7th PRIMaRE Conference 7th – 8th July 2020 hosted by University of Plymouth and Plymouth Marine Laboratory

Please find below the answers to questions posed to the Invited Speakers during the live Q&A sessions. Their full presentations can be viewed on the recordings of each session.

Wave Energy Session I Invited Speaker – Hongda Shi

1. **Wave energy technology is often seen as very expensive compared to competing renewable energy sources; what do you think are the major challenges needing to be overcome?**

Answer: The cost of the wave energy device for safety is much more than that for energy capture and electricity generation. So, the main challenge would be making the foundation save with low price, and that's why we are seeking the way of wind-wave hybrid system.

2. **How do you deal with the decline in buoy performance on the jacket platform which is integrated with the wind power plant during low tide. Is the design adapted to the lowest low tide?**

Answer: The buoy its self is floating, but the rotation axis of the arm is fixed on board of the platform. The maximum tidal range of the selected sea area is about 3m, and the length of the arm is nearly 10m, So, there might be some loss of the wave energy capture during the low tide, but we think it still worth doing.

3. **Are you developing offshore wind? If yes, what kind of wind power density do you use to determine that a site is appropriate for offshore wind?**

Answer: I am not developing offshore wind, but I think the wind farm chosen should be also the farm for wave energy. The total resource of the wind energy in Shandong province is approximately 6.7E10kW.

4. **Are you happy to deal with low TRL technologies?**

Answer: Yes, because every technology comes from low TRL stage, but if it remains no more progress, that will be the end.

5. **Most study is in preliminary? Any actual deployment of prototype in the ocean?**

Answer: Yes for the first question. For the second, there are several prototypes seatrialed, among which the number of the TEC is more than that of the WEC.

6. **How to you plan to handle the challenge of typhoons**

Answer: Its quite a challenge, especially in the far and open sea. Usually, we must have a release mechanism which makes the floaters off the gear box and fluctuate with wave freely, sometimes we lift the floaters off the sea.

7. **Regarding Tidal Blades, do you have any current projects for health monitoring? In your development, how do you take in account the maintenance costs?**

Answer: We don't have any health monitoring for blades yet, because we are focusing on the capture performance of them. I guess the maintenance cost of the tital turbine is quite high.

8. **If I understand you correctly, Zhoushan archipelago is the candidate for the first deployment of tidal stream energy. Do you have a planned timescale for when devices might be installed here?**

Answer: You are right, actually, Zhoushan archipelago has been already deployed several tidal turbines. You can find the information from Zhejiang University Website for ZhainuoShan island.

9. **Do you have a view on the benefits of floating tidal devices compared to fixed bottom designs. Do the risk of typhoons make fixed bottom devices more favourable.**

Answer: I do think a bottom fixed tidal device is better than a floating one in both safety and efficiency. But one of their key techniques is the adaptability to the flow direction.

10. **what is the time frame to have a fully operational tidal energy farm in southern China?**

Answer: more than 5 years.

<u>Cross-Cutting MRE Session I Invited Speaker – Steve Jermy</u>

1. **Is this solution cheaper than other solutions such as windfloat or other semi-submersibles?**

The sector hasn't settled on a particular technology. The options currently include:

- Spar – as at Hywind;
- Semi-Sub – of which windfloat is one;
- Barge – such as Ideol;
- Tension Leg Platform – at a lower TRL at the moment, so we're less likely to see this in the next 5 years;

2. **The Hywind project has now extended to a pilot to connect and electrify 2 x offshore North Sea O&G platforms which will hugely reduce the carbon footprint by reducing fossil fuel reliance for power generation at those platforms. As well as domestic electricity supply connected to mainland, do you see any other opportunities where floating offshore wind can be employed to reduce impact to climate change?**

I think you'll find that its Equinor, rather than Hywind, which are moving to O&G platforms and in the Taipem project, circa 80MW. As regards other uses offshore, then the most obvious one would be delivery of hydrogen for non-domestic uses, my first preference being for maritime transport.

