European Ocean Energy

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INDUSTRY VISION PAPER
2013

OCEAN ENERGY for EUROPE

The European Ocean Energy Association is a fast-growing membership organisation set up - with Commission support - to represent the sector to the European Commission, Parliament and Council of Members. We act as a hub for information and networking.

Our goal is to unite the key European players behind a common plan for commercialising ocean energy technologies, which can be used to leverage strategic investment from the private and public sectors between now and 2020. We will also work closely with the Commission and member state governments to promote a level playing field for ocean energy developers in the single European market.

On the industry front members include 10 large utilities such as **E.ON, EDF, EDP, SSE** and **Iberdrola**. We also count 8 large international engineering and manufacturing firms such as **Alstom, DCNS, Voith Hydro and Andritz Hydro**; together with 16 of the world's leading SME technology developers in our membership. Between them our members have made significant progress in recent years:

- **€600m private sector investment** in the last 7 years
- **EU installed capacity has tripled in 4 years:** representing significant technical progress; with **over 10MW** of operational devices installed today[i], compared with 3.5MW in 2009.[ii] Many of these devices have rated capacity of over 1MW.
- **2GW of projects in the planning pipelines of Europe's largest utilities** and renewable energy project developers.

Capitalising on this progress will, however, depend on creating the right market and investment conditions across Europe in the future.

National trade associations and development agencies from Spain, Ireland, Norway, Scotland, the UK, France, Portugal, the Netherlands, Denmark and Sweden are also members. They believe Ocean Energy will play an essential part in meeting clean energy targets; as well as securing national export revenue and inward investment. Our members also represent experts from engineering departments at leading European Universities.

We promote all technologies designed for extracting energy from the ocean:

Tidal power - tidal streams and currents offer a consistent source of kinetic energy caused by regular tidal cycles influenced by the phases of the moon. Tidal barrages exploit the rise and fall of tides in estuaries and bays to produce electricity.

Wave power – devices are located different distances from the shoreline, either on the sea-bed or surface-floating. All derive energy from the movement and power of ocean waves.

Ocean thermal energy conversion – OTEC – devices exploit the temperature difference between deep cold ocean water and warm tropical surface waters. OTEC plants pump large quantities of deep cold seawater and surface seawater to run a power cycle and produce electricity.

Salinity Gradient - power generation from salinity gradients utilizes the difference in salt content between fresh water and seawater to provide a steady base load of electricity from plants located close to the end-consumer.

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▲ *Alstom 1MW turbine load-out from Kirkwall for deployment at the EMEC tidal site - 2013*

Executive Summary

The European Commission has set out a trinity of energy policy goals: our energy supplies must be **secure**; they must be **sustainable** and they must **underpin Europe's global competitiveness**.

Europe is currently the leader when it comes to exploiting one of the most significant sources of untapped renewable energy globally: energy from the ocean.

Harnessing this unused resource will increase energy security and optimise Europe's clean power supplies - by increasing system stability and bringing down the overall price of renewable energy. It will drive industrial growth, exports and job creation by revitalising traditional maritime sectors. Ocean energy also has the potential to maximise the value of investments in infrastructure, expertise and equipment in Europe's oil, gas and offshore wind sectors. Currently 1000 people are directly employed in this sector. Howerver, Europe must maintain its leadership position if it is to secure the full industrial benefits of a manufacturing supply chain that could create 20,000 new jobs by 2035[iii].

Industry investment of over €600m in the last 7 years has triggered significant progress. Over 10MW of ocean-going devices are currently deployed in European waters, including several devices of 1MW and more. In the next 7 years the industry will continue to invest considerable resources to achieve its vision for the sector. The industry goal is to deliver reliable and cost-effective electricity from several small ocean energy arrays of up to 10MW from 2015; and for the front-runners to deliver larger-scale projects of up to 50MW by 2020 in preparation for wholesale market roll-out from 2025.

European Ocean Energy Association members all have one thing in common: pioneering a new industrial sector. They believe the key to success will be bringing stakeholders together at the European level to develop a unified strategy for managing **three major categories of technical, project and financial and market based risk**.

Our members believe that a step change could be catalysed if Europe also sends a strong signal that it is serious about unlocking Europe's ocean energy potential. This paper sets out a three-point plan for managing the major risks to growth, and invites the Commission to work with us to develop model policy frameworks aimed at facilitating successful market penetration for ocean energy technologies.

In addition to providing policy support and coordination; we recommend that the Commission commits to an annual ocean energy funding call under Horizon 2020 - this would boost support from Member States under the proposed Ocean European Research Area network (ERA-Net). Finally, we invite the European Investment Bank and the Commission to work with us **to develop innovative approaches to reducing investment risk** to guarantee investor confidence; and help the sector secure finance for the first, critical projects planned for delivery by 2020.

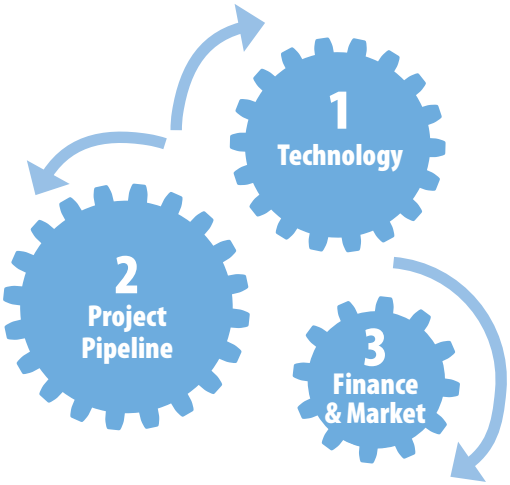


Figure 1 - A 'Three Point Plan' for unlocking Europe's Ocean Energy potential

Introduction

EU Energy Commissioner Oettinger: "during a time when Europe seeks out new pathways to growth, if we promote economic growth on the energy systems of the last century, we will need the resources of at least two planets to power the world by 2030. This is simply not possible".[iv]

Renewable energy is environmentally and economically sustainable. By cutting general pollution and carbon emissions, renewable energy can make a positive environmental contribution. Exploiting Europe's indigenous renewable energy sources also increases energy security; and creates sustainable jobs by acting as an engine for growth and competitiveness, thus contributing to the EU's strategic energy policy goals.

