Context:

2014
In the last decade there has been significant growth in Ireland's renewable electricity generation output, driven largely by onshore wind. 19.6% of Ireland's electricity demand was met by renewable sources in 2012, with 15.3% being met by onshore wind. This rate of progress towards our target of meeting 40% of electricity demand from renewable sources by 2020, places Ireland at the forefront of renewables development. However, there is no room for complacency.[1]

2018
Being the worst performing European country in the CCPI, Ireland ranks 49th. .... Ireland is one of the few EU countries to miss its 2020 emissions targets under the EU effort-sharing decision.... Its performance in the field of GHG emissions is also very low as the country is nowhere near close to being on track concerning its well-below-2C compatible pathway ... We observe a very positive trend in the development of renewable energy .... but the current share ... as well as the 2030 target ... are insufficient... [2]

This mid-term review of the OREDP is to be welcomed.

Here is a contribution to that review from a person with over 20 years' experience of attempting to deliver a commercially viable wave energy conversion (WEC) technology suitable for Ireland's NW Atlantic resource. A short commentary on the fundamental issues is followed by responses to the questions posed in the Mid-Term Review.

Fundamentals

Goals

Avoiding catastrophic climate change is the paramount issue facing humanity. We in Ireland can, - and must, - do more to reduce our GHG emissions. Ocean wave energy was identified as Key Technology 1 in an energy review almost twenty years ago[3]. Electricity from ocean wave energy can replace several coal-fired Moneypoints and power the bulk of our road and rail transport systems. To do so at an acceptable cost and within the next decade is now most certainly possible, given the right technology and the necessary support and commitment to make this happen. More on these, below. Other major and well-documented benefits will follow.

In 2014 the OREDP set three high level goals of equal importance, in summary:

- Harness the market opportunity of offshore RE
- Increase public awareness of the benefits
- Avoid adverse environmental impact

Good progress has been made on assessing environmental impacts of OE developments, but no progress yet in terms of actually reducing GHG emissions. Recent (but localised) problems with the Galway Bay test site suggest little progress in terms of public awareness of the benefits.

At this Mid-Term stage the focus should be on the first of these goals, and that would seem to be very clearly reflected by the ten questions posed in the Review[4]. An effective, operating, offshore,

[1] Introduction to *Offshore Renewable Energy Development Plan*, DCENR, February, 2014
[2] Climate Action Network, Results 2018. https://germanwatch.org/en/download/20504.pdf
[3] *Technology Foresight Ireland, An ICSTI Overview*, Forfas, 1999.
[4] Q9, *Environmental Monitoring* and the EIS/NIS Guidance Documents are directed at ORE developments.

pilot array, a flagship project, will go a long way to enhancing public awareness of wave energy and in resolving environment impacts.

Simply put, the **OREDP must now concentrate on identifying a commercially viable WEC technology.**

The resource

The best of Ireland's wave energy resource is in water depths greater than half a wave-length. In terms of the seas off the West of Ireland, that means **depths greater than 100m**[5]. Ireland has ready access to an enviable energy flux at these depths. Other things being equal, the levelised cost of electricity falls off rapidly as the energy flux diminishes, which it does, exponentially, as the water shallows.

The technology

The theory of wave energy absorption by oscillating systems is now well established, - more so than is necessary or of practical value at this stage of WEC development.

Much has been learnt about the practicality of wave energy conversion over the past forty years, often learnt the hard and expensive way. The European Commission stresses two criteria: **survival** and **reduced costs**. Surviving 60 million or more oscillations over a 20-year project life in an at times extremely harsh environment is a serious engineering challenge. Sensitivity analysis shows that costs/kWh are best reduced by minimising maintenance costs and maximising power delivered.

These challenges and offshore experience gained help define the 'ideal' ocean WEC for an Irish site, for example:

- Sea-worthiness: a single floating body, preferably axi-symmetric, on dynamic (shock-absorbing) moorings, otherwise independent of the sea-bed. Fail-safe is essential. Importantly, and not generally recognised, the commercially most rewarding opportunities will be during winter months. Hence high availability through the winter.
- Low maintenance costs: an energy absorber (the main hull) that may stay on site for 20+ years; all key components readily accessible and above the waterline; plug-in PTO modules suitable for in-factory servicing.
- Maximum recoverable power: The North Atlantic wave climate is markedly seasonal and may change rapidly. Consequently any WEC should be able to adapt to changes of the incident energy, by tuning and by having a modular PTO. Energy varies with the square of the wave-height; the WEC should operate efficiently in waves up to 8m Hs.

