Ocean Energy R&D Policy

MRIA's proposals to regain Ireland's leading global position.

Marine Renewables Industry Association
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Preface

Ocean Energy – electricity generated via Wave and Tidal Energy Convertors - will have a vital part to play in decarbonising the Irish and the international electricity system, both as a source of energy and in its potential to 'balance the grid' considering Ocean Energy's temporal predictability.

Ireland has a magnificent wave resource and a notable tidal capacity. Moreover, Ireland has a global reputation in Ocean Energy arising from work supported under a past State support scheme, the network of facilities developed over the past ten years, and the reputation of Irish companies and researchers. For various reasons set out in this Paper, support for Irish Ocean Energy Research and Development, pilot device deployments etc has largely disappeared and Ireland's position among the world leaders in this field is declining.

There is still the opportunity, given the status of the global development pathways today for Ocean Energy, to regain Ireland's position among the global leaders in this area of Offshore Renewable Energy. The benefits of doing so would include, for example, the scope to develop our Wave resource utilising technology developed and tested with Irish requirements in mind from the outset and the opportunity to play a real part in the global supply chain for Wave and Tidal energy.

This Paper puts forward recommendations which address our national strengths (extensive natural resources, R&D facilities, intellectual capital, enterprising young companies) in Ocean Energy with a plan to reinvigorate the flow of new entrants to the sector (TRLs 1-3/4), enable small scale deployments of devices and subsystems in real sea conditions, notably in Galway Bay (TRLs 3-6) and facilitate test and demonstration of pre-commercial devices (TRLs 6-9) e.g., at AMETS in Mayo. Our proposal envisages a direct aggregate expenditure of c€11m spread over 5 years and would enable the targets advocated in this Paper – 50MW of Wave under development by 2035 and 3 tidal devices deployed for test by 2028 – to be achieved.

1. Purpose

The Marine Renewables Industry Association (MRIA) represents the offshore renewables industry in Ireland with an emphasis, historically, on Ocean Energy[1]- Wave energy and Tidal energy are collectively referred to as Ocean Energy. We also support the other aspects of the marine renewables emerging technologies sector (e.g., offshore solar systems) as these emerge. Our members range from offshore site developers and device makers to utilities to professional bodies and to research organisations. More details may be found at www.mria.ie.

Ireland has Europe's premier wave resource as well as leading expertise in tidal energy (although the local resource is limited) through firms with global opportunities. There is an opportunity to develop and integrate *wave energy* into the Irish energy system and to be a global leader. For *tidal energy*, the opportunity lies generally in exporting technology to global markets as the local tidal resource (estimated at 7.9GW) is focused on localised 'hotspots'. We seek support for R&D in both arms of Ocean Energy throughout this document.

The purpose of this Submission is to set out the case for renewed State support to develop the Ocean Energy sector in Ireland at three levels: first, for early developments up to TRL 3/4 and, second, those at the mid development stage – TRL 3- 6; finally, for pre commercial developments at TRLs 6-9. We believe that Ireland can return to and sustain its former leadership position in Ocean Energy for a total, direct State support to projects of c€11m[2] over 5 years. Adoption of the proposals set out in this document would make a target of 50MW of wave energy under development by 2035 and three tidal devices deployed by 2028 entirely feasible.

[1] [1] Wave + tidal energy = *OCEAN ENERGY* + solar marine and 'hybrids' (link ups between wave and floating wind devices) = MARINE RENEWABLES EMERGING TECHNOLOGIES + offshore wind energy = MARINE RENEWABLES *or* OFFSHORE RENEWABLE ENERGY

[2] This figure excludes possible expenditure on the development of the State test and demonstration sites at facilities such as those in Belmullet, Galway Bay and Cork.

2. Background

The Energy White Paper, 2007[3] set an ambitious target of 500MW of Ocean Energy capacity installed off Ireland by 2020. This target was established as part of a new and wider ambition to move away from carbon-based energy and, also, because Ocean Energy was perceived as a major *industrial* opportunity. Indeed, a study[4] commissioned in those early days by the relevant State agencies on the island (*Sustainable Energy Authority of Ireland* and *Invest Northern Ireland*) on the potential economic impact of Ocean Energy stated that a total of 17,000-52,000 extra jobs in the sector were possible by 2030!

However, the target established in 2007 proved impossible to achieve, bearing in mind that it was set for a demanding, totally new set of offshore technologies at a time when even a less challenging technology, fixed foundation offshore wind, had only started to deploy – e.g., the UK had opened its first offshore wind farm, 'North Hoyle' (with just 60MW of capacity), only three years previously while Irelands first (and, so far, only) offshore wind farm at 24MW had opened off Arklow at about the same time.

Nonetheless, in a visionary move, the Prototype Development Fund (PDF), together with a supporting team, was established in 2009 by the Sustainable Energy Authority of Ireland to support Ocean Energy. Policy support for Ocean Energy was reiterated over the years in various Government energy policy documents. A notable policy support for Ocean Energy was contained in the *Offshore Renewable Energy Development Plan* 1[5], published in 2014, which reached for the local zenith of Ocean Energy funding with a proposed pilot devices revenue support scheme. This set a guaranteed floor price of €260 per MWhr for a national maximum of 30MW of wave and tidal devices. The PDF ran until the end of 2018. A total of 113 projects were supported at a cost of over €20m. The scheme was then suspended pending a review[6].