In the future Europe will need a smarter and more interconnected energy system. One that will maximise Europe's ability to draw on all its available resources. It is only logical that renewable energy sources will form an increasing part of Europe's energy mix in the future. Adding new sources of untapped renewable energy will also be essential.

A successful ocean energy sector could make a significant contribution to decarbonising Europe's electricity supply from the mid-2020s onwards. Estimates of the future installed capacity for ocean energy vary – **and so much will be dependent on getting the correct blend of low-carbon price signals, market incentives and policy frameworks** – but it would be entirely reasonable for Europe to set its sights on installing up to 100GW of ocean energy from wave, tidal and salinity gradient power in the next 3 decades. Ocean Thermal Energy Conversion technology (OTEC) also offers significant export and development potential for overseas European territories and many Cotonou agreement countries.

Large European engineering companies and Utilities have stepped up investment in the sector; and triggered steady progress in recent years. However, maintaining Europe's global lead will depend on overcoming a number of challenges. Technical innovation is needed to increase reliability and bring down unit costs. The industry needs to secure a pipeline of suitable, consented sites for the future. Successful technical innovation and site development will take significant financial investment and positive market signals. The industry still faces significant barriers - but to differing degrees in different countries. This wide variation in policy, regulatory and market conditions is, in itself, a challenge that can only be tackled at the European level.

In 1980 the global installed capacity for wind power was 10MW; today in Europe alone it has exceeded 100GW[v]. This has helped make sure Europe will meet its 20% carbon reduction target for 2020.

Europe has also set a target of cutting carbon by 80-95% by 2050. To do this, it will need to set increasingly proactive regulatory and market support policies to bring new renewable energy technologies online.

In the context of growth in other sectors and future targets - and with strong economic price signals - our members believe Europe can expect to install up to 100GW of Ocean Energy projects by 2050.

OTEC – Land based prototype, installed on La Réunion - 2012

Maintaining Europe's global industrial leadership in Ocean Energy

Europe currently leads the emerging ocean energy industry, with the highest installed capacity in the world at over 10MW.

Globally, the International Energy Agency's 'Ocean Energy Systems: International Vision Report' (2011) estimates that – given the right market conditions – there is the potential to develop 748 GW of ocean energy by 2050, which by 2030 could create 160,000 direct jobs and save up to 5.2 billion tonnes of CO_2 by 2050.

At over 10MW, the current installed capacity in Europe is substantially higher than anywhere else in the world - Canada (0.25MW), China (4.2MW) or Korea (0.25MW). With over 20MW of new projects now consented for installation in Europe, installed capacity is set to increase rapidly from now on.

However, this is not a lead that the EU can take for granted. These other countries are rapidly increasing their investment support for pre-commercial device testing. Given their industrial strength, China, Korea, as well as Japan and the USA have the potential to be substantial competitors.

It is vital for the EU to continue to provide support to the international ocean energy industry. This will ensure that the EU reaps the full benefits of establishing a domestic supply chain that can export onto the future global market, rather than losing our lead and ending up importing technologies manufactured by our overseas competitors. This is an industrial opportunity that the EU must seize fully.

Lunch on board FRED OLSEN Wave Buoy - installed at Falmouth, UK 2012

European Benefits

The **European Parliament and Council** have encouraged the Commission to support ocean energy, in coordination with other policies and initiatives – such as the Atlantic strategy – and build on other actions under "Europe 2020," the Integrated Maritime Policy, regional and cohesion policy, etc.

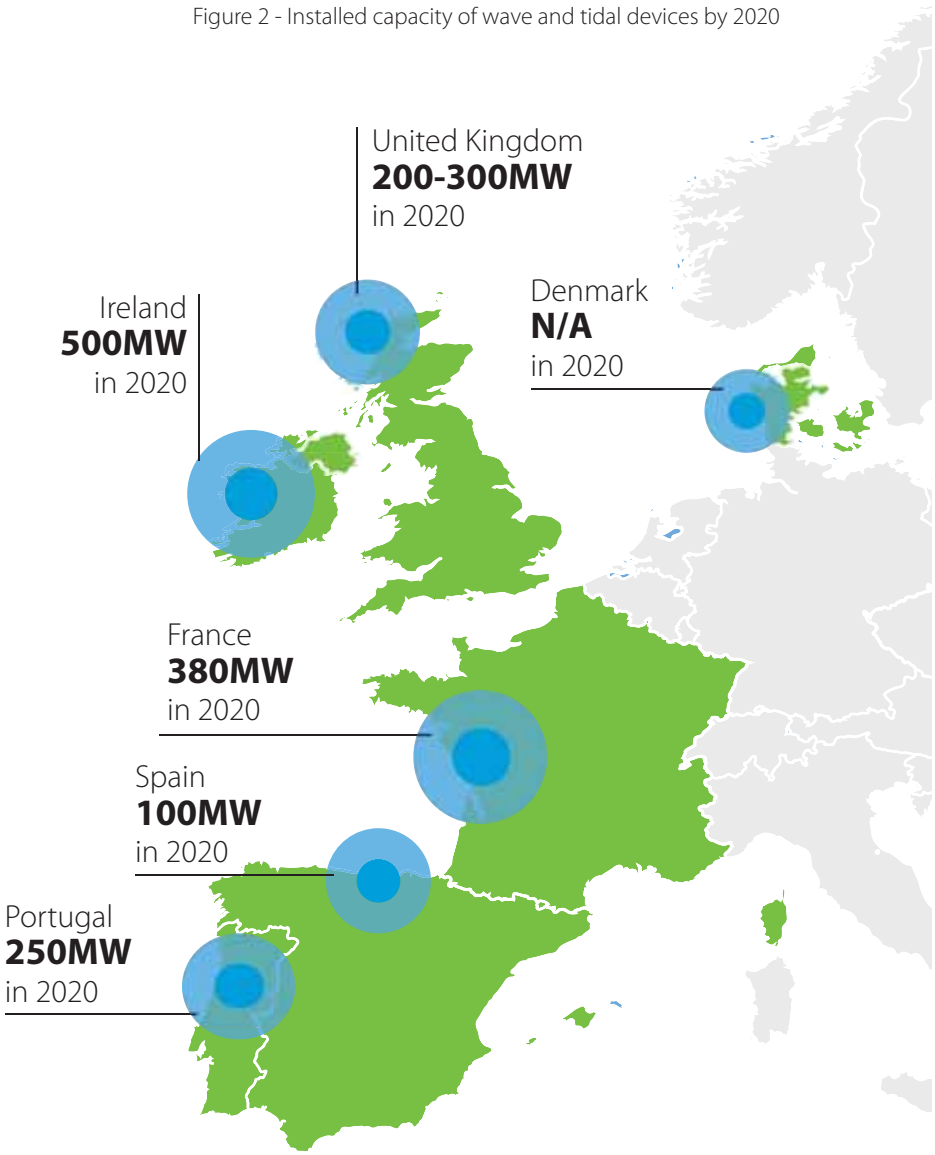
The 2012 Communication on Renewable Energy advocates placing Ocean Energy higher on the EU research agenda. It is also one of sectors of the blue economy highlighted in the 2012 Communication on Blue Growth.

