



Windmills under the Waves Tidal Current Power

Price
30p

As the moon circles the earth and the earth circles the sun, the gravitational attractions pull the earth's water across oceans where it is funnelled and raised up estuaries such as the Severn and accelerated around headlands and narrows. We refer to this movement as tidal, and we know that any moving water contains energy. The interaction of fixed land and moving water causes the tide to move faster and contain more energy at some points than others. The energy is a multiple of the quantity moving and the speed squared. There are many 'good' areas around the UK. More than 60,000

*Fig 1
OpenHydro's
turbine being sited
at the EMEC test
site in the Orkneys*



megawatts (MW) - 80% of the UK's generating capacity - flow up and down the Channel daily though a more likely prize is the Pentland Firth where the flow reaches 3 million tonnes of water/second.

It is almost certain that the most efficient way to extract tidal energy is by building a barrage but construction takes many years and estuarial life is disturbed. The Government decided against providing support for the Severn Barrage in Autumn 2010.

It has only been in recent years that engineers have considered generating electricity from tidal currents. There are 2 ways. First by placing a small 'windmill' or group of 'windmills' under the water, held in place from an anchored boat (as was done in a successful trial in Milford Haven) or fixed into or placed on the sea bed. The turbines are turned by water just as by wind. As water is 800 times as heavy as air the same electricity can be generated with shorter blades despite slower currents than wind speeds.

The second way is to construct a 'fence'. It is easier to

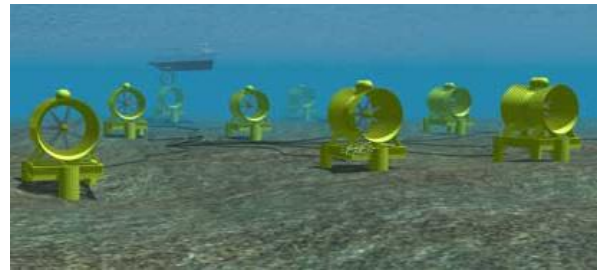


Fig 2 Lunar Power's 'wind farm under the sea' artist's impression

extract energy from faster moving water so a tidal fence is designed to speed water up by concentrating the flow between a series of piers with turbines in the gaps. For example if a tide was running at 2 metres/sec it might be accelerated 4 times to 8 metres/sec. Blue Energy, a Canadian company, have been trying to persuade the Philippine Government (so far unsuccessfully) to support a trial of a 50 MW tidal fence in the Dalupiri Passage which, if successful, could expand to 2,200 MW capacity. There are other sites which could be exploited.

Development is concentrated on different single turbine designs with some already rejected. The Stingray was tested in the Yell Sound in the Shetlands. A vane moved up and down (rather like a whale's tail) pushed by the tidal flow, powering hydraulic rams which turned generators. Sadly costs were high, the electricity wave form different to normal mains supplies, and development ceased, though a company called Pulse Tidal has tested a similar, 150 kW, device in the Humber Estuary and has plans for a 1.2 MW device in Kyle Rhea between the Isle of Skye and the mainland in 2012.

The number of other devices is increasing rapidly.



*Fig 3 The
Seaflow turbine
raised for
maintenance*

An ALDES Briefing Note

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This briefing note arises from a presentation by Dr John Loveless of Bristol University at the Spring Conference 2003 and a talk by Richard Montague of Marine Current Turbines in January 2008. It should be technically accurate but any opinions expressed are those of the editor, Richard Balmer. If you see errors or have comments, please email him at richardbalmer162@btinternet.com

Neptune Renewable Energy Ltd have successfully tested their Proteus NP1000 in the Humber and plan to install the larger NP1500 within 2 years. This is a kind of box resting on the sea bed which reduces from 15 to 6 metres width (to increase the speed of the water) with a turbine at the narrow point. A similar device is being developed by Lunar Energy (see Fig 2). The tubes are 25 metre long and 15 metres in diameter tapering in the middle. A 1MW device completed tests in May 2009.

