

WAVE AND TIDAL STREAM – WILL IT ALWAYS BE JAM TOMORROW?



By Angus McCrone, Chief Editor, Bloomberg New Energy Finance

At Billia Croo on Orkney's main island, off the north coast of Scotland, lush green fields slope down to the Atlantic, populated by plenty of well-fed cows and one utility-scale bull with a ring through its nose. More importantly, there is also a view unique in the world clean energy sector – three wave power devices, each very different in appearance, parked out at sea.

The fact that the three – Aquamarine's 800kW Oyster 2, resembling a giant flap, Pelamis' 750kW P2 with the look of a giant red snake, and Wello's 500kW Penguin, resembling the yellow hull of a ship – are all in the water, the first two of them generating electricity for the grid, is evidence of a new, more grown-up phase for marine energy.

Marine – wave and tidal stream – has tested the forbearance of its investors. Over the last five years, there have been a lot of premature noises from firms about early commercialisation, and about cost-competitiveness with offshore, and even onshore, wind. One of the leading wave power companies raised \$100m in an initial public offering on Nasdaq in April 2007, and has since seen its market capitalisation shrink to \$26m, less than the value of the remaining cash on its balance sheet. Overall, on Bloomberg New Energy Finance estimates, the 12 leading companies had burned through \$600m of investor capital by the middle of last year – and most are still not within sight of profitability.

No wonder it has become far harder for the leading technology developers, plus the approximately 20 up-and-comers, and the 50 or more earlier-stage businesses, to raise venture capital finance than it was five years ago. The biggest VC financing in wave or tidal in 2007 was \$57m according to our database. The largest in 2011 that has been disclosed was \$20m, the largest this year so far just \$8m.

However something else has been

stirring, and that has been the interest of the engineering and industrial majors. In the last three years, Siemens, Rolls-Royce, Andritz and French naval defence company DCNS have bought minority or controlling stakes in the tidal device makers Marine Current Turbines, Tidal Generation, Hammerfest Strom and OpenHydro respectively - while ABB and Alstom have done similar with wave energy specialists Aquamarine Power and AWS Ocean Energy.

As Neil Kermode, managing director of the European Marine Energy Centre, host of the three wave devices at Billia Croo and three tidal machines off another Orkney island, puts it today in an interview in our weekly newsletter, Clean Energy & Carbon Brief: "These companies don't have to do this, but they want to - and that is hugely important recognition that this sector has moved far beyond the man-in-a-shed businesses."

TIME IN THE WATER

The other thing that has changed is that more devices are spending longer in the sea, generating electricity for extended periods. There is still a lot to prove on this, since most devices (with the exception of MCT's 1.2MW tidal machine off Northern Ireland, Wavegen's 500kW Limpet on the shore of western Scotland and Ocean Power Technologies' small 40kW wave buoy off Hawaii) have not yet weathered a full calendar year, with all that the seasons can throw at them. However the Northern Hemisphere winter of 2012-13 will likely be the most

revealing test for the industry yet - with five or six companies planning to have MW-scale devices generating throughout those months.

Survivability is the issue that wave and tidal technology firms need to crack first. Unfortunately, there are likely to be setbacks, given the harshness of the salt water environment, the size of waves (Billia Croo saw them up to 17 metres in the winter before last), the differing periods between waves, and the challenges of keeping devices fixed to the sea bed.

Even if we can report in a year's time that several companies have shown first winter survivability with MW-scale machines, the industry will still have many other hurdles to clear. One is reliability, a second maintainability, a third performance. In theory, wave devices ought to boast capacity factors of 35-40%, comparable to offshore wind with a bit more predictability. Tidal stream devices ought to match that, and also offer full predictability - a valuable characteristic when combined with storage such as pumped hydro or batteries.

And then we come onto cost. Bloomberg New Energy Finance's levelised cost of electricity model shows wave and tidal stream technologies at the far end of the spectrum at present, generating at more than \$400 per MWh. This compares to averages of \$68 for combined-cycle gas turbines without any carbon cost, \$82 for onshore wind, around \$160 for the different PV technologies, and \$230 for

the most expensive of the established renewable power sources, offshore wind.