The forthcoming Commission Communication on Ocean Energy will highlight the importance of taking a coordinated approach to accelerating growth in this sector.

Tapping into Europe's ocean energy resource will reduce risk by diversifying the sources of renewable energy available to European utilities in a single market. Indeed, at a time where identifying new sustainable avenues for growth is a key European policy priority, hard-working investments in areas which will drive job creation, clean power production and infrastructure rejuvenation should be paramount.

Ocean energy offers returns in all of these areas. Of equal interest is the export potential offered by Europe's intellectual and technical global lead in this exciting new field.

Figure 2 - Installed capacity of wave and tidal devices by 2020



Pan-European Project Pipeline and Supply Chain

As a fledgling industry, the European ocean energy sector is making positive progress. Several European utilities and engineering giants from Europe, the US, Japan and Korea have all invested in SMEs, testing programmes and early project development in Europe. This clearly points to growing confidence in the viability of these technologies.

So far the UK is leading European development. The UK has created a haven for high-risk early investment - courtesy of an attractive mix of testing facilities, stable policy and good revenue incentives. However, other Atlantic Arc countries are keen to replicate the conditions which have successfully stimulated inward investment and seeded a project development pipeline which could deliver over 1.8GW of installed capacity by 2030.

France and Ireland are gearing up to ensure that ocean energy arrays are installed in their waters before 2020. Spain and Portugal may be more risk averse in austere times; but they do have some of the most economic wave power resources in Europe, making mass-market deployment off the Iberian coastline post 2020 not just attractive, but inevitable.

Denmark, Norway and Sweden have all recognised the strategic importance of securing supply chain benefits.[vi]

For example, over 35 Swedish organisations, spanning industry and the research community, has just launched a Strategic Innovation Agenda for wave and tidal energy with support from the Swedish government.

The supply chain benefits will extend far beyond the Atlantic Arc. Research into the supply chain emerging to support the sector demonstrates that the ocean energy supply chain is pan-European[vii]. Economic returns will flow to several Member States and not just those with ports, harbours, ocean energy resources and a traditional maritime skills base.

Ocean energy projects will also exploit supply-chain synergies with more advanced sectors such as off-shore wind, oil and gas and ship-building.

Decisions made now will result in Europe becoming the global hub of a new export economy with the associated energy security and tax-take benefits for Member States.

Capitalising on Europe's first mover advantage will also secure high value jobs as we move beyond 2020 towards a low carbon economy.

How many jobs will be created?

There is evidence that ocean energy investment will generate high returns when it comes to jobs – particularly when projects are located in remote areas.[viii]

In its latest report on Blue Growth, DG MARE believes ocean energy employment will increase from 1000, in 2010 to potentially 20,000 in 2035 .

This ties in closely with figures from trade body RenewableUK which estimates the UK ocean energy sector currently has around 800 permanent jobs a with potential to create around 10,000 jobs by 2020 and up to 20,000 by 2035, generating a gross value added of around £800 million pounds per annum[x]. In France, the Senate has estimated 18,000 jobs will be created in marine energy by 2020[xi].

However, European level coordination, practical and financial backing will be critical, as European utilities and large industrials will need **support to manage technical, project development and financial risks** if they are to build the foundations for a new industry in the next 7 years.

Why do we need another source of renewable energy?

Ocean energy is the world's greatest remaining source of untapped renewable energy. Exploiting a new source of utility-scale power will provide **several pan-European benefits**.

European utilities seeking to manage risk by diversifying their energy portfolio will find that ocean energy offers technical and geographical alternative to current renewable energy sources.

Ocean energy is more predictable than, and out-of-synch with other renewable energy sources. Tidal energy is highly predictable; generation can be planned years or even centuries in advance if necessary. Whilst wave power is generated by wind, it is less variable and out-of-synch with wind energy. This is because it takes longer for waves generated by Atlantic winds to reach the European shoreline. Waves also store wind energy and release it more steadily, meaning wave power can be predicted around one week in advance.

The net effect of adding more predictable and consistent sources of renewable energy to our transmission system will be to smooth the overall power supply from renewables. This will increase system stability as well as the penetration of renewables on the grid. It will displace the most expensive balancing plant - depressing the marginal price of energy over the entire generation base[xiii.] Ocean energy will also maximise the asset value of future grid infrastructure - particularly for new offshore-wind projects.

▲ *Pelamis -E.ON P2 and Scottish Power (Iberdrola) P2 wave power devices in operation at EMEC 2012*

Unlocking Europe's Ocean Energy Potential: A 3-Point Plan for Managing Risk

Industry's responsibility is to deliver coherent plans for stimulating market demand by de-risking technology and demonstrating that there is a pipeline of suitable sites across Europe to deliver mainstream power. **This will depend on developing a close working relationship with the European Commission** - to foster consistent policy and support frameworks that will nurture innovation and bring a new industry into the single European electricity market.

A Model Policy Framework for Europe: EU Ready to Act

"The European Commission is now developing a policy framework to support ocean energy. This can help secure Europe's global competitiveness, provide investor confidence, give directions for practical measures and support the scale-up of demonstration projects. It will also help to deliver a number of objectives agreed by EU Member States in recent years, including on climate change, energy, jobs and growth…" (DG Mare, 2012[xii])

For utilities or project developers a core competency for delivering new energy projects is effective risk-management. This is true regardless of the technology selected to generate electricity supplies. Nuclear, solar PV, offshore wind…each carries its own unique risk profile. By definition, technology innovation involves charting unknown territory. At this stage in its evolution, the ocean energy sector carries "first-of-a-kind" risk premiums across the board.

