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The deployment of the first tidal energy capture system in Taiwan

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ABSTRACT

As government policies of energy resources shift towards the inclusion of renewable energy, the ocean resources have become great potential. One of the ocean energies is tidal current energy which can be used to drive underwater turbine and generator. A study on harvesting ocean is done in this integrated project with six subprojects which are investigated by the researchers of cross-disciplinary including mechanical, electrical, ocean, environmental engineering, underwater technology and marine science. The horizontal-axis turbine is attached to a magnetic generator and is installed in a square nozzle and diffusor duct which is semi-submerged and floated. The floating capture system is mooring by steel chains and the anchoring system is concrete gravity blocks. The deployment of the first NSYSU energy capture system is made in 2013 at Penghu Island and the system was safety approved in storm wave condition since it was passed by Teinping Typhoon attacked. A maximum power take off (PTO) nearly equal to 5 kW is monitored which is the largest tidal current PTO in Taiwan and also is the first on-site successful ocean deployment in Taiwan.

1. Introduction

Facing the future challenges of energy security and greenhouse gas emissions reductions, national energy policy has focused on expanding the use of renewable energy and accelerating the development of renewable energy industry. According to "Word Energy Outlook, 2008" presented by International Energy Agency (IEA), development and promotion of new energy science and technology will play a key role to solve future global energy shortage and reduce the environmental pollution impact. Ocean Energy is one of the best green energy in all generation technologies, due to its clean and non-polluting. Besides Taiwan is surrounded by sea, the power of the Kuroshio in eastern Taiwan and the tidal current of Penghu channel offer the great opportunities to develop ocean current power generation.

Green Energy Technology Plan report (Green Energy & Environment Research Laboratories, Industrial Technology Research Institute of Taiwan, 2010) proposed that, Taiwan's ocean energy is expected to reach 200 MW in 2025 if we continue to develop marine energy technology. Marine energy will drive the additional industry efficiency, including wave power $130 billion *with* CO2 reduction of 112,000 tonne/year; thermoelectric power generation $108 billion *with* CO2 reduction of 312,000 tonne/year; Kuroshio generation $130 billion *with* CO2 reduction of 187,000 tonne/year. As government policies shift towards inclusion of renewable sources, the offshore ocean resources have great potential. Worldwide investments in renewable energy technologies reveal that offshore wind energy is increasing and strong growth in offshore wind farms is anticipated. The true potential of wave energy will only be realized in the offshore environment where large developments are conceivable. At present, a large number of concepts for wave energy devices have been proposed, but only a few are likely to have progressed to meet commercial demands. Commercial-scale wave power stations exist and are delivering power to grids. Modular offshore wave energy devices that can be deployed quickly and cost effectively in a wide range of conditions will accelerate commercial wave energy and only through multiple-unit projects wave energy could become commercially successful.

Alternative renewable energy source also from ocean water might be tidal power which converts energy from the ocean into electricity. Tidal power might also be *one of* the most reliable and predictable energy sources and people have developed and used tidal energy for centuries. Tidal current turbines are basically underwater windmills. The tidal currents are used to drive an underwater turbine. Developers have shifted