Public sector funding, via **OREDP, should be focussed on those technologies that can credibly show that they may meet criteria such as these**, and in deep sites. This becomes critical when the proposed technology advances beyond TRL4 towards prototype sea trials.

[5] Based on the distribution of total available power.

Responses to questions

1. *Do you have any suggestions or additional measures to support and enhance the governance structures of the OREDP?*

Once successful, ocean wave energy conversion technology necessarily becomes a major enterprise. There will be opportunities for export of technology including control software. The best of the emerging technologies must therefore be seen as potential HPSU's. The OREDP offers no assistance to, and little understanding of, the corporate and financial needs of emerging SME's. Should not Enterprise Ireland and the IDA now participate in the ORESG?

2. *Do you think that the Exchequer support for Ocean Energy RD&D has been sufficient?*

The estimated cost of taking an ocean energy device from drawing board to prototype ranges from €50 m to €100 m, depending on technology and scale. Public authorities should maintain significant levels of grant funding programmes sufficient to enable testing, demonstration and improvements of full-scale prototypes.[6]

The State's financial support for OE has been sufficient up to now, perhaps more than sufficient, but if all goes well, greater investment will be justified. Meanwhile, there is a need to review the allocation and administration of these funds. In the case of the Prototype Development Fund, the process needs to be streamlined and long delays removed, see answers to questions 7 and 8, below.

3. *Has the distribution of the Exchequer support been appropriate and can you suggest alternative areas that require additional Exchequer support?*

Academic and training: There is a greater and wider need for naval architects and experienced offshore engineers than for further expertise in advanced hydrodynamics or control theory in the absence of a commercially viable technology. There is a conspicuous lack of attention to the issues of immediate importance: designing for the survival of massive oscillating systems offshore and for minimising maintenance costs. A disproportionally high share of the available funds has been allocated to typically rather narrowly focussed post-graduate research, leading to more fresh doctorates than can possibly be absorbed by a technology that has yet to emerge, especially when they have little or no hands-on experience of the offshore environment.

Wave tanks: Europe is well provided with test tanks and test sites, essential assets for the R&D required to deliver a commercially viable wave energy converter. Wave tanks and flumes have wide use in regions with strong traditions in ship design and ship building, whether for commercial, naval, or recreational purposes. The Lir facilities are now established and will have a continuing value as a teaching and research facility; presumably there is less need for further investment at Ringaskiddy. It's unfortunate that the Lir Deep Ocean Basin is not deep enough for spar-buoy point absorbers, an important class of devices[7].

Test sites: See answers to questions 4 and 5 below, but note that there's no secure and equipped facility in Ireland for low cost / reduced scale sea trials. Such a facility provides a useful hurdle to be cleared by early stage developments.

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[6] OE Forum *Strategic Road Map*, prepared for the European Commission, October 2016, https://webgate.ec.europa.eu/maritimeforum/en/node/3962

[7] For example, the Grande Bassin at ECN (Nantes) is 5m deep, with a 10m central pit; similarly the BGO First at Océanide (Toulon). We have used both, preceded by still water tests at the 14th Lock of the Grand Canal, free, with permission from Inland Waterways.

Mature technologies: It would be quite inappropriate for the OREDP to financially support mature or close to commercial technologies that are bankable and/or backed by major industries and project developers. This would include onshore and offshore wind. Hybrid systems (wind /wave) are technically suspect. There *could* be a case for supporting innovative early stage (before TRL7) floating wind turbine technologies where the IP resides in Ireland. But the OREDP would do well, in an Irish context, to prioritise ocean wave energy RD&D.

Prototype development fund. The nature, staffing, and administration of this vitally important State support for ocean energy has to be the crucial topic to be addressed in this Mid-Term review. Why isn't it working better? Why is it so often criticised? It can and must be greatly improved. This is discussed in Question 7, below.