The review found:
'*Through the fund, SEAI has assisted the ocean energy sector to grow and develop making Ireland one of the leaders in the ocean energy sector. The aim was to advance ocean energy*

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[3] *Delivering a Sustainable Energy Future for Ireland: The Energy Policy Framework 2007-2020* Government of Ireland, 2007
[4] *Economic Study for Ocean Energy Development in Ireland* SQW, 2010
[5] *OREDP: Offshore Renewable Energy Development Plan- a Framework for the Sustainable Development of Ireland's Offshore Renewable Energy Resource,* Department of Communications, Energy and Natural Resources, February 2014
[6] *Review of funding supports to the Ocean Energy Sector* SEAI Ocean Energy Development Unit, 2020

technology closer to commercialisation. The fund has helped enhance the sector through research and deployment of test wave and tidal energy capture devices, systems, and sites. However, we recognise that the needs of the industry have matured and shifted to a point where the fund as currently structured is no longer always suitable for many of the developers.'

By the time of the SEAI review in 2018, substantial Ocean Energy infrastructure and schemes, notably the SFI MaREI centre (which incorporated the LíR National Ocean Test Facility), the Galway Bay Marine & Renewable Energy Test Site etc had been set up with SEAI also contributing support to the various funding 'pots' involved.

The PDF has not been reopened since, although Ocean Energy projects have been entitled to apply to the SEAI National Energy Research Development and Demonstration ('RD&D') funding programme scheme which is not deemed generally suitable – see 3. below - by project developers for wave and tidal projects at this stage of the sector's development. The revenue support scheme proposed in the OREDP 1 was never brought into operation.

The early ambition for Ocean Energy coupled with the PDF, policy support and investment in facilities put Ireland 'on the map' for this branch of Offshore Renewable Energy. Irish based companies have featured in early wave energy developments notably the Ocean Energy company's devices and now the Saoirse project promoted by the ESB and the Simply Blue Group and recently awarded almost €40m in funding under the EU Innovation Programme. Ireland has featured too in early tidal devices (e.g., ORPC, GKinetic). The SFI MaREI Centre and Irish Ocean Energy researchers generally have featured throughout the sector's global development. In addition to technology development, the Prototype Development Fund helped accelerate the ORE ambitions generally of Irish (Ocean Energy) project developers such as Simply Blue Group, ESB and DP Energy that are now leading in the development of Ireland's offshore *wind energy* ambitions.

3. Issues with RD&D

The SEAI RD&D fund has proved to be a valuable vehicle for *academic research* on early-stage ORE technologies. The current RD&D programme delivers maximum value for academic partners in terms of fully funded tank testing programmes and finance to employ Post Doctoral Research Associates whilst also providing academic currency for the related institution's status through the publication of papers on novel ORE technologies.

However, from an ORE *technology developer's* perspective, the way that the RD&D fund is structured does not enable engineering design development, fabrication, installation, and testing of prototypes in real world environmental conditions at marine test sites such as the Galway Bay Marine & Renewable Energy Test Site.

Early-stage ORE technology developers tend to be small private firms with limited financial resources who struggle to meet the financial contributions required to comply with EU funding regulations under the RD&D programme. Academic institutions, by comparison, receive 100% grant funding. This funding imbalance means that most ORE technology developers can only afford a limited work scope that *excludes* engineering, fabrication, and testing of prototypes. Unfortunately for early-stage ORE technology developers, the best they can hope to achieve through an SEAI RD&D programme is to verify very small-scale design assumptions and maybe obtain some industry exposure for their technology. The reality is that one week of test data on an ORE prototype at sea is worth months of extrapolated tank test results on small scale models.

Further challenges with the RD&D programme for Ocean Energy technology development include:

- *Timeline-1*: Currently, the RD&D programme offers Calls on an annual basis, with a relatively short application window. This doesn't always line up with when companies would ideally carry out work to accelerate their technology: e.g., a project finishing today would need to wait until May 2024 to apply for a follow up project, which would only commence in Feb 2025 in the most optimistic case.
- *Timeline-2*: The review process currently takes much longer than other funding programmes. Based on previous years experiences, this amounts to 7.5+ months for an RD&D application while, for instance, Horizon Europe takes about 4 months. Added to the point immediately above, it makes it difficult for a company to propose a novel/disruptive project as the feedback cycle would result in a long wait time before a proposal can be improved upon, resubmitted, and eventually awarded funding. A more flexible programme, allowing for shorter, discrete projects, would allow for accelerated, sequential R&D activities.
- *Scope of eligible activities*: previous SEAI feedback has suggested that necessary activities for supporting OE project development, e.g., site

characterisation and engagement on permitting, are not considered as innovative and are ineligible or score poorly at the evaluation stage.

- *Limited engagement by SEAI*: Because it is a formal process in a narrow window, SEAI have not been forthcoming with advice/feedback on how to shape a proposal. Again, this can lead applicants to taking a more conservative approach in their applications to ensure that they are 'fundable'. Clearly there is a balance to be struck and, in the past, there was too much of an expectation on SEAI to help get proposals in a suitable state prior to application, but things have since perhaps swung too far the other way.
- *Evaluation Criteria*: the expectation by project promoters is that projects must hit a lot of different needs beyond producing impactful technology/project development work, e.g., policy impact, social impact, public engagement. These are very commendable and appropriate within the context of RD&D. However, a dedicated Ocean Energy technology development programme with a more focused set of requirements would be preferrable and avoid projects that are trying to fit in too many disparate activities alongside the core priorities to ensure they get funded.
- *Up-front funding*: Horizon Europe and other programmes provide successful projects with a share of the funding as an up-front lump sum. This is particularly important for helping companies to manage their cash-flow in CAPEX heavy projects where there are high costs for building devices etc. that the company would need to bear before drawing down funding. Additionally, processing of financial claims for funded projects is slow, which also has implications for company cash-flow in large project.

