OCEAN ENERGY FORUM

Strategic Roadmap:
Collated "Three-Pagers"

For comment via OEF Website, 21.07.15 – 20.08.15

Collated Three-Pagers

This document is the Ocean Energy Forum's prototype Strategic Roadmap for the industrialisation of the ocean energy sector.

This version follows on from the OEF Open Session in Bilbao on July 1 2015, at which each of the three Working Groups (Environment & Consenting, Finance, Technology) presented their own draft plan in the form of a "3-pager" for discussion.

Since the Bilbao session, each of the three 3-pagers has been further developed by the Working Group Steering Committee Chairs. The 3-pagers are here collated, for the sake of convenience, in one document, to be made available on the OEF website in order to facilitate further comment and feedback from the wider stakeholder population.

Please note that at this stage no attempt has yet been made to integrate the 3-pagers into one cohesive document; this will be done once all comments have been received and considered.

We look forward to receiving your comments; a form has been provided on the OEF website for this purpose.

OEF Secretariat 21.07.2015

Ocean Energy Forum - Environment & Consenting Roadmap Report – July 2015

The development of ocean energy offers a unique opportunity to bring social, economic and environmental opportunities, through the delivery of clean, secure energy. To achieve this, planning and licensing frameworks are required which afford confidence to industry, regulators and stakeholders that development will be taken forward in a sustainable manner.

The Ocean Energy Forum Environment & Consenting Steering Group (ECSG) will promote and facilitate planning and regulatory processes across Member States that are fair, appropriate to the sector and with established commonality, to enhance an attractive EU market for ocean energy.

This will be achieved through considered intervention in current practises in support of Planning, Consenting / Licensing and Research and Monitoring.

Planning can facilitate the effective demonstration of emerging technologies, promote co-location solutions, identify strategic environmental monitoring and research priorities as well as address issues such as the provision of grid and port infrastructure and the competing objectives of different marine stakeholders. The implementation of the Maritime Spatial Planning (MSP) Directive across the EU presents an opportunity for improving the planning and consenting of ocean energy and furthering the market penetration of ocean energy through increasing transparency and certainty for developers whilst simultaneously including stakeholders in decision-making processes.

The ECSG will seek to pro-actively realise the benefits of marine spatial planning to the ocean energy sector, as a key tool to identify opportunity, addressing conflict, enable effective assessment and engage with stakeholders and communities.

Consenting / Licensing - procedures are an often cited barrier to the development and progress of ocean energy. From a regulator's perspective they must have sufficient evidence on which to base their licensing decision and have to ensure compliance with the relevant legislative regime(s). From a developer's point of view, issues surround: the time taken to obtain consent; the number of regulators involved in the process; the lack of clarity and consistency in EIA and AA (Habitats Directive) obligations and application; the costs associated with these and the seemingly overly-precautionary requirements placed on small scale or single-unit deployments.

The ECSG will promote best practice and facilitate the development of new methodologies to reduce uncertainty in national licensing processes and improve consistency in the application of EU legislation.

Research and Monitoring.- there is a need for a pan-European sustained research agenda in relation to environmental effects of devices that answers higher level, strategic questions regarding for example population level effects, cumulative impacts and ecosystem models. This should be accompanied by a robust operational level research programme that enables competent authorities to ask developers questions which they can then address either fully or partly, through their EIA and related site studies.

The ECSG will support and promote strategic research and monitoring to cost-effectively reduce risk and uncertainty regarding social and environmental effects. Critically, this will recognise the extensive work underway globally, and identify opportunities for collaboration with existing networks.

Tackling the Issues - Environment and Consenting – Draft Work Plan

The programme for the group will take an integrated approach between planning, consenting and science (monitoring and research).

Each work package will be tailored around the project development process with consideration to relevant gate checks (ie what needs to be in place to enable close of the consent stage or close of the financial investment decision stage).

It will focus on the following key steps:

A Development of EU Ocean Energy Strategic Plan

This plan will seek to facilitate the development of ocean energy developments in the most sustainable locations within the EU marine area. The Plan will encompass:

A1. A Report on Benefits from Ocean Energy Development

Objective
To provide decision makers and the public with information regarding the potential for local socio-economic benefits for fragile communities on the periphery of Europe; ensuring that relevant information is available to inform strategic planning and project consenting

Outline/content
A series of reports for defined geographic regions/Member States outlining:

- Reductions in emissions and energy security benefits from the development of Ocean Energy
- The potential for local socio-economic benefits for fragile communities on the periphery of Europe

Level
Regional, Member State and Local Authority; building on the EC Blue Growth Strategy

Relevant/supporting information
- EC Blue Growth Strategy
- EC Blue Energy Strategy

Case studies

- Orkney, the European Marine Energy Centre and the Pentland Firth and Orkney Waters Strategic Area

A2. Initiatives to support Marine Resource and Spatial Planning

Objective
To facilitate and identify the most effective areas for the deployment and demonstration of emerging and established as well as addressing issues such as the provision of grid infrastructure

Outline/content

- Guidance to ensure marine resource and spatial planning are informed by constraint and opportunity mapping
- Guidance to ensure marine resource and spatial planning will be informed by sustainability appraisal (encompassing the Strategic Environmental Assessment (SEA), Strategic Habitats Regulations Appraisal / Appropriate Assessment (HRA / AA) and Strategic Social and Economic Assessment (SSEA)
- A marine spatial plan and resource map which will be informed by and set the framework for a programme of strategic monitoring and research, linking to existing research programmes, in order to understand environmental issues within the areas selected for development (ie the areas identified through resource and constraint mapping)
- Will provide a 'route to market' strategy to consider strategic marine grid, connections to existing grid, grid/interconnector upgrade and alternative approaches where grid solutions prove prohibitive in the short to medium term
- The preparation of guidance notes to inform more robust and informed techniques for marine spatial planning

<u>Level</u>

EC, Regional, Member State

<u>Relevant/supporting information</u>

Environmental baseline study for the development of renewable energy sources, energy storages and a meshed electricity grid in the North and Irish Seas.