In summary, the allocation of Exchequer support for ocean energy should be re-prioritised:

- Less funding for
    - post-graduate research in the 'traditional' OE topics
    - Lir and MaREI facilities at Ringaskiddy, as these are now virtually complete
- Increased support for
    - graduate courses and training in naval architecture and offshore engineering
    - AMETS, - this should become a test site of World importance
    - Prototype RD&D, in particular after TRL4
    - Emerging micro-enterprises in the OE sector

4. *Do you think sufficient progress has been made on the development of the Atlantic Marine Energy Test Site in County Mayo?*

AMETS is most important, and will be an exceptional and important facility in World terms. A detailed analysis of the wave climate for the AMETS Outer Berth shows it to be in a different league to Billia Croo at EMEC. There will be, and to be hoped soon, a need for full data logging, operator facilities and support services.

WestWave is quite a different proposition. AMETS will provide a valuable and necessary stepping stone before commissioning pilot wave farms in deep water, ie where the best resource is to be found. WestWave (maximum depth LWS 45m) could be an alternative to Galway Bay, or as a test site for floating wind turbines, but is unlikely to have the long term commercial potential for wave energy to be gained from deep water sites.

5. *Do you agree that significant progress has been made on the Galway Bay Marine and Renewable Energy Test Site and that it is having a positive impact on the development of the offshore renewable energy sector in Ireland?*

Galway Bay has its problems. 22m at low water springs is too shallow at for the prevailing wave climate and consequently prone to scend when Atlantic swell predominates, as it often does. This, and a tendency for a confused wave climate (short period wind waves and longer period ocean

waves) makes for an interesting, if useful, challenge. The shallowness makes it quite unsuitable for devices of significant draught such as point absorbers when scaled to suit the local wave climate[8].

There's a confused signal here, - surely the priority has to be to get a WEC technology working and to get power from Ireland's ocean energy resource into the grid, preferably with an Irish technology? That means making use of the best available test sites, wherever they are and without inhibition. The wave climates and water depths at the Bay of Biscay sites, BiMEP and (to a lesser degree) SEM-REV, are more suitable than Galway Bay for intermediate scale sea trials. As for the risk of companies leaving Ireland, it's probable that a successful WEC technology will attract a big multi-national corporation. But the Irish wave energy resource won't move, and is expected to improve[9].

There's no secure and equipped facility in Ireland for low cost / reduced scale sea trials, such as that at Nissum Bredning, Denmark. Such a facility provides a useful hurdle to be cleared by early stage developments.

6. *Do you think that there is a positive impact from the development of the MaREI Centre and Lir National Ocean Test Facility?*

Not sure about Lir, having made good use in the past of the HMRC when at the Old Munster Agricultural College and later when at Pouladuff. The Lir facility is intended for support services up to TRL4. The Deep Ocean Basin isn't suitable for spar-type point absorbers larger than ~ 40th scale sized for the N Atlantic. An offer of temporary contract work made to a recently qualified UCC post-graduate was deflected to Lir and then unrealistically priced.

7. *Do you believe that the PDF is a suitable funding structure for the sector?*

The SEAI is very positive about the future of wave and tidal energy technologies for Ireland. The renewable energy resource available off Ireland's shores is truly massive,[10] re-affirmed in the stated objective of the SEAI Prototype Fund: *to accelerate and enhance support for research, development and deployment of wave and tidal energy devices.* [11]

The comment in the Review that Prototype development Fund *remains a viable and popular funding source* must be questioned, and may reflect that fact that only one of the Key Stakeholders consulted, IWEDA, represented actual wave energy developers. The Prototype Development Fund is the only port of call for small or micro enterprises in this sector, so it has to be 'popular'.

But the execution and adminstration of the fund is far from perfect. The fund[12]:

- does not encourage international co-operation:
  - *In some circumstances, the programme may support Irish entities on work undertaken overseas, where it is necessary for the completion of the work. In*

[8] Wavebob was the first to use the site (20th March – 19th May 2006). The wave climate suggested a nominally ¼-scale device, but the allowable draught was far too short for sufficient metacentric height and it pitched excessively. There were other problems.