OpenHydro, an Irish company, installed a 250 kW unit (with some difficulty due to the strong currents) at the European Marine Energy Centre in the Orkneys (EMEC). The unit resembles the front of a large jet engine (see Fig 1). The successful trial was followed by another of a 1 MW turbine in the Minas Straights, Bay of Fundy, Nova Scotia. This finished at end 2010 when damaged turbine blades were found but 2 further units are planned. Other companies are using propellers. Meygen, a company backed by bankers Morgan Stanley, are currently testing the AK1000 twin bladed floor-resting device at EMEC; Tidal Energy Limited have permission to install a 1.2 MW 'Delta Stream' turbine in Ramsey Sound, Pembrokeshire probably in 2012; Ocean Flow Energy have grid-connected a one tenth scale model of the 'Evopod' moored turbine in Strangford Lough with plans for a fourth scale version later to be tested off the South Kintyre coast. Scottish Power Renewables plan to test the Norwegian HS1000 device at EMEC in 2011 with firm proposals for 10, 1 MW units in the Sound of Islay and more, possibly, in the Ness of Duncansbay later.

At present the leader is probably the Bristol based Marine Current Turbines (MCT). Their first tidal turbine, the Seaflow (see Fig 3) generated 300 kW using blades 11 m long in a tidal flow of 2.7 m/sec. The test machine was mounted on a column 2 miles offshore from Lynmouth in Devon. At end May 2005, after 5 years of trials, funds were obtained for a 1.2 MW 'SeaGen' commercial prototype. This has twin turbines mounted either side of the single column fixed in the sea bed. It was installed in Strangford Narrows, Northern Ireland, where there are 4 tides a day, in April 2008. Despite early control problems it supplied 350 MWh of electricity to the Northern Ireland grid in the second 6 months of 2009 without any apparent harm to marine life. There are proposals to install another SeaGen in the Minas Straight, Bay of Fundy; 8 SeaGens in the Skerries area off Anglesey; 4 Seagens at Kyle Rhea; 100 MW of SeaGens off the Antrim Coast and more in the Pentland Firth.

In the last year alone plans (not, it must be emphasized, commitments) have become much more ambitious. OpenHydro and Meygen have won the rights to develop 200 and 400 MW tidal farms in the Pentland Firth respectively and Lunar Energy is planning a 300MW

farm in the Wando Hoenggan Water Way, South Korea. EMEC lists 75 companies developing tidal turbines worldwide, just under half based in the UK and a quarter in the USA.

It is now clear that tidal turbines can work in several different forms. However there remain several unknowns. Are there environmental downsides? Though the turbine blades move relatively slowly, at perhaps 25 revolutions/minute, there could be a risk to fish and marine mammals such as dolphins and seals. Will silt build up or scour undermine the floor-resting models? How reliable will the turbines be? It is expensive and, in stormy conditions, often impossible to place a ship in position to lift a turbine out for repair.

What about costs? MCT's Kyle Rhea 'farm' will cost £40M and produce only 5-8 MW at peak which is over £5M/installed MW, 5 times the cost of onshore wind and twice the Severn Barrage. This is not encouraging. Nor is the fact that all the electricity is being generated miles from where it is needed. Actually getting a device in place is an expensive business. A high tech barge, which may cost £50,000/day, is required. These are few and far between and much happier putting in scores of offshore wind turbines at one farm than a single tidal turbine down a remote estuary. Should the device be fixed to the sea bed? If it merely rests on the sea floor will it slew out of line with the current?

Initially every unit of tidal electricity generated in the UK received a subsidy of about 10p but this increased to 15p for those in Scottish waters from April 2011. The 10p rate is a mistake. It is no more than paid to offshore wind which is a more mature and thus less risky technology and will provide easier pickings.

Frankly the Government needs to give every incentive to establish which devices are the best and whether they can produce electricity at any kind of reasonable cost as quickly as possible. Unlike wind, tidal electricity output is predictable. Unlike wave energy tidal turbines are protected from the worst storms. Unlike a barrage they can be installed one at a time as needed. Placed around our coasts output would 'peak' at different times so increasing their overall usefulness.

Estimates suggest 20 TeraWatt hours of electricity could be generated each year (over 5% of UK total demand) which would require some 6,000 MW of capacity or 5,000 SeaGen or equivalent turbines. Perhaps 20% of that could arrive by 2020. A useful quantity of renewable energy is within our grasp but Government must give the right financial encouragement.