<u>Case studies</u>

- Member State and Regional SEAs, Sectoral Plans etc

A3. <u>A Communications and Consultation Strategy</u>

<u>Objective</u>

To provide outline processes for effective communication with regulators, statutory stakeholders, NGOs, communities and key representatives from other marine sectors.

<u>Outline/content</u>

- Update of any new and key issues arising
- Update of OEF programme status across three sectors
- Identify best practise / appropriate forums for stakeholder liaison

<u>Level</u>

EC, Member State & Regional, Local

<u>Relevant/supporting information</u>

<u>None identified</u>

<u>Case studies</u>

- Marine Scotland Marine and Offshore Renewables Stakeholder Brief

B. Development of EU Ocean Energy Industry Plan

Ensuring Regional support and Community endorsement is critical to the long term aspirations of ocean energy. This plan will seek to identify and facilitate how supply chain and economic development activities associated with Ocean Energy can take place in regions where development is hosted. It will be informed by the strategic social and economic impact assessment (SEIA) and be taken forward input from the other work groups on aspects relevant to their interests. The Plan will encompass:

B1. Regional Manufacturing / Industrial Plans to Maximise Economic Development

Objective

To map and understand the onshore planning implications and related skills and supply chain requirements relating to the associated construction, operational and maintenance requirements of the planned wave and tidal developments

To enable preparatory work to place in Member States which host development in order to ensure maximisation of potential social and economic benefits

Outline/content

- Identify planning measures to facilitate the formation of Regional Supply Chain Networks
- Establish Regional Investment Funds (to be taken forward jointly / with specialist input from the Finance Group)
- Explore the use of integrated Commercial Arrangements for Lease and Tariff Agreements to facilitate development within the Spatial Plan areas (to be taken forward jointly / with specialist input from the Finance Group)

Level

Member State, Regional, Local Authority

Relevant/supporting information

- Strategic Social and Economic Impact Assessments in support of Offshore Renewable Energy

Case studies

Marine Scotland Scenario Mapping for the East and North East Regions of Scotland

C. Development of EU Ocean Energy Environment Plan

Enhancing knowledge of the marine environment is crucial to informing better plans and more efficient licensing. This plan should be informed by the strategic environmental assessment and habitats regulations appraisal / appropriate assessment (SEA / HRA / AA). It will encompass:

C1. A review of the Environmental Impacts associated with new and emerging technologies (to be taken forward jointly / with specialist input from the Technology Group)

Objective

To ensure that the best and most up to date information and data regarding the potential impacts of ocean energy projects is available to decision makers, developers and stakeholders.

Outline/content

- Collated series of position papers/briefing notes on the potential impacts of marine energy development on the ecological, physical and human environment for use in marine planning, SEA, EIA and HRA
- These should be supported/championed by the Steering Group as the best available information regarding the potential impacts of ocean energy and
- These should be reviewed when deemed necessary by the Steering Group
- These should contain all relevant links to other key documents; particularly other strategic reviews regarding the potential impacts associated with new and emerging technologies
- The applicability of 'one-stop shop' consenting procedures across Member States

Level

This should be undertaken at an EC level, providing all Member States with a common information platform

Relevant/supporting information

- Ocean Energy Systems' Annex IV State of the Science Report
- NERC/Renewable UK position papers

Case studies

- Marine Scotland Licensing Operations Team 'One-Stop Shop' Approach

C2. Establishing a Data Gap Analysis and Research Programme to cover emerging gaps in Knowledge

Objective

Establish a strategic environmental research programme to address key consenting issues

Outline/content

- Undertake a research gap analysis; identifying knowledge gaps/areas of uncertainty that should form the focus of a strategic research programme to address key consenting issues relevant to ocean energy projects
- Create and maintain a database of ongoing and planned research relevant to the potential impacts of ocean energy; incorporating Member States' strategic research plans
- Continuous review of global and European research programmes related to understanding the marine ecosystem and the potential for impacts from ocean energy technologies.
- Raise awareness of relevant existing information and data platforms
- Publish recommendations for strategic research projects following regular reviews of the research gap analysis

Level
This should be undertaken at the EC level to create a common information platform that can then be used by Member State's to inform national strategic research plans.

Relevant/supporting information
ORJIP Ocean Energy Forward Look (Aquatera and MarineSpace, 2015)

Case studies
Offshore Renewable Joint Industry Programme (ORJIP) for Ocean Energy

C4. Establishing a framework / structure for project monitoring which is focussed on likely environmental impacts and seeking to progress projects through a risk based approach

Objective
To provide guidance for determining project baseline characterisation requirements and developing project environmental management plans that are proportionate to the level of risk posed by any specific proposed ocean energy project.

Outline/content

- Produce strategic guidance that can be used by decision makers, developers and stakeholders to determine project specific baseline characterisation requirements using a risk based approach
- Produce strategic guidance that can be used by decision makers, developers and stakeholders to develop project environmental management plans for small and large scale projects using a risk based approach to ensure that requirements are proportionate to the risks posed by a particular development
- Ensure that this guidance is kept up to date and is informed by regular reviews of the effectiveness of mitigation and monitoring measures and the best available understanding of the potential impacts of ocean energy projects

Level
Guidance should be developed at an EC level and used by Member States to inform national guidance and decision making.

Relevant/supporting information
TBC

Case studies
Marine Scotland's Survey Deploy and Monitor Strategy

D. Development of EU Ocean Energy Licensing Plan

This will be informed by and demonstrate how the key aspects and issues arising from the social, economic and environmental planning work (outline above) can enable more efficient licensing processes. It will encompass:

D1. Establish Risk Based Processes to Introduce Consenting Efficiencies

Objective
To ensure that consenting processes and requirements are proportionate to the potential environmental risk posed by a specific development

Outline/content

- Review of and promoting the adoption of the RiCore Project findings
- Develop 'Licensing Bands' which cover small scale low risk projects through to large commercial developments
- Review Licensing Structure considering how scale, environmental sensitivities and risk of impacts are treated differently

Level
Guidance should be developed at an EC level and used by Member States to inform national guidance and decision making.