The Irish ORE industry needs: a better balance between academic study and real-world testing of large-scale ORE devices; new ORE funding mechanisms (two proposals are set out at 7. below) with an emphasis on engineering, building, and testing of devices in real-world environments would provide that missing key to help unlock many high potential early-stage ORE technologies. Academic institutions and technology developers both agree that the deployment and testing of ORE prototypes in a real-world environment would accelerate technology development.

It is noteworthy that other countries are ramping up support for Ocean Energy. In the UK, there is a special 'CfD' allocation for Tidal projects - £10m has recently been awarded - while in Scotland there are four projects underway in the Wave field alone under the auspices of the Scottish Government's *Wave Energy Scotland*. Canada is another pioneer with seven Tidal projects underway and four separate Wave deployments at the advanced planning stage. Other countries with active programmes of support for Ocean Energy include Denmark, Spain, and Sweden while countries as varied as the US, Singapore, China, and Japan are also active.

4. International collaboration

There are opportunities for international collaboration on R&D activities in Ocean Energy. Ireland (via SEAI) is a member of the Clean Energy Transition (CET) Partnership[7], a multilateral and strategic partnership of national and regional research, development, and innovation programmes in European Member States and Associated Countries. The CET Partnership organises joint co-funded calls for transnational research projects and could be a valuable mechanism for encouraging collaboration between Irish companies and peers in the other leading European Ocean Energy nations. Unfortunately, the level of funding available to Irish participants (€200k per project, €500k across the entire programme in 2023) both limits the scope that they can pursue and reduces their chance of success. MRIA members who were part of unsuccessful consortia participating in the 2022 joint call received feedback highlighting the (*underlying*) lack of ambition in the projects as a negative.

5. Why Ireland should support Ocean Energy

Well documented history[8] suggests that Ocean Energy is in its formative phase and that current time horizons envisaged for Ocean Energy e.g., tidal energy being deployed at scale, particularly in niche markets such as isolated communities, in the second half of the 2020s and wave energy at scale in the late 2030s. These forecasts are in line with historic data and trends for *energy technologies.* They suggest too that the direction of policy ('institutional context'- see Appendix 1) e.g., support for R&D, test facilities, increased funding, innovation initiatives etc is vital and should be stepped up.

However, past experience offers a cautionary tale about efforts to *rush* the commercialisation of Ocean Energy – 'Policies pushing to commercialise pre-mature (energy) technologies by picking a technical design or shortcoming key

[7] https://cetpartnership.eu/
[8] See Appendix 1

formative processes can result in failure'[9] Examples included the traumatic 'Growian'[10] experience in terrestrial wind in the 1980's which almost put paid to the German wind industry and, in Ocean Energy, the experiences of Aquamarine Power, Open Hydro and Pelamis.

Resource and market outlets

Ireland has a magnificent wave resource – quantified by OREDP 2[11] at almost 24GW 'Gross Technical Resource Capacity' - with a further c8GW of tidal capacity potentially available. Generation of electricity from wave and tidal devices, however, does not necessarily lead to the national grid or export via interconnectors as being the sole 'routes to market', although Ocean Energy has, as briefed below, major benefits to offer in the 'grid balancing' field alone.

Significant opportunities also exist in applications of Ocean Energy in the wider 'Blue Economy', separate to direct connection to national grids. The US Department of Energy has recognized the value proposition of Ocean Energy across a range of critical applications[12], with power requirements ranging from low kWs to MW scale, broadly grouped under two themes:

- *Power at Sea*: Providing power at sea to support offshore industries, science, and security activities.
- *Resilient Coastal Communities*: Meeting the energy and fresh water needs of rural, coastal and island stakeholders.

Irish companies are well placed to lead in these alternate markets, including aquaculture (where two Irish Ocean Energy supply chain firms – Exceedence and TFI Marine are currently active), remote communities (ORPC and GKinetic are both involved in projects in this area), desalination (three out of ten short-listed technologies of the US Department of Energy's 'Waves to Water' competition used Irish developed wave technology), ocean observation, hydrogen production etc.

[9] *Industry Vision Paper* 2013 Ocean Energy Europe

[10] Growian –derived from the German word for 'wind-powered device' – was a pioneering 3MW wind turbine, built by MAN in the early 1980's. It had a 100m tower, a 100m rotor diameter, a nacelle that weighed as much as a jumbo jet and the overall project cost €75m! Growian worked for 1% of its life and was closed in 1987. The influential Der Spiegel commented that 'We built Growian to prove that it cannot be done!'

[11] *The Second Offshore Renewable Energy Development* Plan (OREDP II) 2023 Department of Environment, Climate and Communications

[12] LiVecchi, A., A. Copping, D. Jenne, A. Gorton, R. Preus, G. Gill, R. Robichaud, R. Green, S. Geerlofs, S. Gore, D. Hume, W. McShane, C. Schmaus, H. Spence. 2019. *Powering the Blue Economy; Exploring Opportunities for Marine Renewable Energy in Maritime Markets. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy*. Washington, D.C.