The major risks facing the sector fall into three broad categories: technology, project development, and uncertainty on market policy and financing. Delivering reliable and cost-effective ocean energy technologies will depend on eliminating or reducing risk in all these areas. Neither the public nor the private sector can manage these risks in isolation.

Avoiding private sector "risk fatigue" and keeping the momentum going will require concerted EU support three areas: policy, coordination and funding. Delivering the industry's vision for the sector will hinge on managing risks.

The Ocean Energy Association proposes that this should be done by taking a partnership approach to delivering three programmes designed to tackle risk in the following areas:

Understanding the Risks

1. Technology Advancement

The industry needs to deliver technologies that work at a capital price the market can afford. These technologies must survive for at least 20 years in harsh conditions. Installation, operations and decommissioning costs have to be both predictable and affordable.

2. Project Development Pipeline: Policy and Infrastructure

Breaking into the electricity market in the first instance; and delivering mainstream power in the longer-term will depend on the availability of a pipeline sites. These sites must meet all regulatory and permitting requirements and enjoy broad stakeholder support.

Building, installing and operating ocean energy farms will require significant infrastructure: manufacturing, vessels, ports and harbours need to be planned. Last, but by no means least, projects will need timely and affordable grid connections to connect them on time and at a fair price.

3. Market Mechanisms and Finance: Combined Financing Target >€1bn

Financing technical and project development will take market push to reduce technology risk via private and public capital support. Standalone market competitiveness will depend on market pull – this will take strong private sector commitment to delivering ocean energy projects, which can only be stimulated by a matching public sector commitment to market revenues support mechanisms in the early years. Soft-loans, co-investment and public guarantees will also help to de-risk project finance.

The UK Model for Risk Management

The UK marine energy industry has been forecast to be worth £6.1bn creating nearly 20,000 jobs by 2035[xiii].

The UK has secured a critical mass of investment in ocean energy by large companies from across Europe and overseas. This inward investment did not occur spontaneously. In fact the UK Government's integrated support for ocean energy points to a model which arguably could be applied at a pan-European level. The UK has taken the lead when it comes to sharing and managing risk with the private sector. Accelerated UK growth has occurred as result of:

Market Pull: attractive revenue incentives - The UK Renewables Obligation has so far stimulated investment and project planning. Similar levels of support are either lacking or fragmented across other Member States; and the current UK review of market support for low-carbon energy sources is affecting market confidence.

Market Push: Focused and sustained grant support - The UK has, in recent years, focused on delivering a coordinated grant funding system, working in close consultation with the private sector – this strategic approach has delivered several successful projects.

Policy Intent and Regulatory Framework - A one-stop shop for consenting (Marine Scotland).

World class technology testing facilities - Device developers and supply chains have clustered at the European Marine Energy Centre.

Project pipeline and site availability - A carefully managed first round of sea bed licensing has provided sites for project deployment.

European Marine Energy Centre: a haven for high-risk early development... attracting investment from all over the world

PROGRAMME 1
Technology Advancement

Project and technology developers recognise that they are attempting some of the most **technically challenging projects in the history of the energy industry** at a time of extreme fiscal and financial pressure[xiv]. (RenewableUK 2013).

The private sector has invested heavily and will continue to invest in technology advancement. The focus in the next 7 years will be reliable performance, survivability and cost reduction.

Delivering technology that performs reliably and can survive in harsh operating environments is a prime driver for research and demonstration. This is the first step towards commercialisation. Proven and reliable performance will make it possible for manufacturers and underwriters to offer warranties and insurance to project developers in the future.

Technology that performs well, but is too expensive will not succeed. Of equal importance is a cost reduction pathway for the sector. This should clearly demonstrate how, when and where costs can be reduced. The objective for the sector is to deliver projects that will provide concrete evidence that ocean energy technologies will come down the cost curve on target for wholesale market roll-out by the frontrunners from 2025 onwards.

There is already good consensus on the main technical risks facing the sector (see illustration)[xv]. By focusing on addressing these challenges at the European level, the industry can identify specific action areas where a unified and coordinated approach is required.

> **Delivering new, offshore technologies is capital-intensive. The Ocean Energy sector is currently prototyping first and second generation machines with a final target retail value of €4-5m/MW.**
>
> **Increasing the reliability of devices and driving down the cost of energy is a universal goal for all ocean energy developers.**
>
> (Ocean Energy Association, 2013)

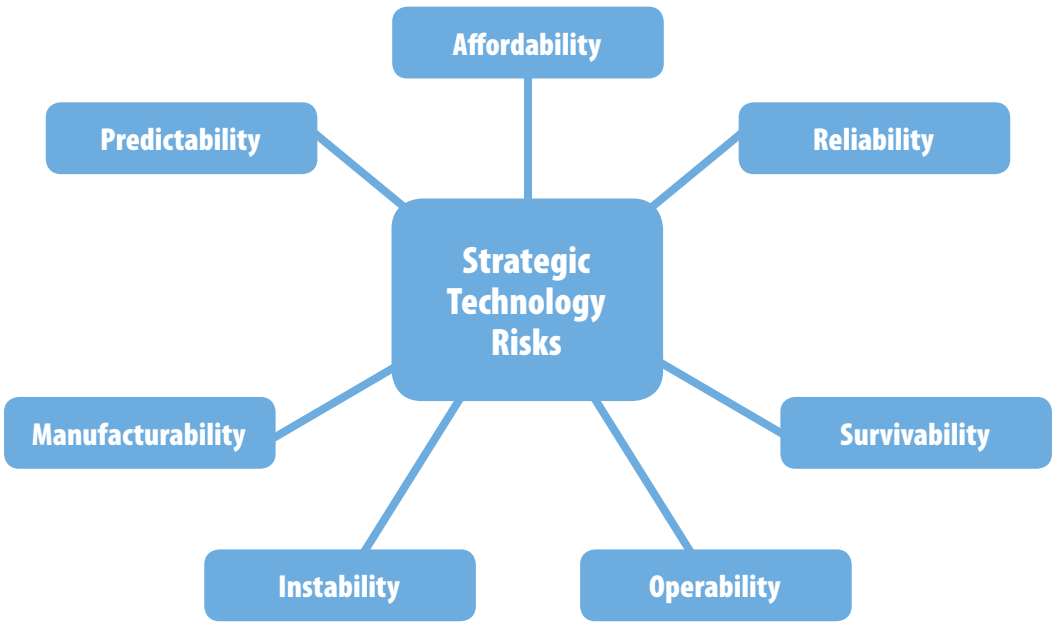


Figure 3 - High level technical risks (adapted from ORECCA Road Map and cited by SI OCEAN 'Ocean Energy - State of the Art') [xvi]