Relevant/supporting information
TBC

Case studies
RiCore

D2. Develop a European Licensing Manual or set of Licensing Guidance Notes focussed on addressing common issues and developing processes to address common issues

Objective
To ensure that best practice and experience gained in consenting ocean energy projects by regulators, agencies and developers is shared throughout the EU and that this information can be used to inform future decisions and processes

Outline/content

- Produce a series of guidance notes to help address key consenting issues
- Guidance notes should focus on common issues that face decision makers, developers and stakeholders across the EU
- Guidance notes should be used to inform the development of Member State level licensing manuals and, when appropriate, the development of a European Licensing Manual
- Topics/consenting issues that would benefit from guidance at the EC level will be proposed by the Steering Group and regularly reviewed

Level
Guidance should be developed at an EC level and used by Member States to inform national guidance and decision making.

Relevant/supporting information
TBC

Case studies
NERC Renewable UK positional papers

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Ocean Energy Forum – Finance Work Stream

The EU Ocean Energy sector has the potential to deliver 10% of EU electricity consumption, provided it reaches its full potential, currently estimated at 100GW of installed capacity across 5 technologies: Tidal Current, Tidal Range, Wave, OTEC, and Salinity Gradient.

To reach this potential, enough electricity and knowledge must be produced to improve technologies, make them mainstream and bankable and so reach commercialisation. Ocean energy technologies are emerging form the prototype stage at different speeds, tidal current in the lead. The stage of technological development, the specificities of the marine sector, as well as the current investment climate call for specific, and sometimes new, financing models.

0. [Placeholder for key messages/recommendations/actions on finance, targeted at EU, MS, regions, industry, stakeholders]

1. Introduction: Financing ocean energy in today's energy market with a limited pool of potential investors

The pool of available investors for emerging technologies has been reduced by the economic crisis, calling for state support to go beyond research and development stage.

Historic power producers ("utilities") are constrained by a stable EU electricity demand, overcapacity on many electricity markets, and inadequate market design. Their strategic approach to investments pre-economic crisis have mostly been replaced by a more bottom-line oriented, short term approach, removing them from the financing picture for emerging technologies.

OEMs' balance sheets are equally constrained by their clients' slow market which hampers their appetite for developing emerging technologies on their balance sheets.

Studies confirm that investments with the level of risk of first ocean energy projects don't fit with the business models of Venture Capitalists and Business Angels.

This means that most of the financing sources and mechanisms used for e.g. wind energy deployment in the last 10 years are not available for ocean energy. New models must be found and public support for new technologies and the first farms will be critical to success or failure of the sector.

2. Before the first farms – financing full scale prototypes

Not all ocean energy technologies are "first-farm-ready". Several devices, especially for wave energy, require further rigorous single device testing before they can reach the next stage in their development stage: the first farm.

Financing instruments for this stage of development are mostly and rightly grant-based – Horizon 2010, Member States research programmes - though not necessarily with the required budgets to keep the EU at the forefront of technological development.

Further standardisation of testing could help de-risking technologies and access to finance by e.g. creation of recognised pre-defined milestones (MWh produced, running hours…). Such a "testing-stamp" could help private investors and public authorities choose among proven technologies.

Recommendation for public authorities: maintain significant grant funding programmes enabling demonstration of full scale prototype

Recommendation for industry: develop EU-wide standards for testing of full-scale prototypes

3. A critical first step: finance to deliver the first farms

Before the ocean energy sector can achieve commercial viability, the first ocean energy pilot farms must reach financial close. Pilot farms require a specific financing approach, as high levels of uncertainty and risk make them unsuitable for commercial debt or revenue-based finance. After full scale prototype testing, this should be considered "R&D phase 2" rather than "pre-commercial".

Technology-specific pilot projects are likely to be required, as learnings from a given pilot farm will be difficult to transfer from one technology to another, e.g. from tidal current to wave or OTEC.

For these early projects, risks cannot be insured and are too high for a single player, calling for government backing.

3.1. High CAPEX requirements call for upfront capital availability

Ocean Energies, like most renewables, are CAPEX-intensive technologies: the cost of the device, infrastructure and installation represent a very high share of the kWh cost. This contrasts with e.g. gas-fired power stations, where the station itself only represents about 25% of the electricity cost, the remainder coming mostly from gas purchases. Whilst different for each ocean energy technologies, total CAPEX is estimated to represents up to 60% to 80% of the final cost of energy.

This means the financial effort must be provided upfront, before any electricity – and therefore revenue – is generated. Support schemes for the first arrays must therefore include a high proportion of upfront finance, whether debt-, grant- or equity-based.

Beyond a certain volume of installations per technology [*to be defined*], revenue support will prove useful as an incentive for stepping up deployment of technologies, which will, by then, be proven.

3.2. Uncertainty inherent to innovative projects in a harsh marine environment constrains available finance

All energy projects bear a certain amount of risk and all risks – market, technological, regulatory – impact project revenue.

Ocean energies bear additional specific risks linked to the marine environment, their innovative nature and their emerging stage of development. Risks are linked to both installation (foundation, weather window, availability of vessels, device itself) and operations (weather again impacting both production and maintenance, device yield, failure rates and maintenance requirements).

Experience from installations and operations of past projects is required to make those risks – e.g. production risk – predictable, measurable and either bearable or insurable. The data required is currently lacking and can only be gathered progressively, as more machines are put in the water. This knowledge gap impacts the ability to commercially finance projects and also means ocean energies technologies are more expensive to insure.

3.3. Guidelines: "How to" structure public finance for the first farms

3.3.1. Keeping financing schemes flexible to account for changes inherent to innovative projects planning

Innovative ocean energy projects are by their very nature subject to planning uncertainty. Financial mechanisms put forward by both EU and governments need to keep pace with developments in the ocean energy sector and respond quickly to new developments, delays, and small changes in project parameters. Several ocean energy projects did not proceed or risked failure (e.g. Skerries, NER300-funded projects) for the inability of the support scheme to adapt to delays.

Recommendation: Innovation funding processes need to be less bureaucratic, more flexible and more responsive, so that they match the fluid nature of innovative technology development.