Ocean Energy benefits the grid
The recently published EVOLVE study[13]**,** led by the University of Edinburgh, is a landmark work which models the benefit to European power systems of Ocean Energy. It is recognized by the National Grid in the UK as a technically acceptable benchmark and is being peer reviewed.

Economic dispatch models were built representing three regions: Great Britain, **Ireland**, and Portugal, at three different points in time: using established future energy scenarios for 2030, 2040, and 2050. The proportion of wave and/or tidal stream generation within each scenario was varied, whilst keeping the total available renewable energy constant, to quantify any potential system benefits purely from the inclusion of Ocean Energy within the generation mix.

These system benefits can be quantified over a range of metrics: increased renewable dispatch; decreased fossil fuel dispatch; decreased curtailment volumes; decreased dispatch costs; decreased carbon emissions; decreased price volatility; and increased price capture for ocean energy technologies. For example, results indicate that when including 1GW of wave energy, for modelling purposes, within the Irish 2030 energy mix, the renewable dispatch and the proportion of renewables dispatched increase, compared to the baseline case with no wave energy. Some other metrics are found to decrease, including curtailed renewables, fossil fuel dispatch, average marginal price, dispatch cost and carbon emissions. These metrics quantify the potential annual cost savings to the Irish consumer from 1GW of wave energy as €272M.

The key result of EVOLVE is that including a higher proportion of Ocean Energy within our future electricity mixes consistently results in higher renewable dispatch, for the same total renewable energy availability, due to the offsetting of Wind and Solar generation with more predictable Wave and Tidal. The ability to dispatch more renewables results in lower fossil fuel and peaking plant dispatch, and thus lower total dispatch costs and carbon emissions. At this stage, the EVOLVE study is an economic dispatch model to consider the benefits wave can bring to the electricity system. It is not a cost/benefit study and does not consider the cost of developing wave energy.

The EVOLVE results are backed up by other international studies on the value proposition for Ocean Energy, such as a recent study by the ORE Catapult estimating a price premium of up to 50% for tidal over adding additional wind

[13] *The system benefits of ocean energy to European power systems -Technical note: EVOLVE country-scale modelling study,* January 2023

capacity to the UK energy system[14], and the Pacific Northwest National Laboratory in the US demonstrating the grid value proposition for Ocean Energy, including increasing resource diversity helps to meet electricity needs while minimizing the overbuild of wind, solar, and storage resources[15].

Innovation driver
Ireland has been an innovator in Ocean Energy. Past support has led to the emergence of intellectual property and expertise in leading companies such as Simply Blue Group (originally focused solely on Ocean Energy), Exceedence, TFI, Dublin Offshore, ORPC, XOCEAN, BlueWise Marine etc. It was the driver behind the creation of the LíR National Ocean Test Facility, the creation of the SFI MaREI Centre and development of the test facilities at Galway Bay and Belmullet. Ireland's Ocean Energy resources – natural, infrastructural, and intellectual - and reputation has resulted in a strong Irish presence in international collaborative programmes such as OPIN, MaRINET2, MaRINERG, ProtoAtlantic etc. There are also the facilities at Queens University Belfast including the important tidal test site in Strangford Lough and the Bryden Centre. Irish scientists and engineers are engaged, via the International Electrotechnical Commission's TC 114 – Marine Energy programme, in setting the global technical standards for wave and tidal. Ireland is represented on 13 out of 14 TC 114 groups and is regarded internationally as being in the top four countries globally in this field.

However, Ireland's leading international position in Ocean Energy will wane unless a new ambition – with resources to realise it – is set for this sector. Indeed, there are signs that a decline is already occurring with a dearth of new entrants to Ocean Energy here recently.

Supply chain effect
Given the scale of the local bottom fixed wind opportunity and the maturity of the related device manufacturing industry, it is unlikely that Ireland can attract significant industrial (e.g., manufacturing) opportunities in bottom fixed wind. On the other hand, floating offshore wind and green hydrogen and wave and tidal are at an earlier stage where dominant manufacturers and industrial locations have yet to be determined.

[14] https://ore.catapult.org.uk/?orecatapultreports=cost-reduction-pathway-of-tidal-stream-energy-in-the-uk-and-france
[15] https://www.pnnl.gov/projects/marine-energy-grid-value

The recent ETIP Ocean[16] report makes the point that 'The first movers will unlock the greatest economic and social benefits' from Ocean Energy. It tracked a sample of the highest value-added contracts (114 in total; valued at €45.3m) for 9 recent wave and tidal developments in European waters which cover both the supply of products (e.g., device components) and services (e.g., marine operations). One finding was that 2/3 of the total contract value remained with the countries where the deployments are taking place.

The scale of the wave resource, the quality of the early Irish wave and tidal companies and the extent and reputation of institutions such as LíR NOTF should attract new investment from both domestic and FDI resources, given engagement by Enterprise Ireland and the IDA. The key requirement, however, at this stage is to provide an 'ecosystem' of support for both the deployment of pilot devices/sub-systems and the commercial development of Ocean Energy companies.

When this ecosystem was healthier in Ireland, i.e., a Prototype Development Fund mechanism in place, Galway Bay Marine and Energy Test Site open for testing, and ESB's WestWave project (now revived de facto in a joint venture recently announced with the Simply Blue Group, supported by the EU Innovation Fund off County Clare) creating a market pull, there was a significant pipeline of the world's leading wave energy companies actively engaged in the Irish market. This can be achieved again!