Funded by the European Commission and led by the European Ocean Energy Association; the Strategic Initiative on Ocean Energy (SI OCEAN project) will continue to consult closely with industry to deliver recommended actions to overcome these risks. SI OCEAN's first technical report has identified that whilst some of these risks can be tackled at the single-prototype level, the sector will face a new set of challenges as it moves to installing small arrays. Beyond this phase the project life of the first commercial farms – from engineering design to decommissioning will also bring significant new challenges.

For the supply chain and technology developers who are pioneering innovation in this area - initial risk exposure is high. Capital support for R&D and demonstration continues to be vital.

Grant support should not be limited to individual device designs – strategic funding should also be targeted at generic systems, new materials and enabling technologies. It will also be important to direct support toward innovation in the supply chain.

- **Demo and Array funding** - get demo machines into the water. Keep them operational for as long as possible – to generate performance and environmental data.

- **Improve system and individual component reliability** - onshore and offshore sub-system and component testing; and design to improve system integration and performance.

- **Supply Chain, Enabling Technologies and Materials** – R&D and testing

- **Cross-cutting enabling technologies and components** - with wider application in other sectors.

Finally, strategic investment in practical support and facilities will also accelerate innovation. The best example of this is the European Marine Energy Centre (EMEC). Co-investment from Europe, the Scottish & UK Governments has created a self-financing hub for learning and technical advancement – and leveraged millions in private finance into the sector and the local economy. Another strong example is the EC funded project - MARINET[xvii], which will give developers low cost access to state-of-the-art testing facilities across Europe.

Early prototype of the Voith Hydro 1MW device fabricated in Heidenheim, Germany. The 1MW machine was shipped in April 2013 to EMEC for assembly and installation in Summer 2013

Ocean Energy Technologies – Understanding the Risk (SI OCEAN 2013)

Affordability: Cost reduction

The Carbon Trust estimates that for tidal technologies the levelised cost of energy (LCOE) is in the range £290-330/MWh and for wave technologies the range is £380-480/MWh[xviii] (assuming that the first 10MW of similar devices have already been installed; and a 20 year life and 15% discount rate).

Many analysts expect the range of cost reduction to be 15-18%,[xix] which compares well to the historic learning rate for other renewable energy technologies. This will be based on progress in the 3 areas known to contribute to cost reduction: R&D; Learning-by-doing; and Economies of scale.

Continued efforts at improving the affordability of ocean energy technologies will require significant technical innovation, and cost reduction will have to be targeted for successive models of device.

Reliable Performance and Surviving a Lifetime in the Ocean

It is crucial for offshore renewable technologies to perform reliably and survive in extreme conditions for up to 25 years. Downtime for planned and unplanned maintenance must be kept to a minimum.

This is true for all technologies, but more so for ocean energy technologies. All ocean energy technologies will need to survive millions of cycles of sustained and extreme loads in a naturally corrosive environment. Added to this, life expectancy and failure modes are not yet proven.

Manufacturing, Installation and Operations

So far, innovation in this area has supported the manufacture and installation of one-off machines. Scaling up will require streamlined manufacturing and installation processes, together with optimised maintenance routines. Some supply chain players have already started to work on bespoke solutions for the ocean energy sector – seeing this as a future growth area.

Stimulating the supply chain is part of the solution. At this early stage, technical risks are compounded by limited installation and operational experience. Supporting the deployment of more demonstration machines at sea more often - and keeping them operational for as long as possible - will help to make these processes cheaper, safer and quicker in the future.

The Science of Resource Assessment and Performance Prediction

We are still some way away from delivering the first "bankable" yield estimates for ocean energy devices. There are two issues at stake. First, industry needs to understand the resource, and its impact on power output and energy capture. Second, industry needs a better understanding of the reliability of devices themselves. Several projects, including SI OCEAN are currently developing standardised systems for improving the accuracy of yield estimates for single devices and arrays.

Sustained investment in industry-level coordination and cooperation in this area will be essential to delivering standardised methodologies that project financiers and banks can trust in the future.

PROGRAMME 2
Project Development Pipeline: Policy and Infrastructure

In the UK, the Crown Estate has awarded almost 2GW of leases, and the first commercial sites are already under development in advance of technologies being scaled up for commercial deployment – backed by some of the largest utilities in Europe such as Iberdrola, GDF-Suez, E.ON and SSE.

The industry has ambitious plans for project development in France, and the Irish government has received several GW of applications for sea bed leases[xx]. Portugal, Norway, Denmark and Spain have all awarded leases and consents for project demonstrations in their waters.

In some cases renewable energy expansion is badly hampered by complex and time consuming permitting processes, although early experience shows high public acceptance of ocean energy projects compared with other energy sources. Projects are also negatively impacted by delays and uncertainty over necessary grid extensions.

The European Commission can play an important role in facilitating and encouraging the transfer of best practice in the areas of Marine Spatial Planning, regulation and market support to cross-pollinate success around the continent to the benefit of citizens, enterprise and the environment.

Why do we need a pipeline?

Developing a pipeline of appropriate sites now will help the industry secure the goals of reliable power production by 2020; mainstream power production from 2025 and up to 100GW installed by 2050.

We cannot bring a new energy technology onto the European market without first developing suitable sites where that technology can be deployed. The timeframe for offshore renewable project development can take five to eight years from concept to commissioning. Countries hoping to kick-start ocean renewable projects by 2020 should be putting policy frameworks in place now.

Determining the deployment pipeline at a European Level

One challenge facing the sector is clarity on expected levels of deployment over the next few years. In recent years the industry has provided a greater degree of realism in its projections of potential device deployment. Typically for nascent sectors, early forecasts did not take account of all the risks and hurdles to project delivery. The experience of the front runners has indicated that deployment will be slower than previously predicted.