3.3.2. Fit for purpose revenue-based support - CfD, Green Certificates, FITs, etc...

Limited certainty of both generation revenue and maintenance costs means financial risk remains high and transition to a demand-pull dominated mechanism is premature of ocean energy. R&D funding and upfront capital support to support investments remain essential for pilot projects.

However, revenue-based support schemes can and should give long-term visibility and confidence to investors and hence reduce costs of capital. Short-term or "stop-and-go" support systems don't give market players the visibility required for long term energy investments.

If designed properly, revenue-based schemes have been shown to drive innovation, deployment and cost reduction in renewable energy technologies, such as in Denmark for onshore wind in the 90s. They should be **introduced at the right time in a technology's development, be suitably targeted, and stable**. Given past experiences in e.g. solar PV, revenue support can also be gradually reduced in time to adapt to cost reductions and avoid over-compensations.

Regulatory uncertainty, such as during the Electricity Market Reform (EMR) debate, contributes to a reduction in confidence, in increasing the cost of capital and in the worst cases such as retro-active changes to support in Spain, the destruction of industrial potential.

Recommendation 1: Technology-push mechanisms should remain an essential part of support systems until commercial phase is reached. If withdrawn too soon in favour of demand-pull mechanisms, there is a risk that the technology may not have reached the required maturity to draw down the award.

Recommendation 2: Governments should strive to achieve cross-party support for ocean energy, to avoid any political risk to the support systems and hence lower the cost of capital for early projects.

3.3.3. EIB – From commercial bank back to an EU Investment bank, with a more risk-friendly culture

With the current risk profile, commercial debt will not be available in the short term for ocean energy projects. Consequently, the current low-risk investment position of the EIB is inadequate both for the ocean energy sector and for Europe's industrial development in general.

Recommendation to public authorities - Bringing the European Investment Bank and European Investment Fund to support the industry progress into the next phase of development could be key to unlocking risk capital. The new Innovfin scheme with initial investment of €100million is an important step in this direction. At a later stage the EFSI will equally become relevant for ocean energy.

3.4. Potential solutions to finance early arrays across all ocean energy technologies

A number of potential tools could help match available funding at EU and Member State level with the required finance for ocean energy projects. Below ideas that

Solution 1 – The Meygen approach - A funding plan combining upfront capital support, ongoing revenue support and debt (from EIB/EIF) matches risk profile and recognises the risk being undertaken throughout the process.

Solution 2 – Publically funded tidal pilot zones – Several tidal technologies are reputedly first-farm ready. The cost of cabling, substation, environmental assessments and other permits is prohibitive for a single project to carry, potentially multiplying project costs by a factor 3-5. Public funding (e.g. structural funds, NER300, Horizon 2020 etc.) could be oriented towards preconsented areas for tidal deployment, including infrastructures such as a grid connection, cabling, subsea hub etc.

Solution 3 – The Wave Energy Scotland approach – recognising that most wave energy technologies are not yet first-farm ready at full scale, creation of a similar EU-level process to fund critical component testing before full scale demonstration could be a successful approach.

Solution 4 – Creation of an EU insurance offering or fund to underwrite various project risks – targeted at the first ocean energy projects to cover risks such as availability, performance, unforeseen events, failures, etc... A common reserve fund available to multiple projects in the initial farm roll out, to spread the risk and reduce the cost of providing guarantees.

4. Beyond the first farms – getting the sector to commercial bankability

Once the first [50-100] devices have operated for a given length of time, the sector should get closer to commercial bankability. Based on past production data, evaluation of future production and, hence, of return on investments will be made possible.

4.1. Making commercial debt available through provision of production data

To date it is believed that no commercial banks have financed an ocean energy project as financial uncertainties on production and revenue are perceived as too high.

Traditionally, commercial debt only becomes available to **any technology stream** when the technology and projects are de-risked enough, proven in water and the OEMs are able to provide full warranties.

Commercial debt can also be made available for a specific project – e.g. a phase 2 extension of a pilot farm - once it has operated satisfactorily with regards to performance, yield, and maintenance costs (potentially 2-5 years).

The ultimate answer to obtaining commercial debt is therefore having sufficient operational hours and devices in the water, which in the short term requires different funding mechanisms.

Once ocean energy fits with banks' due diligence requirements, keeping lending costs down will be the next objective. The more comfortable the bank feels with the technology or the project, the lower the lending cost.

4.2. Reducing insurance costs by building knowledge in both ocean and insurance sectors

Current insurance for ocean energy projects is expensive, with high deductibles and limited cover. Early stage test site deployments can face disproportionately high costs compared to project costs.

In the insurance sector, insurers' experience to date in ocean energy has been very limited, particularly with regard to marine operational issues.

In the ocean energy sector, operating data and credible estimates of potential claims costs are still being developed. The number of players in the sector with relevant credible experience is limited but growing. The ocean energy sector must accelerate insurers' confidence in, and knowledge of, the sector, its technology and the likely claims costs for insurance costs to be managed.

Recommendation for ocean energy sector: Establish a working group with developers, contractors, etc. and insurers/brokers, to derive a contract structure model with risk options and strategies, codes of best practice, certification standards for marine deployment, moorings, cabling, sea fastenings, vessels, studies of weather risk etc. and use it to engage with insurance industry.

4.3. Loan Guarantees - A solution for upfront CAPEX financing?

At the current stage of development of the ocean energy sector, the risk profile of projects means that there is limited or no availability of commercial debt, with commercial models relying on equity and grant funding. Market analysis suggest that there are limited sources of equity availability from venture capital sources or the public equity markets with project returns being too low.

Through the use of loan guarantees, the public sector may be able to leverage much more finance into the sector than would otherwise be the case were it simply to provide direct grant support.

Loan Guarantees can cover the risk of default as well as the cost of the scheme. Pricing this risk is critical and the responsible Public Sector body must have the required commercial expertise to undertake the necessary due diligence.

These instruments are more fitting for the post pilot farm phase, yet work on their design needs to begin now so that they are available when needed. This will also give technology developers and funders a line of sight to future funding opportunities and so incentivise near term CAPEX funding.