European ambitions

The European Commission has set a target of 100MW of pilot devices in wave and tidal energy to be deployed by 2025 (which is likely to be achieved) and full commercial activity by 2030. An EU target of 1GW deployed by 2030 has been set and this can only be fulfilled at scale at a small number of EU locations, including Ireland0, due to the geographical concentration of the wave resource.

The bulk of the c250 (small) companies[17] globally engaged in wave and tidal device and component development are European where most patents world-wide in this field are held and nearly all existing projects worldwide use European technology. The European Commission is backing up its targets, and its nascent industrial ambitions in this field, with the recent easing of 'State

[16] *2030 Ocean Energy Vision* www.etipocean.eu
[17] European Marine Energy Centre (EMEC)

Aids' rules for pilot devices and support being offered under several separate headings for Ocean Energy projects in the Horizon Europe scheme.

ETIP[18] Ocean is an advisory body to the European Commission and is part of the EU's main research and innovation policy, the *Strategic Energy Technology Plan* ('SET Plan'). Recent work by ETIP Ocean[19] suggests that up to 10% of Europe's current electricity needs could be met by Ocean Energy by 2050 with 100GW deployed and 500,000 new jobs created. The European Parliament has called for 5% of new renewable energy capacity to be of "innovative renewable energy technology'' while the European Commission is actively encouraging through the revised Renewable Energy Directive (RED 111), the development of Ocean Energy under the Horizon Europe research programme and under the innovation initiatives set out in REpower Europe.

The recent award of almost €40 million from the EU's Innovation Fund for the Saoirse Wave Energy project (a 5MW array scale wave energy farm utilising CorPower technologies), being developed off the West Clare Coast, is the most significant show of confidence in European wave energy in the last 15 years. It is the first time the Innovation Fund (one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies) has awarded grant funding to an Ocean Energy project. However, this support will not materialise without significant support from the Irish State, in the form of both revenue support and a viable consenting pathway, all of which must be mapped out and navigated within an extremely tight 4-year timeline.

6. Ireland's ambition for Ocean Energy

The arguments to support Ocean Energy have been set out above and may be summarised as:

1. We have a huge wave resource and a notable tidal capability
2. Ireland's Renewable Energy-sourced electricity targets will require 'grid balancing' which can be met by Ocean Energy with demonstrable economic and emissions-reduction benefits
3. Endeavours in the Ocean Energy field have given Ireland a position as a leading innovator in this field

[18] European Technology and Innovation Platform for Ocean Energy
[19] Op cit at 15.

4. There is a real opportunity for Ireland to develop a global supply chain position in Ocean Energy which is still at an early stage with no dominant industrial 'players'.

So, what should Ireland's ambition in Ocean Energy up to, say, 2035 look like?

MRIA believes that Ireland can adopt one of two potential levels of ambition in Ocean Energy going forward – follower or leader.

Follower
This option would see Ireland taking a passive, 'follower', role as other countries take the lead and benefit from the jobs and income likely to be created, particularly in coastal communities. In practical terms, it means that Ireland's wave resources *could be* exploited as technology developed elsewhere matures (but perhaps is not fine-tuned to local conditions) while the supply chain opportunities internationally for local tidal energy technology developers could be diminished. It also means, however, that current local companies in Ocean Energy may relocate or move their main 'value adding' functions to other jurisdictions, the intellectual capital built up over the past 20 years will scatter internationally and the infrastructure built up in the past decade will atrophy. There are signs that all these negative aspects are beginning to emerge. Ireland may lose its opportunity to be a leader in a new area of technology ideally suited to exploiting its bountiful natural resources in the ocean.

Leader
MRIA believe Ireland's ambition should be to become (again) a leader (but not the exclusive leader – international engagement is vital) in Ocean Energy. This, in our view, is the approach which would best meet the arguments for supporting Ocean Energy set out earlier.

We believe, following discussion with the experts in Ireland in Ocean Energy and those in Europe who are thought leaders[20] in the field, that Ireland could have up to 50MW of wave devices under development by 2035. It is difficult to identify an appropriate target for tidal energy because of the range of generation capacities – from KWs to MWs – involved in tidal and the

[20] Sourced through the respected Ocean Energy trade association, *Ocean Energy Europe*, which is a partner, for example in ETIP Ocean

uncertainty around the resource at localised hotspots. Accordingly, we consider the deployment of three tidal devices demonstration projects providing power to Blue Economy use-cases by 2028 under the right environment of funding and licensing support as being realistic. The aim for wave energy should be to test and demonstrate devices with a view to future deployment off Ireland as the technology matures (forecast for the late 2030s) while with tidal the intention would be to test and demonstrate devices at various capacities and use-cases to enable local companies to build up their export sales.

Stages of technological development

Support for device and sub-systems development, testing and pilot deployment is vital to the progress of the Ocean Energy sector; related service activities will be prompted by the extent and success of early devices and sub-systems. Ocean Energy has well-developed protocols based on international best practice. Hence, we develop our views later regarding a framework for Ocean Energy development based on stages of technological development of devices and sub-systems, as set out below. These are based on protocols developed by the Ocean Energy sector arising from international 'best practice'[21]: This structure has been developed from the perspective of public sector funders, including the European Commission and the US Department of Energy, and will provide Irish policy makers with a well-validated framework for minimising risk and ensuring value for money in any supports provided to the sector.