Now, marine's supporters might counter that our LCOE result for the second quarter of 2012 is conservative, and that lower cost-of-generation figures will be possible soon. However, given the shortage of hard data, and proof on survivability through the seasons, we prefer to be much more cautious than one wave device maker that claimed in August last year that its technology is "now commercially competitive with other forms of renewable energy, such as onshore wind".

Where we do agree with the industry is that big cost reductions will happen between now and 2020. One driver will be familiar to everyone in the wind or PV sectors - mass production. A second important driver, for wave and tidal as for offshore wind, will be installation techniques.

If installation always relies on a relatively small number of ships with large cranes, then costs will remain high. However several companies are now making progress with new approaches, such as Tidal Generation with a nacelle that floats and can be towed behind a boat before being fitted to the sub-sea structure.

A third driver is weight, or to be precise, mass. Research we did last year showed that current onshore wind turbines produce 7kW to 10kW of power per tonne of steel, whereas the equivalent figures for most wave devices were between 1kW and 2kW, and for tidal, between 2kW and 4kW. Total mass has an influence on the installation cost, and total mass of steel has a big impact on overall capital cost.

Efforts are being made in the marine energy sector to improve these figures, although most companies insist - correctly - that the first thing must be to produce machines that survive, and then work on making each generation of machine less costly than the one before.

Pelamis is experimenting with the use of concrete rather than steel for a large proportion of the material in its device. Aquamarine is looking at fibre-reinforced plastic for its flap, instead of steel.

Where does this all leave wave and tidal power? Well, one message is that the sector now has firmer foundations than it did in the last decade. It now has the support of the engineering majors, and some serious outside companies such as Kawasaki of Japan are starting to nibble at the industry with their own devices. Technology developers have also shown an ability to survive without frequent, large infusions of VC cash, thanks to collecting project grants from governments and selling machines to utility partners. Nevertheless, the shake-out that has already seen a couple of casualties is likely to gather pace in 2012-14, particularly as some technologies either fail to hit performance milestones or develop faults.

TIDAL VERSUS WAVE

Another message is that tidal stream looks to be at least a year ahead of wave. There are a few different types of device in tidal (three-bladed turbines from Atlantis, Andritz Hydro Hammerfest and Tidal Generation; a pair of two-bladed turbines from MCT, a single turbine with a hole in the middle from OpenHydro), but each of the main players has had utility-scale devices generating power for a time, and several are committed to install multi-MW projects by 2014-15. They have done enough to convince RES, one of the world's largest builders of wind farms, that tidal's time has come and that it should get into the engineering support business for tidal projects.

In wave, the diversity of device species is far wider, and I suspect the evolutionary shake-out will be more violent. There are big projects at the development stage such as OPT's planned 10MW array at Reedsport, Oregon, but most full-scale devices still

have to prove ocean survivability over the seasons before these can proceed. And then show increasing cost-effectiveness. The Renewable Obligation register maintained by the UK's regulator, Ofgem, shows that in the 2011-12 financial year, tidal power (mostly MCT's device in Northern Ireland) earned 2,379 certificates, while wave power earned just 35. That is a measure of how much wave still has to do to prove itself. The earliest most firms can hope to have multi-MW projects generating is probably 2016.

The early customers for wave and tidal stream power look set to be the UK - the focus of the greatest amount of activity at the moment - Canada's Bay of Fundy, Australia (where device makers Oceanlinx, OPT and Carnegie have conditional government grants agreed for projects), and Portugal. By the second half of this decade however, it would be no surprise to see China and Japan emerging as markets.

The UK has set an aspiration to reach 1.3GW of wave and tidal stream capacity operating by 2020, producing 3.95TWh (implied capacity factor 35%), under its National Renewable Energy Action Plan. Last year, we estimated that would be likely to cost some \$8bn in capital outlays. Given the likelihood that the industry will continue to inch forward through ocean testing in places such as EMEC, to pre-commercial arrays, and then the first commercial projects (third-party equity and debt finance, or utility balance sheets, allowing), 1.3GW by 2020 may well be too ambitious.

Those cynical about marine power - and there are many, particularly among those familiar with more mature renewable energy sectors such as wind and solar - might say that with wave and tidal, it is always "jam tomorrow".

Bloomberg New Energy Finance is gradually growing in confidence that there will be jam one day - just not today, or tomorrow. And most of it not till the 2020s.