Recommendation to industry: Setup a working group on loan guarantee design [to be validated by SC]

4.4. Leveraging private investment with public money

Although ocean energy support has greatly improved at EU-level, public sector funding is finite and must been seen to provide value by leveraging private sector capital.

This requires EU funders to create the right conditions for utilities, infrastructure funds, pension funds, commercial banks and insurance underwriters to engage in the sector. The potential solutions listed below range from the most proven to the most innovative. As the sector progresses more will be available. Typically, private investment can be leveraged through:

i. Public sector grants
ii. Soft equity investments - E.g. Meygen
iii. Soft loans (debt) – E.g. Meygen
iv. Government-backed OEM warranties attracting commercial debt (and thus commercial equity)
v. Government-backed business interruption insurance that attracts commercial debt (and thus commercial equity)

4.5. Impact of State Aid Rules on ocean energy projects – relaxation, communication, flexibility

Emerging technologies such as ocean energy require *investment*- or *project*-specific support rather than pure revenue support, such as feed-in tariffs. Even with the more restrictive State Aid Guidelines as per 2014 revision, it is still possible for national governments to set up adequate revenue support schemes to incentivise ocean energy production. However, for investment and project-specific (individual) support, EU state aid guidelines remain burdensome and restrictive.

Recommendation for the EU and Member States: EU state aid guidelines should enable Member States to adequately support new technologies as they emerge and reach demonstration and pre-commercial stages. An explicit distinction needs to be made, therefore, between support for mature technologies and support for emerging technologies.

- Notification thresholds for individual and investment aid for emerging technologies should be increased to €30mn.
- Using the same logic as for projects developed in European regions with low per capita GDP, eligible costs caps should be increased for emerging technologies.

Moreover, national authorities should offer guidance on combining diverse sources of funding into a successful investment support for projects.

5. Finance Annexes – Learnings from Case studies

5.1. MeyGen - combining public and private finance

MeyGen will probably be the first pilot farm in EU waters. While not necessarily replicable it can provide a number of lessons.

The key elements are qualities that flow from the drivers for the involvement of the various funders/investors combined with the freedom that results from a general directive to achieve the outcome without prescriptive regulation on how. Having people with the right skill sets delivering the public funding element is very important.

If you do not have a "Coalition of the Willing", truly empowered to find a way to deliver funded projects you will fail.

This does not imply a lack of oversight or of accountability. The organisations involved in the two case studies below are amongst the most conservative and highly regulated bodies involved in the sector; rather it requires the absence of upfront limitations on " what, how, when and how much" and a focus on " deliver this, with this resource… and if you need more… make a case and we will listen" .

If you adopt the above you MAY succeed.

This is about the discipline of the public sector being imposed on the private sector COMBINED WITH the entrepreneurial approach of the private sector freeing up the public sector to achieve the right balance that actually makes projects possible.

REIF £17.2m debt equity mix – all commercial terms

Crown Estate - £10m enhanced rent product

DECC - £10m grant

HIE £3m Grant

Private equity

This is a project finance deal; fully (very) diligenced

It was very hard to do

It is a pathfinder project for the world

5.2. Carnegie Wave Energy – raising funds on public equity markets

Carnegie Wave Energy's Wave Energy project in Perth is the world's first wave-to-wire operating array of wave energy converters (WECs). CWE has been able to secure support from over 8000 shareholders, most of them small investors. This is essentially "patient capital".

CWE has shown that it is possible to raise equity, as a listed company on a recognised securities exchange for long term marine technology development purposes. This was made possible by a number of key factors:

- Initial support: CWE has been able to secure capital from a number of High Net Worth (HNW) individuals as well as some institutional type investors, for the very first phase of the project
- Suitable R&D schemes: CWE benefited from such a scheme to introduce debt into the next stage of its technology development. This debt is secured against the cash flow arising from the credits.
- Market discipline**:** CWE then worked towards delivery of regular & realistic milestones for development including costs and timescales and communicated it to their shareholders making further financing rounds possible.

Next steps: CWE plans to develop its CETO 6 technology at scale in Europe. It may "dual list" on the UK AIM market. However such a listing would have to be supported by a credible project pipeline which would provide attractive returns to investors.

Caveat: the possible risk appetite of Australian investors coupled with the relatively minor effects of the Global Financial Crisis (GFC) in that country may mean that the success of CWE in raising equity capital may not be replicable in other markets.

Concluding query: what policies might EU authorities contemplate to encourage the replication of CWE's Australian funding success in Europe?

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Ocean Energy Forum:

Technology work-stream recommendations

17 July 2015

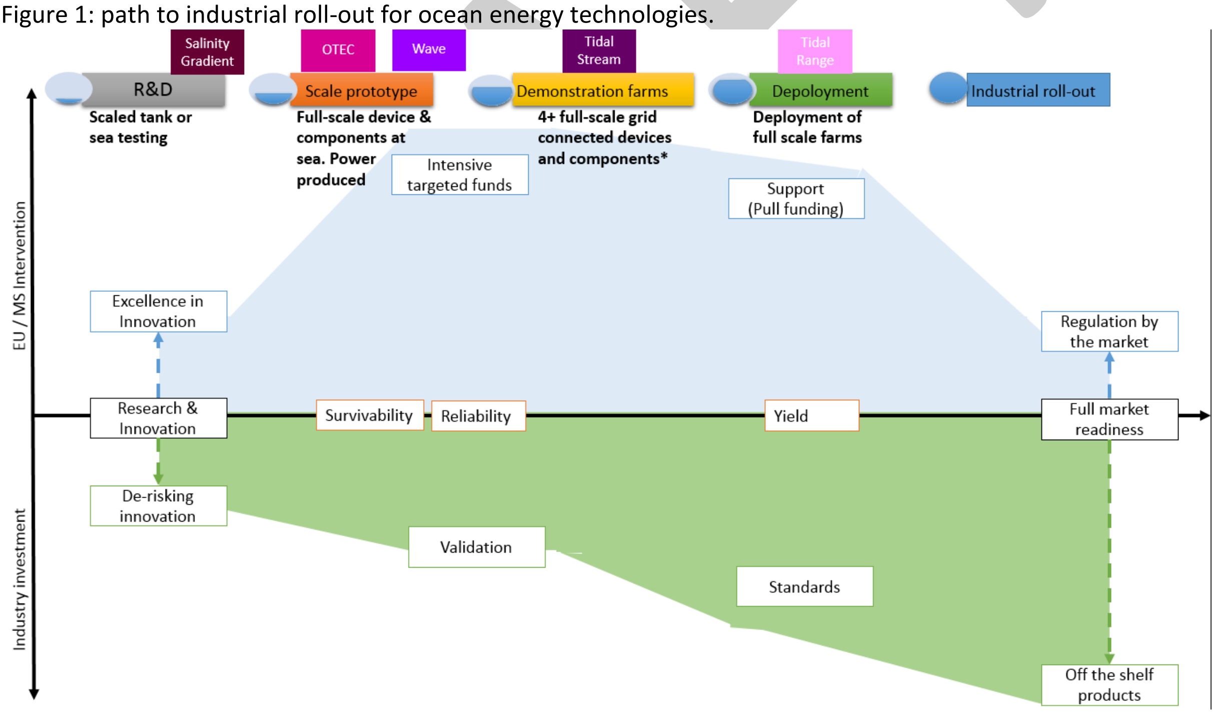
State of play [This section and fig. 1 could be integrated in the general introduction to the roadmap]

Ocean energy technologies are at different development stages. Although the end game is the same, to produce energy at an industrial scale and at competitive cost, it is necessary to adopt different strategies for each technology depending on where it is on the path to industrial roll-out.

Whereas some technological challenges are the same across the entire ocean energy sector, others are specific to the individual technologies. It is, therefore, necessary to ensure that monies – whether public or private – spent on research, innovation or deployment are appropriately allocated enabling the sector as a whole and each technology individually to move forward.

Beyond financing, other actions, such as regulatory or knowledge sharing and management will accelerate the move along the path to industrial roll-out.

Figure 1: path to industrial roll-out for ocean energy technologies.



1 * Number of devices not relevant for OTEC and Salinity Gradient.

2 Source: Ocean Energy Forum

Objectives

The overall objective of the ocean energy roadmap is to build on European leadership in ocean energy and develop a technology that can meet a significant amount of Europe's power demand over the next 35 years. To achieve this, the cost of energy from ocean energy technologies needs to come down to around €c10/kWh of power produced and, therefore, become a competitive source of marine energy fully integrated in the European power market.

The competitiveness of ocean energy technologies will be tributary of their productiveness and reliability. Reaching €c10/kWh will require among others increased availability.

Development of ocean energy requires early Research and Innovation and deployment efforts. Deployment of ocean energy follows a phased approach:

- *R&D* - Small-scale or component testing prototypes
- *Full-scale prototypes* – single full-scale devices with full-scale components are deployed in the sea and produce power, although not necessarily grid connected;
- *Demonstration farms* – Tidal stream, wave and tidal range: a series (four or more) of full-scale devices are deployed in the sea in an array and are connected to the grid – OTEC and salinity gradient: grid connection of full-functionality down-scaled power plant;
- *Deployment* – first full-scale farms composed of several lines of devices (arrays) are deployed and feed power to the grid;
- *Industrial roll-out* – full-scale commercial ocean energy farms are deployed.

All ocean energy technologies face similar hurdles on their path to industrial roll-out. General R&D priorities and policy recommendations are, therefore, proposed for the whole sector in the following two sections. However, based on the position of each ocean energy technology on the path to industrial roll-out, a specific approach, prioritisation and objectives are also required. These are addressed further down.

General priorities

Demonstration and Modelling

Validation of concepts and development of high-definition modelling through demonstration under real conditions and deployment is of prime importance for the sector's development. This step is not linear, both demonstration and modelling on sub-systems, components, the entire device in real and controlled environments are needed at the different stages of the technology's development.

Installation and logistics

Stimulate the development of a dedicated installation and operation and maintenance (O&M) value chain for ocean energy. Although there is significant scope for sharing infrastructure (harbours, vessels, power cable, grid connection…) and processes (training, health and safety, processes…) with other marine industries, a new generation of waterborne and sub-sea solutions is needed to match the specificities of ocean energy devices and reach the targeted costs per kWh.

Reliability and Survivability:

Increase the reliability of ocean energy devices by developing monitoring systems in real conditions to identify potential failures and, therefore, improve designs. Where necessary, develop mechanisms to contain and by-pass faults, increasing the survivability of devices ensuring they remain available for power production.

Power generation and Grid

Deliver grid compliant power into the energy mix meeting the needs of the power producers. Remoteness of ocean energy devices and quality of the grid and ancillary systems is an important challenge for the development of the sector. Grid operators often cannot commit to investing in upgrades until new ocean energy projects are secured, paradoxically, the latter cannot reach financial close, if there is no guarantee of adequate grid connection.

Standardisation of the industry: develop off-the-shelf ocean energy products and services.

Policy recommendations

1 - Create early demonstration farm zones before 2020

Enough areas need to be prepared to deploy the first ocean energy demonstration farms. Obtaining permits and grid connection for smaller projects can be time consuming and costly, compromising a project's financials, thus delaying or blocking deployment.

Based on an analysis of the marine resource, national authorities need to plan fully grid connected ocean energy zones where one or more technology and project developers can deploy demonstration farms with the necessary equipment to collect and process data.

Such zones could, moreover, be financed and managed by or on behalf of more than one country, reducing cost for individual national authorities and allowing for greater cooperation, knowledge and learnings sharing across the European ocean energy supply chain.

Member States, national and regional authorities – 2015 to 2020

- ⇨ Ensure, EU-wide that at least 10 deployment zones, able to connect around 30MW of ocean energy devices are permitted with secured power grid connection.