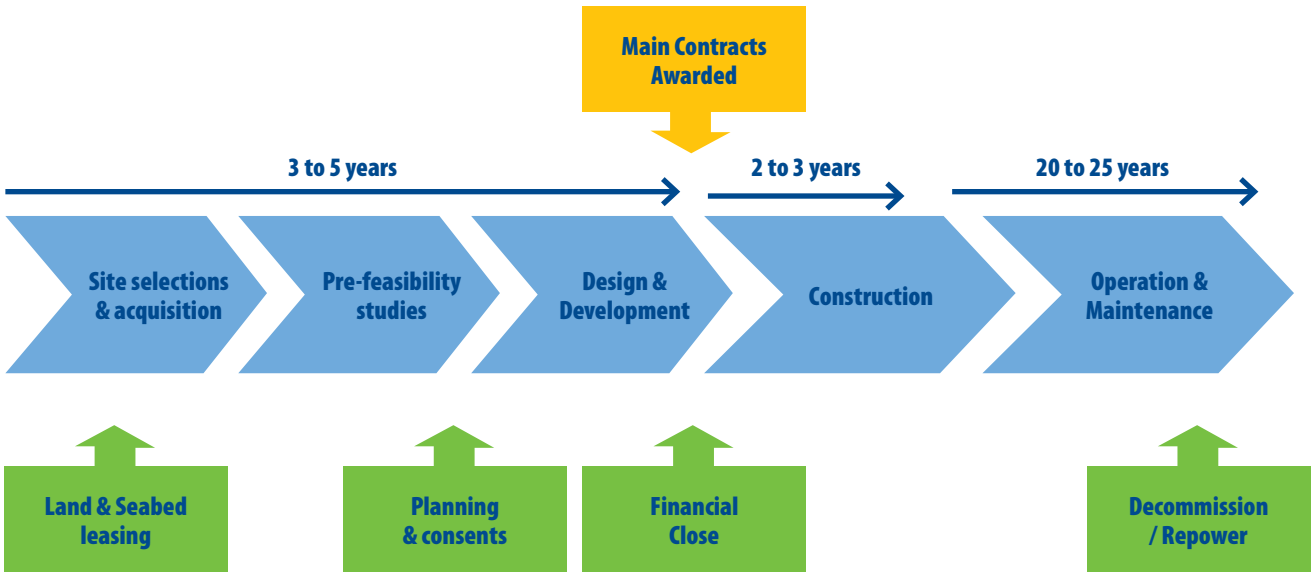


Figure 3. Adapted from Mott MacDonald Report for IEA-RETD (2011)[xx]

It is essential that we have a good grasp on expected deployment levels so that Member States can put tailored and appropriate policy and support measures in place. The Industry will play an important role here – information from project developers will ensure that a realistic and accurate project pipeline can be determined.

From a European perspective, the industry can also highlight proactive examples of best practice that can be adapted and adopted by other member states to stimulate development in their jurisdictions. In the context of the current austerity drive, this also carries an additional advantage – upfront investment requirements will be limited to the administrative cost of developing new policies and procedures, without requiring immediate capital or revenue commitment.

Policy Frameworks and Support for Project Development – Key Risks

With facilitation and support from the Commission at the European Level, the industry can lessen the impact of potential barriers. This will be done by working closely with regulators and decision-makers across Europe to identify examples of best practice; provide valuable practical data and develop standardised solutions to help manage key project development risks, many of which are outlined below:

- **Planning and Consents for a new sector**. The task of developing a tailored and targeted consenting regime that serves the dual objectives of enabling projects and protecting the marine environment is a challenge that industry and regulators must tackle together.
- **Environmental impact assessment and mitigation**. More work is needed to develop appropriate and proportionate baseline and post-deployment monitoring regimes, and to develop suitable measures to mitigate potential impacts.
- **Health and safety** remain amongst the foremost concerns for industry. Up until this point, the industry has maintained an exemplary record with no major incidents recorded. Embedding health and safety as a priority in the whole life cycle decision making process remains a lynchpin of the industry's risk and cost reduction strategies.
- **Supply chain constraints and skills shortages** can slow project delivery but the emerging ocean energy industry can utilise existing European engineering, manufacturing and scientific expertise - catalysing inward investment, new employment opportunities and economic opportunities.
- **Production, port and research facilities** are important enablers of the industry and it is vital that the required ports, production facilities and research capabilities are fostered or created to ensure that ocean energy can take an accelerated development pathway.
- **Transmission infrastructure** is crucial to all ocean energy projects and, as the industry has witnessed in the UK, the lack of adequate transmission infrastructure can halt the development of projects. Policy makers should support the installation of essential infrastructure through any means available to them.

The Ocean Energy Association will provide a central information point for project development. The Association will capture and disseminate existing knowledge, and steer research agendas towards the most pressing issues in each of these areas. We will also channel relevant commercial data to decision-makers; and will take a lead on fostering cooperation and collaboration between project developers, the Commission and Member States.

> **There has been a significant shift towards project development...this step away from device developers taking the lead in both technology and site development is a sign that the sector is maturing and beginning to resemble that of the wider energy market.**
>
> (RenewableUK 2013)

PROGRAMME 3
Getting Projects in the Water: Market Mechanisms and Financing

In the last 10 years, the Commission allocated up to €140m towards ocean energy development. In the last 7 years, the private sector has invested over €600m.

The members of the Ocean Energy Association believe that risk-sharing and investment will have to step up significantly in the next multi-annual framework if ocean energy is to meet the target of providing mainstream power from 2025.

Private companies in Europe have invested over €600m in ocean energy technologies in the last 7 years. In the past 10 years, the European Commission has invested €80m for ocean energy development[xxvi]. In 2012, this level of support almost doubled when the NER 300 competition results announced that a total of €60m will be made available for three small ocean energy arrays (5-10MW).

There is good evidence the private sector will continue to invest – seeing the strategic advantage of bringing a wholesale renewable energy source online. Fred. Olsen and Total joined a growing list of heavyweight investors from the utility and engineering sectors when they announced a further £7.6m investment in tidal technology in partnership with the Scottish Government in December 2012.