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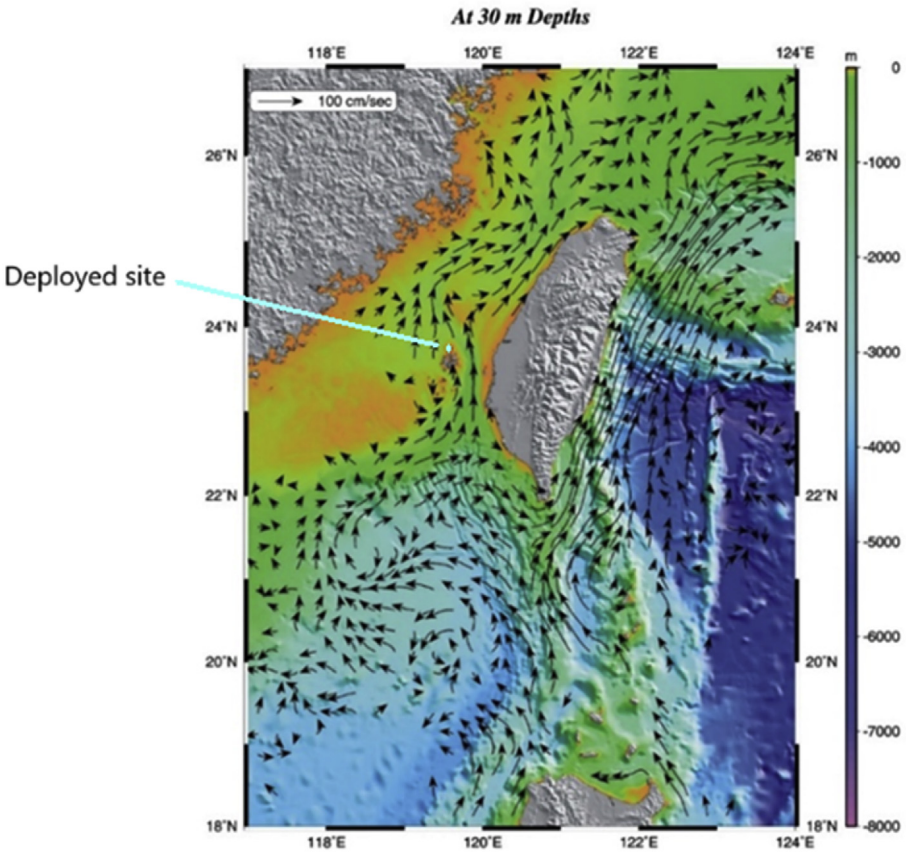

Fig. 1. Overview of the flow field near Taiwan (Source: Ocean Data Bank, National Center for Ocean Research, Taiwan, 2008) at 30 m.

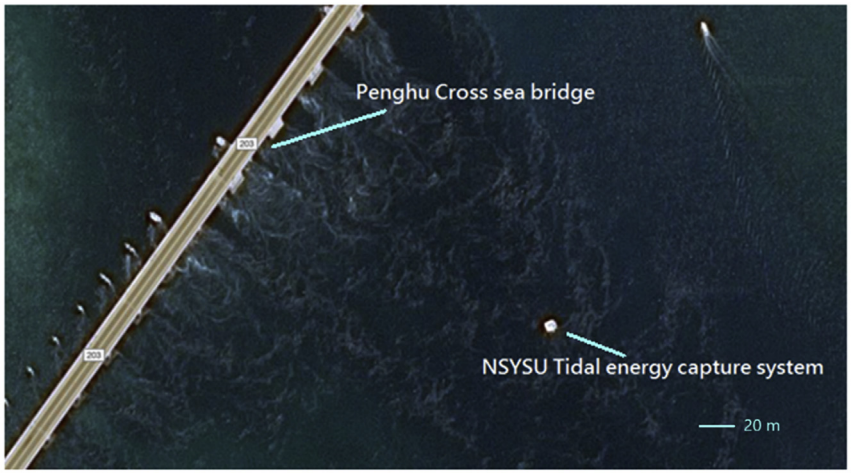

Fig. 2. The Penghu cross sea bridge and the NSYSU Tidal energy capture system which can be seen from Google map (captured in 2016).

toward technologies that capture the tidally-driven coastal currents or tidal stream. Smaller units that can be deployed individually or in multiple units characterize tidal current stream technologies. Currently, the dominance of offshore wind does not mean wave and tidal energy are not important. With time and sufficient financial supports, sizeable wave and tidal farms could be in place by the next decade.

Taiwan is an island and 98% energy are imported. Overview of the flow field near Taiwan is shown in Fig. 1 and a branch of North Pacific Gyre (Kuroshio) passes through the east coast of Taiwan. The range of Kuroshio is around 170 km wide and 700 m deep with an average speed up to 1.25 m/s (Hsueh, 2000) and it is equivalent to 120 GW/h. If 1% of the Kuroshio power is taken, that is 1.2 GW, while Chen (2010) suggested a 30 GW power plant and it can nearly replaces all the power plants needed in Taiwan. The Kuroshio power is, therefore, a good opportunity to become a major resource of future power generation in Taiwan. Part of the Kuroshio travels along the west coast through a strip between Penghu and Taiwan.

In globe development, many nearly matured and successfully deployments were reported. **In Europe**, as early as 2003, the 300 kW prototype, SeaFlow, installed in the Bristol Channel. To further study the tidal energy technology, including related engineering, management system and environmental impacts. The SeaGen tidal turbine was installed in Strangford Narrow, Strangford Lough, Northern Ireland by Marine Current Turbines Ltd (MCT) in 2008 that is a 1.2 MW production