2 - Strategically focus research and demonstration [This recommendation could be integrated in part or in whole in the general introduction to the roadmap]

Public research, demonstration and early deployment funds should focus on the priorities and gaps identified by the ocean energy industry. This Roadmap summarises the priority areas and is based on the detailed Ocean Energy Technology and Innovation Platform (TPOcean) Strategic Research Agenda.

European ocean energy industry – in 2016

- ⇨ Publish and communicate a comprehensive Strategic Research Agenda, correctly identifying and prioritising research and development areas to accelerate ocean energy deployment.

National authorities – from 2016, taking into account the priorities identified by the industry and all the possibilities offered by EU research, infrastructure and development funds

- ⇨ Increase coordination of national and EU ocean energy research programmes and cooperation among EU Member States.
- ⇨ Leverage available EU (co-)funding and facilitated cooperation[1] opportunities to run multi-Member State or sea basin-wide ocean energy innovation and demonstration programmes.

European Commission, national authorities and European ocean energy industry

- ⇨ Set up a public-private partnership (PPP) providing funds for innovation in ocean energy.
    - o **2017 to 2025 -** For wave energy, establish a phase-gate procedure for sub-systems, components and devices whereby funding is only made available once clear

[1] Such as European Research Infrastructure Consortium.
[2] http://www.waveandtidalknowledgenetwork.com/

performance indicators, determined by an independent multi-disciplinary panel of experts from a variety of stakeholders, have been achieved.

- **2017 to 2022** - For tidal stream, focus on demonstration farms.

3- Knowledge sharing

Knowledge and data sharing mechanisms across the industry will help leverage the learnings from one project to the next reducing where possible duplication of efforts in both research and deployment. Structured knowledge and data sharing mechanisms, therefore, play a significant role in accelerating the cost reduction pace and achieve a competitive cost of energy. However data sharing mechanisms need to take full account of businesses' commercially sensitive information, at the risk of seeing a reduced appetite to invest in innovation and take first mover risk.

Ocean energy industry, European Commission and national authorities – 2017 to 2025

⇨ Set-up a European-wide industry run platform where data in standardised and anonymous form is fed in by project and device developers. Public or EU-funding for individual projects could be made conditional to fully participating in the data and knowledge platform. Clear rules to protect intellectual property rights are required to ensure full industry buy-in into the system. This action could build on initiatives such as the Wave and Tidal Knowledge Network[2].

4 – European ocean map

Data on ocean energy resources, seabed conditions and overlying water column should be collected in a multi-resolution ocean map. Such a map would inform maritime spatial planning exercises, help plan future power grid reinforcements and extensions and facilitate site selection and development, improve environmental impact assessments reducing costs for the industry and permitting lead-times.

European Commission, building on existing EU projects and programmes[3] - by 2020

⇨ Create a publicly accessible multi-resolution map of the seabed and water column of European seas and oceans.

5 – Standards and certification

To make the leap to industrial roll-out of ocean energy devices and projects, bespoke standards and certification practices are required. Information and data gathered during the phases leading up to industrial roll-out is fundamental to move the standardisation process forward: for industrial roll-out, project developers and investors need to have guarantees on machine performance. Standards and certification are a pre-requisite for ocean energy devices to become "off the shelf".

Power producers, test sites and centres – by 2020

⇨ Develop and share guidelines on the optimal device operation and farm lay-out requirements as a first step to the development of industry-wide standards. This action could be carried out, within the knowledge sharing platform under recommendation 3.

[2] http://www.waveandtidalknowledgenetwork.com/

[3] EMODnet, Copernicus Marine Service, WISE-Marine, European Multidisciplinary Seafloor and Water Column Observatory, …

6 – Power remote locations and islands competitively

Smaller sized ocean energy projects can already be used to produce power competitively for remote locations and isolated grids still often powered at significant cost by diesel generators. Beyond the benefits of providing rapidly grid-parity priced power and reducing fossil fuel consumption, such deployment would also allow ocean energy devices to clock operating hours allowing for further development of the technology.

Regions and national authorities – by 2020

⇨ Launch tenders to connect ocean energy devices to diesel generators powering remote areas and isolated power grids, such as islands.

Technology specific priorities

Tidal stream – competitive from 2030, bolstering EU worldwide leadership

It is expected that tidal stream's demonstration farms phase will be underway by 2020 with around 100MW of capacity expected in Europe alone. Consequently, tidal stream technology is at a stage along the path to industrial roll-out where full-scale demonstration is needed to push development forward. Under the right policy and economic conditions, deployment can begin in the early 2020s.

Objectives are:

⇨ demonstrate around 100 MW of tidal stream farms capacity by early-2020s;

⇨ deploy at least four farms (20MW to 30MW) with devices laid out in several arrays by mid-2020s.

⇨ be fully competitive during the 2030s, reducing LCoE to around €c10/kWh.

To achieve this

⇨ **Prioritise deployment**. Increase reliability of devices through testing and deployment permitting the certification of sub-systems and components.

⇨ **Focus Research, Development and Innovation**. Focus R&D&I efforts on technologies and processes necessary to develop and optimise farms such as subsea power hubs, lay-out optimisation, and characterisation of the environment (modelling O&M, turbulences, yield).

Wave – Breakthrough innovation to deploy large farms by 2030

Wave energy converters (WEC) have progressed significantly the last decade, from scaled testing to full scale prototypes. Data and learnings collected from sea tests has shown the importance of further research into subsystems and components. An increasing number of innovative concepts are being developed. WEC development will accelerate with a consolidation of sub-systems and components as a step to reducing costs.

Objectives are:

⇨ install different wave energy converter scale prototypes for a total of minimum 20 MW in Europe by 2020;

⇨ use the learnings of this phase to improve sub-systems and components competitively through both modelling and testing;

⇨ subsequently, demonstrate the most promising consolidated concepts in farms for a total of a further 100MW in Europe by mid-2020s;

⇨ be a competitive source of marine renewable energy during the 2040s, reducing LCoE to around €c10/kWh.

To achieve this, breakthroughs are required on components and sub-systems, power take-off systems need to be optimised through modelling, testing and demonstration.