[9] See Figure 7 in: http://www.met.ie/publications/IrelandsWeather-13092013.pdf

[10] Brian Motherway to Dail Eireann, http://oireachtasdebates.oireachtas.ie/Debates%20Authoring/DebatesWebPack.nsf/committeetakes/TRJ2012112100003

[11] *Ocean Energy Prototype Research and Development Programme Application Guide*, SEAI 2015

[12] The quotes in italics that follow in this answer to Q7 are from the Application Guide

exceptional cases, funding of work overseas may be supported where there is a demonstrable contribution to solving Irish issues.

- restrains where it should accelerate:
  - *The indicative decision time from the receipt of a completed application is from 8 to 12 weeks*
  - *Expenditure incurred before [the date of approval] is ineligible. Therefore Applicants must not begin any work for which funding is sought before the date of approval.*
- is unrealistic:
  - *The total grant amount will not be permitted to escalate under any circumstances, once approved.*
  - *Only new products shall be installed for the purposes of the project.*
- is averse to risk, when it should 'enhance support':
  - *Availability of financial resources must include the total value of the project including the SEAI grant amount.*

The Ocean Energy Prototype Development Fund, as presently constituted and administered by the SEAI, has been criticised by many of those that it should be supporting and encouraging. As presently set up and administered, it is most emphatically not fit for purpose.

- Under-staffed: in practice a single person interfaces with entrepreneurs wishing to access the fund.
- Slow response time: the processing of applications can take an inexcusably long time. For example:
  - Following consultation with SEAI, an application for support for a €21k feasibility study was submitted 29th August, acknowledged 4th October, refused in January. Over four months to make a decision on a €15k grant.
  - An OCEANERA-NET application, 2nd Call, 2nd February 2016; OEDU application submitted by the Irish partner to SEAI 17th May, 2016, full proposal approved by OCEANERA-NET 11th November 2016, Irish partner approved by SEAI 26th June, 2017. SEAI could have processed and approved the project in advance of and subject to OCEANERA-NET approval. Instead it took over a year.
  - An urgent, un-anticipated, and no-cost amendment to the tasks within a well-defined category took five months from notification to approval. It could have been an executive decision made within a day.
- Excessively bureaucratic: the system for processing grant claims is nit-picking and frequently irrational. It is time-consuming and can be immensely frustrating.
- Financially onerous: the applicant has to 'bank' a project from the time of first assembling the proposal until receipt of the first progress payment, - a total of 23 months in the case of the OCEANERA-NET example above.

Note that these are criticisms of the rules and systems within SEAI, not of any individual.

SEAI disciplines that may be appropriate for managing grants for fitting domestic solar panels or attic insulation are not the best where the intention is to *accelerate and enhance support for research, development and deployment of wave and tidal energy devices.*

8. *What if any improvements would you suggest?*

OE technology developers that wish to access the PDF tend to be very small enterprises, usually with no top line revenue. From about TRL3 / TRL4 onwards the costs of the necessary R&D rise rapidly, as do the fixed monthly overheads. Developers that have reached this point should have established a

track record with the funding agency. At this stage the SEAI could usefully adopt an increasingly supportive role, more than merely administering a grant scheme.

Reduce the administrative burden:

- Speed up all processes, set targets.
- Note carefully the EC recommendation: *Innovation funding processes need to be less bureaucratic, more flexible and more responsive, to match the fluid nature of innovative technology development.*[13]
- Discuss and agree appropriate lump sum costs for specific project overheads such as travel and accommodation, and leave it to the proposer to make best use of the available funds.

Ease the financial burden:

- Allow the R&D project to commence once the OEDU application has been received and validated, ie the developer takes the risk of no grant if the proposal is rejected. This saves valuable time at no cost to the State.
- Adopt the EC Framework pattern, a significant fraction (say 1/3rd) of the approved funds is transferred once the proposal has been accepted.
- Allow a percentage to cover administrative and office overheads.

Once above TRL4, focus on potential winners:

- Measure the technology against pre-set criteria, with the emphasis on survival and the LCOE. Advise promoters of technologies with little prospects of success to re-consider.