Voith Hydro is investing in developing and testing its own in-house tidal technology. Andritz Hydro and the Spanish utility, Iberdrola have both invested equity in Norwegian tidal technology. Iberdrola is now committed to delivering a 10MW tidal array deploying this technology in Scottish waters – stimulated by revenue support under the NER 300 scheme.

These cases illustrate that in every single case, **risk has been shared – and private investment leveraged – by public support from Member States or the Commission**. This demonstrates that the rate and pace of investment will be determined by the level of risk-sharing by the Commission, the European Investment Bank and Member States.

As well as sharing risk; the European Commission and the European Investment Bank (EIB) have clear roles to play in providing advice to Member States on designing pro-investment policy environments – as well as advising on the impact of grid-access; planning and leasing policies on project bankability.

> **Long-term support mechanisms, which have been successful in encouraging investment in other types of renewable energy, will also be needed for emerging ocean energy technologies.**
>
> (Blue Growth, 2012)

By balancing **market push** grants with the right **market pull** support schemes, the Commission and some Member States have boosted investor confidence in the ocean energy sector – using a blend of supportive policy frameworks, clear economic price signals and capital support for technological advancement.

Whilst the private sector has made significant investments the ocean energy sector in the last seven years, a key barrier to continued investment is the size of investment required to scale up these technologies, which is the next logical step down the cost curve.

The European Ocean Energy Industry advocates deploying public financed support for ocean energy project development in the following areas in the future:

Blending capital and revenue support to enable the first ocean energy projects

Right now the challenge for the sector is moving to the next stage: demonstrating the first array projects. Even with significant backing from large utilities investing financially and indicating some willingness to accept a lower IRR for these first projects; **it is proving impossible to secure project finance for small arrays without public sector financial support**.

At this stage both a technology push and market pull are required. The availability of revenue incentives will play an important part in making these first projects economically viable. However, electricity production from the earliest projects will be relatively unpredictable. This means revenue incentives alone will not be sufficient – capital grants will also still be required to help reduce the amount of developer capital at risk. Continued Member State Government support will help to make marine projects more attractive investments and comparable with other renewable energy generation options.

Market support mechanisms - Instigating customer pull at scale

By offering higher levels of support for earlier technologies; support schemes can leverage significant inward investment very early in the development process. For example, the price signal of 5 ROCs (£250/MWh +base price) introduced in Scotland, and later across the UK has played its part in turning the UK into a haven for investment – at negligible cost. Future cost will be limited because a relatively small number of projects will need this level of support. It will also offer excellent returns by creating a new energy sector for Member States.

Of the six countries that have introduced or announced special feed-in-tariffs for ocean energies, almost all of them are currently under review. This creates uncertainty and there is evidence that this could stall investment that would otherwise come into the sector. At a European level, lack of certainty on the level of revenue support could be mitigated in several ways. This includes providing information and guidance on the benefits and relatively low-cost of introducing higher tariffs for ocean energy; helping to create a level playing field using European instruments such as the NER300 second call, and giving active consideration to a follow-on mechanism post NER300, to provide universal access to all technologies that meet the qualification criteria.

Another obvious area for support would be to encourage best practice reforms to **grid regulation and rules on underwriting** which are damaging early projects in some countries. In almost all ocean resource-rich countries, connecting early projects to the grid is already or will be a limiting factor. The degree of impact and reasons behind it differ from country to country. However, there is a clear role for the Commission to highlight best practice and ensure that connecting Europe's sizeable ocean energy resource to the mainstream grid is integrated within its own strategy for grid development at the European level.

Andritz Hydro HS1000 Tidal Machine Load-out at Kirkwall for installation at EMEC - 2011

The Danish wind industry 1980–2010: Lessons for the marine energy industry (Aquamarine Power, 2011)

The Case of Onshore Wind in Denmark

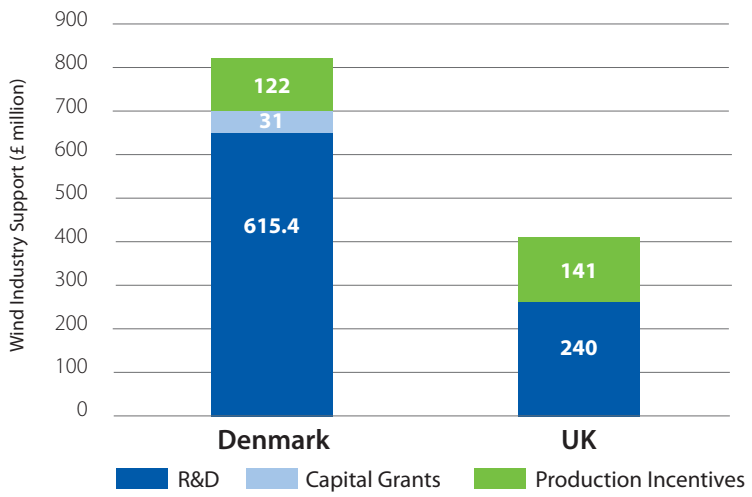
Recent retrospective analysis of the development of both the Danish and British onshore wind industries has identified that disparities in support mechanisms between the two countries was a key factor in determining the variation in the present day market share and correlated economic benefit received from development of this industry.[xxiii]

Development of Onshore Wind

It is particularly interesting to review the total investment which the two Governments provided to support the industries (Figure 4). Even though both Governments invested similar sums of money into R&D activities, the Danish Government awarded grants from 1976 to 1981[xxiv], five years earlier than those which occurred in the UK, providing the Danes with an essential early mover advantage. This was swiftly followed by the establishment of premium revenue incentives[xxv] and a holistic policy package.

Since these early initiatives, a total of 20 years' consistent market and policy support have laid the foundation for a technological revolution that has resulted in a global export market worth over €5.7bn in 2008. With a 20% share of the global wind turbine market, the Danish wind industry provides employment for 28,000 workers and contributes €1.5bn in GVA to the Danish economy each year[xxvi]

Figure 4 - Comparative Wind Industry Public Support made available in the UK and Denmark[xxvii]



Member States' Position Paper and ERA-Net Application

November 2011, the European Ocean Energy Association produced a Position Paper "Towards European industrial leadership in Ocean Energy in 2020" in collaboration with a Member States' Ocean Energy Interest Group: UK, Spain, Ireland, Denmark, France, Belgium, the Netherlands and Portugal.