3. **With respect to upscaling of floating wind towards commercial scale floating windfarms (with the learning of Windfloat, Hywind and other development scale projects) what do you see are the main challenges to overcome e.g. higher voltage dynamic export and array cables; port access and infrastructure; vessel availability?**

All of the above are challenges, except vessel availability. So too The three strategic challenges are:

1. Offshore – what does an offshore installation operation to install large scale FLOW projects look like? No one yet knows.

2. LCOE – how do you accelerate cost reduction? We simply need to get projects into the water, so we can learn by doing.
3. Planning – how do you reduce the current offshore wind farm planning cycle, where it takes 8 or so years to get a wind farm in the water.

4. Will you rename the Wave Hub to Flow Hub?

We will almost certainly rename, but I suspect not to Flow Hub, given that we're divesting the site. I anticipate, though, that FLOW will be in the new name somewhere!

5. Is hydrogen production being considered in Celtic Sea

In principle yes but in practice no, however this is only because we are at a very early stage in sector development.

<u>Tidal Energy Session I Invited Speaker – Simon Cheeseman</u>

1. What are the struggles that Tidal Stream have besides production costs? Is maitenance costs a big problem? If yes, how are you trying to avoid those costs? Is it UK working with health monitoring systems to try to reduce those costs?

Maintenance costs not yet fully understood as devices have not been deployed for long enough. The more we deploy, the more we learn, the more we spot areas to reduce costs, do things quicker.

2. Near the start of the presentation, there was a predicted growth chart for wave/tidal deployed capacity that had come out of the ETIP report in 2012. The first prediction was for 2020 - now that we're in 2020, how are we doing vs. the predictions from 2012?

We are not doing well against any previous deployment predictions. The big hurdle was created when the UK Government removed the ring fence around generating subsidy for Wave & Tidal. This killed the market for W&T in the UK as those systems cant compete with offshore wind in the current Contracts for Difference auction process.

3. We have been at teh critical stage for over 20 years. The costs indictae that we need to better to compete with other renewables? How can you convence the government to invest in a better way than the past?

We cant compete with the capacity and falling costs of offshore wind. However, recent Energy Systems modelling suggests tidal plays a part in a future energy mix that enables the UK to meet its 2050 targets. We need to campaign from an alternative perspective – e.g. UK supply chain capability, enabling an indigenous manufacture capability, knock on investment in coastal communities

4. Q following Simon's talk regarding technology convergence. Do you think we should be converging on a technology currently at the market or is the technology still too far off and need further development?

We try to encourage convergence through collaborative projects, lessons learnt and a desire to reduce costs through economies of scale.

5. **Where do you think projects like MeyGen sit with this learning required to drive the tidal sector?**

MeyGen is right at the forefront and have been very open in sharing lessons. Often this is driven as a requirement from European funding grants, but it does work.

6. **What about speaking about SCOE (Social Cost Of Energy) rather than just LCOE (Social Cost Of Energy). Could that be a way to convince our Government?**

Some of those SCOE issues form the backbone of the UK Governments Clean Growth – 3 tests. Our 2018 Wave & Tidal cost reduction report assessed these, GVA, jobs, return on treasury investment. One area we didn't hit was Social effects, maybe too obvious it passed us by. At the end of the day we need to talk in terms the Government understands.

<u>Wave Energy Session II Invited Speaker – Pater Mazurenko</u>

1. **What type of Control have you implemented with in the PLC? Passive or Active? Thanks**

In terms of PTO control, the control system used would be categorised as passive. The PLC provided the interface between the device sensors, wireless network, damping and safety systems. While the PLC allowed the user to control the pendulum damping coefficient, via activation of relays directing the path of current through the 3 load bank immersion heaters, the system did not exhibit active control, i.e there was no dynamic control of pendulum motion to match the seastate. Active control has been identified as a key development in order to bring FPDVA performance up to the theoretical maximum for pitching WEC devices and we have seen positive progress integrating it into FPDVA's.