[21] E.g., IEA – *OES Evaluation and Guidance Framework for Ocean Energy Technology*, INTERREG OPIN *Technology Assessment Process*, etc

Stage	Description	TRL
Stage 0	Concept creation	1
Stage 1	Concept development	2 3
Stage 2	Design optimisation	4
Stage 3	Scaled demonstration	5 6
Stage 4	Commercial-scale single device demonstration	7 8
Stage 5	Commercial-scale array demonstration	9

Early (1-3) Analytical and numerical models

Mid (3-6) Experimental tests in controlled environment

Late (6-9) Experimental tests in representative environment

7. Support proposals for Irish Ocean Energy

The development of the Ocean Energy sector in Ireland has several key requirements. These are financial support for device and sub-system development, test facilities and commercial mentoring.

Financial Support

EARLY PHASE: TRL 1-3/4

ISSUE TO BE TACKLED	Principally, numerical and analytical modelling
SUPPORT AT PRESENT	De facto, limited to 'MaREI tank' Calls and forthcoming limited support for numerical modelling
FUTURE SUPPORT RECOMMENDED	1. *New*: 100% grant for materials, travel fees etc. Competitive call every 6 months. 2. Increase MaREI tank support to a total of £150k pa (£70k today) 3. Increase numerical modelling support to £150k pa. 4. Introduce business planning support: €100k pa.
WHAT DOES SUCCESS LOOK LIKE?	Set a target for new entrants to the sector for a 5-year period.
TOTAL COST OVER 5 YEARS	€5m in total: £2m for 2-4 above and €3m for 1.
NOTES	Title for 1-4 above: '*Ocean Energy Innovation Fund*'?

MID PHASE: TRL 3-6

ISSUE TO BE TACKLED	Experimental tests/scaled demos in controlled environment of devices and sub-systems
SUPPORT AT PRESENT	RD&D – see 3. in main text for MRIA reservations
FUTURE SUPPORT RECOMMENDED	1. *New:* Fund to support build, deploy, ongoing O&M and decommissioning in real sea conditions e.g., in Galway Bay. Annual competitive Call 2. Boost *National Infrastructure Support Funding* to €200K pa to back a variety of supporting deployments and projects to test e.g., comms systems, connectors, coatings, materials, sensors, and other small-scale R&D projects.
WHAT DOES SUCCESS LOOK LIKE?	Set a target for 5-year period based on building up to 2 new projects pa.
TOTAL COST OVER 5 YEARS	£6m: £5m for 1. above and £1m for 2. above
NOTES	Collective Title for 1-2 above: '*Ocean Energy Prototype Support Fund*'?

MRIA believes that the national Ocean Energy effort should provide for the Early and Late Phases as outlined via two new funds (totalling c£11m over 5 years) but that we should also focus on technologies that are TRL6+ to *scale wave energy*, otherwise there is a risk it will be immaterial relative to offshore wind (fixed and floating). The ORE industry will greatly benefit from technology convergence and successful full-scale demonstrators to show that Wave energy is a credible renewable energy source, and that Wave Energy Convertors are not a technology that only works in a controlled environment.

LATE PHASE: TRL 6-9

ISSUE TO BE TACKLED	Experimental tests in a representative environment
SUPPORT AT PRESENT	None beyond the very limited envelope of RD&D – see 3. in main text for MRIA reservations
FUTURE SUPPORT RECOMMENDED	1. *New:* Revenue Support utilising ORESS model; occasional Calls; upper limit on quantum of MW per project. 2. *New:* Ireland to join a future iteration of the Europe Wave project. Cost unknown 3. Facilitate Irish projects' applications to Horizon Europe where appropriate.
WHAT DOES SUCCESS LOOK LIKE?	50MW of wave devices under development in Irish waters by 2035 and 3 tidal devices deployed by 2028
TOTAL COST OVER 5 YEARS	No direct call on Exchequer for project support but presumes that State test sites at Belmullet, Co Mayo and Galway Bay will be developed and kept up to date.
NOTES	The Revenue Support scheme advocated would be a direct charge on the consumer. No provision made for investment in State test facilities or for Europe Wave

8. International leadership

There is scope for Irish leadership in Ocean Energy at international level; indeed, the residual reputation of Irish Ocean Energy is such that international players (n.b., UK, EU) still look to Irish companies and institutions as obvious partners in projects but, often, this is not possible due to the paucity of national support schemes and failure to participate in international programmes of late. Steps that could be taken to regain our previous position include:

- Participation in Europe Wave Mark 2 – see above
- Increased support for the CET Partnership joint calls
- Partnership with Northern Ireland on research, testing and planning for Ocean Energy, in keeping with the all-island grid, to unlock the full system benefits of Ocean Energy (including that arising from Northern Ireland's strong tidal resource)

- Increased Irish presence at international Ocean Energy events e.g., return to having an Irish pavilion with spaces for Irish companies at key industry events n.b., ICOE/OEE. This could be led by Enterprise Ireland using the *Marine Ireland Industry Network* branding etc in line with their approach at offshore wind, shipping conferences.
- Include international market development as a 'module' in a future accelerator programme (see 10. below).

9. Test and demonstration facilities

Over the course of development of devices and systems, test and demonstration facilities are required, and Ireland is well endowed with already sunken investment and with potential here.

