonably quickly. A 240 MW barrage in La Rance in northern France has been in operation since 1967 and a new 254 MW barrage at Sihwa Lake near Seoul began operations in June 2011.

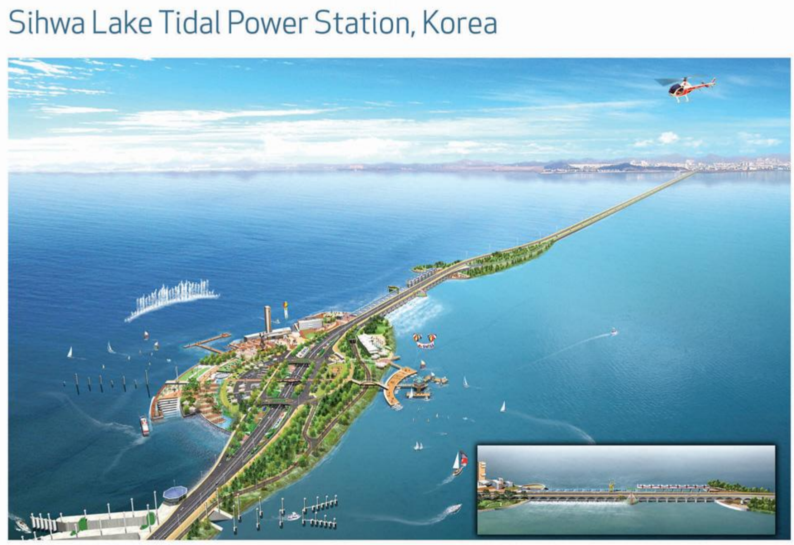

Figure 2: Sihwa Lake Tidal Power Plant

Tidal current power captures the kinetic energy of the moving water of the tide. Tidal current turbines come in a number of different basic designs, are generally modular and intended for deployment in 'arrays' for commercial use in order to obtain a significant combined energy output, as for wind turbine generators in wind farms.

Ocean current energy technologies are being developed to capture the kinetic energy contained in seasonal unidirectional ocean currents, such as the Gulf Stream off Florida. Ocean current flows may be larger and more continuous than tidal current flows but they tend to be relatively slow-moving (1 m/sec), thus requiring different technologies from tidal current turbines. The primary design concepts for ocean current energy are based on submarine turbines, deployed in arrays.

Ocean thermal energy conversion (OTEC) is a technology that draws thermal energy from the ocean depths and converts it to electricity or commodities. This technology requires a temperature difference of at least 20°C between warm surface water and cold deep water and as such is only possible in certain areas of the world, principally the Tropics. Key uses for OTEC may be to generate electricity, desalinate water, provide heating and cooling and support aquaculture. Projects have so far been restricted to relatively small-scale prototype applications.

Salinity gradient power is energy from the chemical pressure difference based on 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 saline water. There are two technologies being developed to convert this energy into electricity: pressure-retarded osmosis (Figure 3) and reverse electro-dialysis. These technologies are still at the R&D and pilot plant stage.

Figure 3: Membranes at Statkraft's Osmotic Power Plant, Tofte, Oslo Fjord, Norway

What are the key markets for ocean energy technologies?

There are three key markets for ocean energy technologies: grid-connected electricity, off-grid power for remote communities, and other uses including desalination. While electricity generation will likely be the dominant market, technologies can be developed for a range of other uses, including seawater air conditioning, heating and desalination for drinking water. In communities where both clean energy and fresh drinking water are scarce, an ocean energy and desalination plant could be a critical technology and important market opportunity. The expected growth in the desalination market between 2008 and 2016 is estimated to be worth around USD64 billion.

What is OES?

The OES is an intergovernmental collaboration between countries which operates under a collaborative framework established by the IEA (Multilateral Technology Initiatives). It brings together countries to advance RD&D of conversion technologies to harness energy from all forms of ocean renewable resources. Membership is open to public or private organisations within OECD member or non-member countries, international and non-governmental organisations.

What is new in OES?

Created in 2001 the OES will complete its second five-year mandate in early 2012. Part of its strategy for its next 5-year term includes a strong Communications Plan designed to raise the profile of OES and position it as an authoritative international voice for ocean energy. A new logo and website were recently launched and an informative 16-page brochure outlines the vision and mission of the OES.

For more information contact the Operating Agent.

Where is most activity currently taking place?
The principal regions of research, development and deployment are in north-western Europe, North America, North Asia and Australasia. Most countries in which marine energy technologies are currently being developed have renewable energy generation targets but fewer have specific policies to promote ocean energy uptake. These countries use 'technology-push' mechanisms through capital grants or financial incentives to create early-stage opportunities, though 'market-pull' mechanisms such as renewable obligations certificates and feed-in tariffs are becoming more common. The United Kingdom and, particularly, Scotland, have the most activity and the most sophisticated funding and regulatory regimes for marine energy. The UK Government has a number of funding mechanisms and institutions to support R&D, including a series of offshore testing centres for offshore devices. Permitting and market mechanisms are also used to promote uptake of marine energy.

In spite of the fact that the ocean is an almost unlimited and renewable resource, marine technologies are the least developed of the renewable energies. What is needed for more rapid expansion?
Development of an international ocean energy industry presents significant opportunities for new participants and for existing suppliers in related supply chains, e.g. offshore oil and gas, offshore wind and other forms of renewable energy.
However there are challenges. These include the development of a supportive policy environment, industry and market development, technology development through continued R&D, improved understanding of environmental effects, and a clear and supportive planning framework. But there is also a range of solutions and recommendations being discussed and developed around the world, as can be seen in Figure 4.

What is the potential for ocean energy in the coming decades?
OES believes that there will be significant developments in marine energy in this and coming decades. Various scenarios predict that between 200 and 750 GW of new ocean energy generating plant might be installed by 2030 and OES believes that up to 160,000 direct jobs could be created by 2050. Development has been slowed since 2000 by operational difficulties and international policy changes. However, ocean energy technologies edge closer to being commercially viable and may become part of mainstream generation supply in coming years. Ocean energy also offers opportunities for other products, including drinking water, district heating and cooling, aquaculture and biofuel production.

Challenges for the ocean energy industry

CHALLENGES	POTENTIAL SOLUTIONS AND RECOMMENDATIONS
POLICY ENVIRONMENT	• Development of an integrated policy framework with ocean energy specific regulations • International guidelines and standards • Regulatory reform and planning leading to efficient and appropriate consenting processes
INDUSTRY DEVELOPMENT	• Strategic supply chain planning, development and growth • Ocean energy infrastructure development • Technical and professional workforce training and development
MARKET DEVELOPMENT	• Development of appropriate tariff support mechanisms to provide clear market signals to the investment community. • Appropriate electricity market access and grid connection access
TECHNOLOGY DEVELOPMENT	• Prototype devices need to be very robust to withstand the marine environment • Demonstration and testing facilities • Research and innovation support and enabling technology support to facilitate cost reduction and performance improvement
ENVIRONMENTAL EFFECTS	• Establish an improved understanding of baseline environment • Strategic environmental research which is enabled by sharing of environmental data • Consider adoption of deploy and monitor schemes to facilitate sector progression • Familiarity in affected communities
PLANNING FRAMEWORK	• Marine spatial planning leading to the development of common approaches to space and resource allocation.

OES OCEAN ENERGY SYSTEMS

Figure 4: Challenges for the ocean energy industry
(from "International Vision for Ocean Energy", Huckerby, J.A., Jeffrey and Moran, B., 2011)