2. **It is often said that the wave energy sector needs to achieve design convergence to progress and see cost reduction - what are your thoughts on this?**

I would agree that wave energy requires economic incentives to be widely adopted. Wave energy technology needs to reach a commercial tipping point before commercial adoption and rapid development will occur. Prior to a global shift towards renewable energy and the widespread adoption of wind energy, decreasing the cost to produce wave energy (via reduced technology cost from technology convergence and technological breakthroughs) was likely the only method of reaching this tipping point.

We have seen that the huge development costs (easily $100m+) required to bring a WEC device to commercial readiness are insurmountable if working against a commercial gradient. This in my opinion is why technological convergence has not occurred and will not occur without market support. The small number of maverick developers prepared to take on this risk does not provide a big enough base to iteratively converge on one technology.

The reason AMOG has invested in wave energy is because market forces are shifting. Our increasing reliance on wind energy has driven a need for supplementary renewable energy sources to regulate utility scale power supply. Wave energy fits perfectly into this category and has already attracted attention from large firms forecasting future opportunities. Upon commercial implementation, it is certain that wave energy technology will rapidly converge as developers race to capitalise and improve upon the winning formula.

In summary, I feel the statement is true. It's just that the financial cost of achieving convergence is so great that without economic incentives it is almost impossible and once economic incentives are in place convergence to some extent is a given.

3. **Would you change the PTO for the full scale device?**

The fully developed full scale device will have a hugely different almost unrecognisable PTO. We have done a lot of work looking into linear generators and direct drive high pole number generators which are starting to be a focus of the wind industry. Either of these we would look to incorporate into our next device iteration. Using either means that a gearbox would no longer be required and the device would simplify further.

Tidal Energy Session II Invited Speaker – Beth Scott

1. **Thank you for a very interesting presentation. With regards to ecological impact of array design is a smaller denser array better or worse than a less dense array over a larger area?**

Answers: The ecological impact of array design is very dependent on which species are using the areas where the arrays are placed. For instance causing a barrier in a tidal stream can have important effects on the migration routes of pelagic fish (i.e. herring, mackerel, also consider – Basking Sharks) and may very much increase the possibility of collision for mammals (seals and cetaceans) as they have less room to manoeuvre around densely placed turbines.
Other issues for larger arrays – can be the daily displacement (possibly large increases in the use of energy for travel) of nesting seabirds and pupping seals – which have to leave and return to nests/beaches, for seabirds this can be several times a day to find food for chicks/feed for themselves – and the evidence in from radar studies in the North Sea show that 99.9% of seabird individuals will avoid the entire area with the turbines. New work in Pentland Firth from tagged seals shows similar large avoidance rates of seals when tidal turbines are running.

2. **Are the differences shown in the Kittiwake/sandeels impact plot (ECOWATT2050 slide) determined from coupled hydrodynamic and IBM predictions, or inferred change based on understanding of hydrodynamic change mean patterns?**

The work behind these outputs can be found in methods paper in
2017 https://doi.org/10.1002/ece3.3081
and climate change paper in 2020 https://doi.org/10.1002/ece3.5973

We used Bayesian hierarchical hurdle and zero-inflated joint models with integrated nested Laplace approximation (INLA), to fit
joint models (both predator and prey are response variables). We used 25 years of data (1989-2014) to test the relationships between predator/prey overlap and which bio-physical variables (from NEMO+ERSEM – a 3D hydrodynamic model coupled to an ecosystem model) gave best fit. In the climate paper we used NEMO+ERSEM projections of 25 years centred around 2050 to capture inter-annual variation to make the mean values for 2050.

Cross-Cutting MRE Session II Invited Speaker – Andrea Copping

To follow