Early Phase
The SFI MaREI Centre and the LíR National Ocean Test Facility are well equipped to meet needs in this Phase and, when relevant, in later stages too. The principal requirement for success here is to boost the funding for 'tank' Calls and provide more capacity for numerical modelling etc, to be done in parallel with the physical testing. In addition, there should be the opportunity to compete for occasional infrastructure improvement grants to enable adaption to the changing and varying requirements of the sector. This should be the case for the test sites as well.

Mid Phase
This Phase will usually be conducted inter alia in the Galway Bay test site. It is critical to the success of a national Ocean Energy strategy that the State prioritises the final leasing arrangements for the Galway facility and enables it to reopen after many years closure. In addition, a project funding scheme as outlined earlier is recommended. Where suitable testing facilities do not currently exist in Ireland due to insufficient resource or site license or facility issues, support should be provided to Irish developers to access facilities outside of the State (e.g., the Queens University Belfast test site in Strangford Lough), subject to clear criteria e.g., % of project expenditure within the ROI.

Technically, activities outside of Ireland can be supported under the SEAI RD&D programme "*In exceptional cases, funding of work overseas may be supported where there is a demonstrable contribution to resolving specific Irish issues*" but there is a lack of practical guidance as to how this welcome principle might be applied in practice, including in Northern Ireland.

Late Phase

We recommend a triple approach here. First, develop the Atlantic Marine Energy Test Site (AMETS) as a test site for both Floating Wind and for Wave. This means following through on current AMETS development plans and, also, determining a route to the provision of cable to the new mooring site (currently in the consenting stage) – it is most unlikely that industry can fund this. The system should be grid connected and permitted by 2027/28. We envisage AMETS as a short-term test facility in which projects would be tested for survivability and performance in Atlantic conditions. Financial support should take the form of revenue support through an occasional ORESS Innovation auction.

It is worth noting that a recent study[22] has shown the economic impact of the nearest equivalent to AMETS, the European Marine Energy Centre in Orkney.

EMEC is not only a major contributor to the local economy in a remote island community but has played a significant part in giving Scotland a leading international role in Ocean Energy. All berths at EMEC are booked out for some time to come which is an indicator of possible demand for a 'step up' facility at AMETS.

We also recommend that demonstration zones be identified from time to time for the deployment of small arrays of Ocean Energy devices where weather and seabed conditions may match the likely, and varied, development of the technologies over the next decade. These zones could probably share space with wind energy developments but would require appropriate advance cabling and access to grid.

Considering limited resources to support the development of Designated Maritime Area Plans (DMAPs) at central Government level, we recommend

[22] See www.emec.org.uk , May 9th, 2023, re report by BiGGAR Economics

that, for at least a period of time, experimental/pilot/demonstration Wave and Tidal deployments be confined, as follows:

- Within 5KM of the coast (this would enable the DMAP task to be undertaken by the relevant local authority once the appropriate arrangements are put in place
- Or at State test facilities – currently AMETs (may require a DMAP) and Galway Bay (does not require a DMAP)
- Or within an Offshore Wind DMAP ('co-location')

Finally, we need a fast-paced consenting system at MARA for projects testing and demonstrating Ocean Energy devices and systems, an approach which is in line with REPower EU.

10. Commercial mentoring

The small scale of companies engaged in Irish Ocean Energy at this stage is a concern and a feature globally of the sector. Something special needs to be done to help the generally small or even micro sized companies *develop as businesses*.

'Accelerators' are a well-established tool to support early-stage growth-driven companies through education, mentorship etc. Companies, typically at a start-up stage, enter an Accelerator for a fixed period and usually as part of a cohort of companies. The Accelerator experience is a process of intense, rapid, and immersive education aimed at fast-tracking the life cycle of young, innovative companies, compressing years' worth of learning-by-doing into just a few months. The value of the Accelerator lies in the learning environment itself and Accelerators seem to have a positive impact on entrepreneurs, particularly regarding fund raising.

There are various Accelerator experiences in Ireland already e.g., ESB are working with several start-ups in Ireland under the 2050 Accelerator programme. It is recommended that an Accelerator specific to Ocean Energy be arranged from time to time by Enterprise Ireland. This would involve a modest expenditure and represent a departure from normal Enterprise Ireland practice of dealing only with companies capable of reaching employment or revenue scale quickly (unlikely at this juncture, with Ocean Energy firms), known as High Potential Start Ups. But the national industrial 'prize' to be won with an ambitious national Ocean Energy strategy merits an exception in this case. Ocean Energy firms would benefit from learning together and the networking effect is also desirable. An Ocean Energy Accelerator could be tailored to the needs of the industry. In due course, consideration can be given to Ireland taking the initiative, to establish an Ocean Energy Global Accelerator along the lines of *Free Electrons* which involves eight utilities (including ESB) and eleven energy start-ups[23]