- **Prioritise subsystems and components.** R&D&I in wave energy should focus on key components and subsystems, tested both individually and as part of the whole device.
- **Power take-off (PTO) systems.** PTO systems in particular require near full-scale demonstration in real sea conditions for validation**.**

Offshore Thermal Energy Conversion (OTEC) – Exporting by 2030 European industry and know-how

The construction of a 16 MW OTEC project (NEMO) in Martinique, France, demonstrates the potential for the EU to develop a technology and know-how for export around the world's tropical regions. Moreover, the potential for high average capacity factors could rapidly lead to significant reductions in cost of energy.

Objectives are

- reduce levelised cost of energy to between €c30/kWh to €c55/kWh, through connection of scale prototypes (up to 20MW) by early 2020s;
- subsequently reduce LCoE to between €c13/kWh to €c25/kWh through demonstration power plants (around 100 MW) during the 2020s;
- gear up for industrial roll-out in export markets through deployment of large power plants achieving an LCoE of around €c10/kWh in the 2030s.

To achieve this research on increasing the efficiency of thermal energy conversion and up-scaling are required.

- Focus efforts on improving heat exchangers.
- Develop materials and manufacturing processes to scale-up significantly the power plant, notably the cooling pipes' dimensions to allow a better yield.

Salinity Gradient – First large plant by 2030 demonstrating EU state of the art

Salinity gradient is in the R&D phase, up-scaling to the megawatt prototypes is expected around 2020. Whereas still research driven, the technology could rapidly grow increasingly commercial.

Objectives are

- Develop a 50MW demonstration plant by mid-2020s as a first step towards a full-scale (200MW) deployment plant to achieve a LCoE of less than €c15/kWh
- Develop module salinity gradient storage solutions to be used in combination with other renewable energy systems by 2030.

To achieve this

- Focus research on membranes, bio-fouling and materials.

Tidal range – ready by 2030 for roll-out in Europe

The Swansea Bay Tidal Lagoon project (320 MW), expected to be operational in 2019, will set the standard for future development in tidal range projects. The lagoon set-up is innovative but the power generating technology is well understood as it has been used in early tidal range projects in Europe (such as La Rance, France, 1966 – 240 MW) and around the world and is informed by traditional hydro-electricity projects.

With the accumulated know-how from past projects and a successful project in Swansea Bay, tidal range technology will be in the demonstration phase, one step from industrial roll-out. Tidal range's main challenge is not the power producing technologies *per se*, but rather how the individual aspects to build and operate the project fit together. There are also consenting challenges that require innovative approaches to facilitate project development.

The Roadmap's objectives for tidal energy should be

- ⇨ Complete and fully grid connect a new tidal range power plant bringing Levelised Cost of Energy (LCoE) to €c20 to €c25/kWh before 2020;
- ⇨ Reach a LCoE of €c13/kWh to €c18/kWh through the deployment of a further 2GW plant by mid-2020s;
- ⇨ Begin industrial roll-out before 2030.

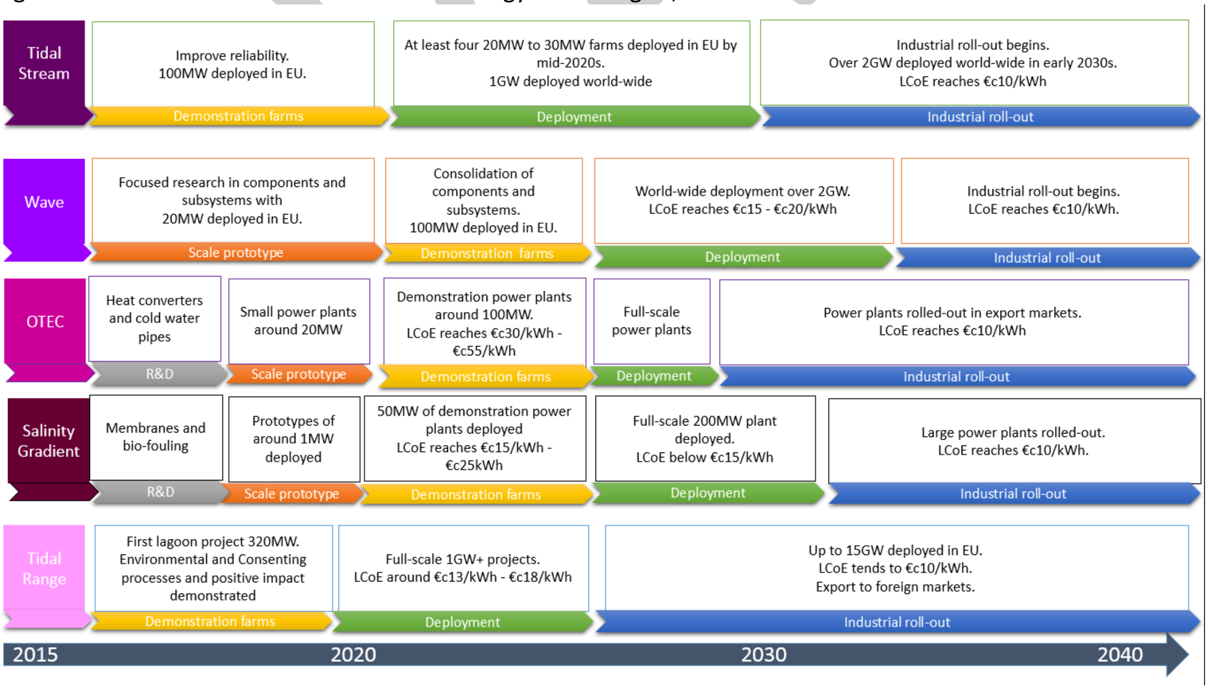
To achieve this, it will be necessary to prioritise action to

- ⇨ Support research and demonstration including in environmental approaches.
- ⇨ Promote enabling policy frameworks to streamline and facilitate consenting processes.

Timeline and milestones

Figure 2 summarises the development stage of each ocean energy technology and the milestones identified in this roadmap on their path to industrial roll-out.

Fig. 2: Path to industrial roll-out for ocean energy technologies, timeline and milestones.



Source: Ocean Energy Forum