9. *Do you have any suggestions for additional Exchequer support required for the development of the offshore renewable energy sector in Ireland?*

Increase support for demonstration projects:

The maximum level of support allowable to an SME for 'experimental development', taken to mean sea trials, is capped at 60%. At present it is extremely difficult to get serious co-investment before the WEC technology has been thoroughly demonstrated.

100% funding should be considered.

10. *Do you have any suggestions on how to enhance or further implement support tariffs for this sector?*

Agreed, it would helpful to increase the proposed support tariff and the total MW for wave energy. The support tariff for floating offshore wind may be less, recognising that the technology is further advanced. If extended to floating wind, then it and wave energy should have ring-fenced support schemes. It should not be extended to hybrid wind/wave technologies.

11. *Do you think that Ireland should develop offshore renewable energy resources to export electricity?*

[13] As before https://webgate.ec.europa.eu/maritimeforum/en/node/3962

Yes, but also encourage new value-adding enterprises to use the power within the State. With high average wind speeds and abundant ocean wave energy, energy costs in Ireland will in time become more competitive, especially as fossil-fuels become increasingly un-acceptable.

12. *Do you have any suggestions on further measures that can be taken to support the implementation of this action?*

Nothing further.

13. *Do you think that significant progress has been made, to develop the supply chain for the offshore renewable energy industry in Ireland?*

No immediate problems, but in this regard Ireland is a long way behind Scotland. If Brexit allows, then closer co-operation with the UK (Belfast and Scotland) could be mutually beneficial.

14. *Do you have any suggestions on how to further implement this action?*

From the perspective of a private sector entrepreneur, SEAI and Enterprise Ireland are very different organisations, with contrasting cultures. It's like the difference between 'enterprise' and 'authority'. There's a need for a bridge from the SEAI to Enterprise Ireland (and very possibly the IDA) that's open and accessible to a small OE technology *enterprise* with the potential of becoming an EI HPSU.

15. *Do you think that Ireland has been presented at home and abroad as open for business in offshore renewable energy?*

Maybe a bit of a cliché? We have the wind and wave energy resources, but right now little to compare with Scotland, France, or Spain in terms of the supply chain and technical expertise in offshore engineering.

16. *Do you have any suggestions on how to further implement this action?*

If the business is to 'sell' MaREI / Lir / Galway Bay test site, then these are being managed locally and quite effectively, but the competition is stiff. NW Europe is now perhaps over-supplied with wave tanks and test sites of various types.

A fully developed AMETS will be in a class of its own, truly a unique selling point. It is a much more powerful and challenging test site than EMEC's Billia Croo. It's like the difference between a black ski run and a red run, - and WEC technology must prepare to move 'off piste' to deep water.

17. *Does the progress section capture all the relevant information and activities that have taken place for this action since publication in 2014?*

MaRINET2, FORESEA, OCEANERA-NET and CO-FUND are welcome initiatives. As for wave energy conversion, we have an excellent chance, in World terms, of demonstrating innovative technologies that may attract the attention of multi-national corporations.

18. Do you have any suggestions on how to further implement this action?

Help the leading WEC innovators, when ready to do so, to engage with the IDA.

19. Do you think that sufficient progress has been made on the action to introduce a new planning and consent architecture for development in the marine sector?

From a WEC stand-point, progress is sufficient for the present state of the art.

20. Do you have any suggestions on how to best implement this action?

Utility-scale arrays are likely to be beyond the foreshore. There is time, before then, to define and implement the necessary regulations, taking due account of the requirements and nature of the emerging technologies.

21. Does the progress section capture all the relevant information and activities that have taken place for this action since publication in 2014?

22. Do you have any suggestions on how to further implement this action?

From a WEC stand-point, progress is sufficient for the present state of the art in the context of the Galway Bay and, yet to be completed, AMETS test sites.

23. Does the progress section capture all the relevant information and activities that have taken place for this action since publication in 2014?

Yes

24. Do you have any suggestions on how to further implement this action?

Fully agree with the suggestion that Ireland is in need of a Flagship project.

The responses above to questions 7, 8 and 9 suggest what would greatly help this respondent to develop the technology that could meet this challenge.

Thank you for the opportunity to contribute to this Mid-Term Review.

[redacted]
Swirl Generators Ltd