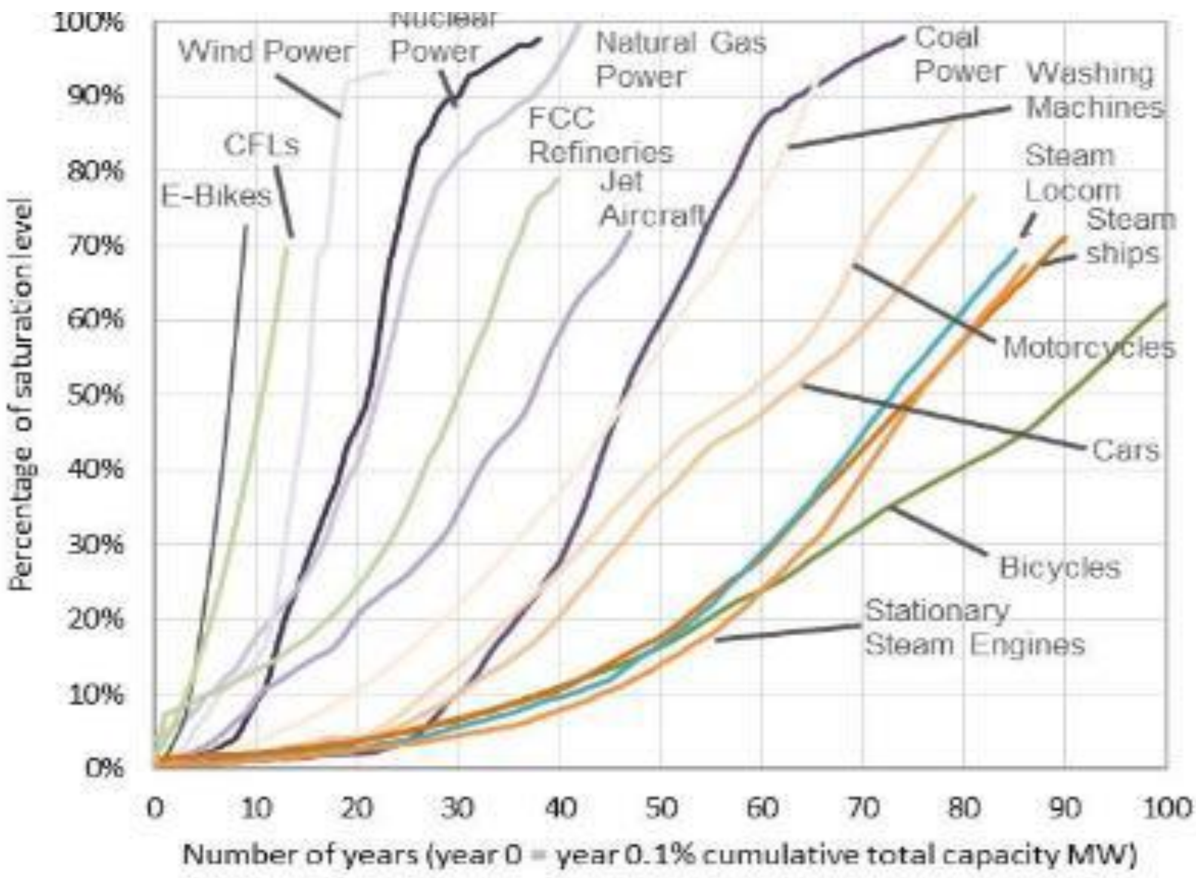
MRIA recommends that all applicants for financial support towards device or sub-system development should be required to attend, at an appropriate stage in their development, an Ocean Energy Accelerator as a condition of grant support. Such an experience will also help to prepare firms for collaborative ventures. The process will, of course, need teasing out: e.g., what should happen if an applicant is a mature firm etc? But the principle must be firm: Ocean Energy is a unique opportunity for Ireland and all actors must play their part in ensuring that the maximum benefits are derived from it for Ireland. This means, among other things, fostering a robust population of Irish device and sub-system developers and they must be required, in return for State funding, to go through an accelerator to give their businesses the maximum chance of success.

[23] www.reeelectrons.org

Appendix 1: Precedents for Ocean Energy technology

Precedents in energy technologies

The length of the formative phase for a variety of energy technologies can be protracted e.g., natural gas power's formative phase may have taken up to 71 years! But, encouragingly, the mean and median figures for the formative phase for all technologies is in the region of 20 years and is in line with research which indicates that the speed of diffusion of new technologies has speeded up over the past century[24].



[24] Captured particularly well in *Measuring the duration of formative phases for energy technologies* Bento and Wilson published in *Environmental Innovation and Societal Transitions Journal* 2016

Energy technology	*Central estimate*	*Longest estimate*
Stationary Steam Engines	85	168
Steamships	19	114
Steam Locomotives	21	96
Bicycles	25	83
Coal Power	9	79
Natural Gas Power	25	71
Cars	23	82
Washing Machines	15	58
Motorcycles	21	71
Wind Power	15	115
E-Bikes	35	114
Jet Aircraft	7	40
FCC, Fluid Catalytic Cracking (refineries)	4	5
Nuclear Power	13	22
Mobile Phones	14	55
CFLs, Compact Fluorescent Lamps	20	27
Mean (all technologies)	**22**	**75**
Median (all technologies)	**20**	**75**

However, the encouraging 'news' for Ocean Energy is that the research to date does not consider the impact of 'systemic conditions' (e.g., investment in the production chain, supportive institutions) that accompany the emergence of new technologies'[25]. There is already some investment in the Irish Ocean Energy production chain e.g., the various R&D and test facilities and, as was touched on earlier, the institutional framework was supportive and could become proactive again.

Moreover, most important, research into innovation shows that '……institutional context was found to be *decisive* in the formation of new technologies' e.g., jet aircraft whose formative phase was squeezed into the World War 2 period because of demand (from Air Forces seeking an advantage over opponents) and technology push (resources concentrated on solving the engineering issues involved

[25] Op cit at 24