They announced their collective willingness to work together and co-operate on ocean energy technology development and called for ocean energy to play a more prominent role under the EU's Strategic Energy Technology (SET) Plan. In the short term they requested significant support from the EU's technology development funding programmes; and set a medium term goal for ocean energy to be launched as a new European Industrial Initiative under the SET Plan.

Since then, Sweden has joined the Member States who have now submitted an application for EC support under the European Research Area Network (ERA-Net). If successful, the ERA-Net will bring together 16 state agencies from nine Member States with the common goal of gaining the benefits of coordinated transnational activities and research funding. They also plan to cooperate with the EERA Ocean Energy Joint Programme; other relevant European projects and industry stakeholders.

Siemens 1.2MW Seagen Device – Operational at Strangford Lough. Since 2008 it has generated over 3GWh.

CONCLUSION and RECOMMENDATIONS

What roles should industry; the Commission and other European institutions play to support growth?

The industry goal is to deliver reliable and cost-effective electricity from several small ocean energy arrays of up to 10MW from 2015; and for the front-runners to deliver larger-scale projects of up to 50MW by 2020 in preparation for wholesale market roll-out from 2025.

Europe has a long maritime heritage and strong off-shore industries. She has been a major global player in offshore fossil fuel extraction, and now leads the world in the field of offshore wind. European businesses and research institutions are now pioneering ocean energy innovation. The skills, knowledge and supply chains supporting these activities mean that Europe is well-positioned to lead the world in the field of ocean energy exploitation.

Unlocking this new source of renewable energy is not a task solely for one constituency of stakeholders or for one sector alone. Delivering power from our oceans to Europe's towns and cities - and building a new export industry - will require collaboration and cooperation across a number of sectors and institutions.

What is needed now is for all parties to sign up to a common plan to accelerate ocean energy to the renewable energy fast lane from 2020 onwards. The members of the Ocean Energy Association have identified three priority areas for action to reduce risk and remove barriers to growth, namely: technology development, project development and financing/market support mechanisms.

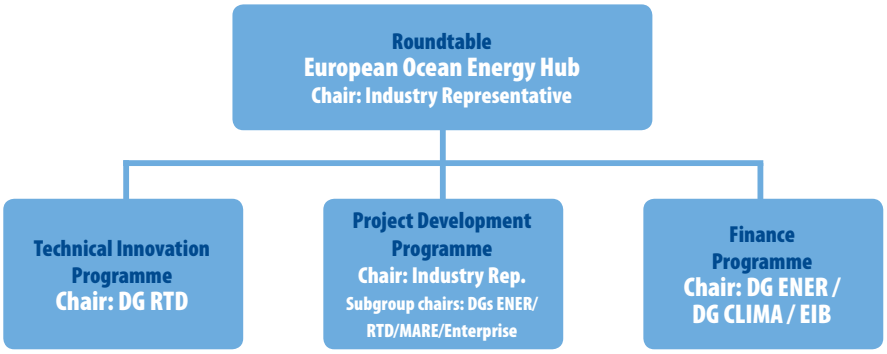
Key Recommendations – Working in Partnership:

The Ocean Energy Association believes that strategic growth could be supported in the future by creating a European Industrial Initiative under the SET Plan, or by forming a suitable public-private partnership. This initiative would be industry-led, and act as a vehicle for the industry, Member States and the Commission to work together to de-risk this emerging sector and accelerate growth.

Our members believe that this approach is justified on the basis of the level of future commitment indicated by leading European industry players; the scale of resource and technical progress since 2009. All of which indicate a positive commercial pathway to 2030 and the ability to deliver jobs and clean power.

As a first step, the Ocean Energy Association plans to convene an industry-led "**European Ocean Energy Hub**". This would effectively act as a programme board, which would steer progress at the EU level and deliver a united strategy. This strategy will form the basis of **a road map for commercialising the sector – including agreed targets and milestones for growth**.

Figure 5 – Ocean Energy Hub Structure



The industry-led board will convene three sub-groups, tasked with delivering detailed programmes for the road map. These programmes will be devised to tackle each of the major categories of risks facing the sector: technology, project development and finance/markets. The industry invites DG ENER, the European Investment Bank, DG Mare, DG CLIMA and/or DG RTD to provide a Chairperson for each of these groups – as indicated in figure 5.

1. Technology Advancement Programme – Plans and Recommendations

Technology Innovation Programme

The goal for this programme will be to set out a commercially viable technical pathway – to de-risk technology and deliver reliable low cost solutions to the market-place. Results would provide a practical lead-in to standard cost reduction from learning-by-doing and volume production; and act as an effective guide for coordinating and targeting innovation funding between now and 2020.

Horizon 2020 and Coordinated Support from Member States and European Research Networks

Overcoming technical risk will require sustained Europe-wide R&D programme – to be defined and led by the industry. Industry will share information; outline technical research requirements and take a stronger lead on coordinating development in this area in the future. In addition to chairing a technical innovation programme; we recommend the following support from the Commission:

- An annual call for ocean energy under **Horizon 2020**. Innovation should address technical risk across all areas of the project life-cycle; therefore calls should be open to **the entire supply chain** – from SMEs to small component manufacturers and installation contractors.
- The recent application by nine EU Member States for support under the **ERA-NET scheme** should be supported.
- Finally, a dedicated follow-up of the **Intelligent Energy Europe Programme** will prepare the ground for market entry and mass-market rollout.

Led by the Ocean Energy Association, the industry will also continue to coordinate with new and with existing EC and member state funded research efforts in this area such as the **European Energy Research Alliance (EERA) Joint Programme on Ocean Energy**, SI Ocean and MARINET.

2. Project Development Pipeline Programme – Plans and Recommendations

The goal for this programme is to deliver an expert assessment of viable EU projects and a robust strategy for commercial roll-out across Member States and overseas territories – determining the pace and volume of installation in line with national circumstances.

This work would facilitate the development of gold-standard model policy frameworks for tackling the main practical and policy-based barriers to project development.

Informed by practical information and guidance from an industry-led main group; it is envisaged that separate sub-groups would draw on expertise from across the commission to deliver recommendations aimed at minimising project development risk in distinct areas:

- **Spatial Planning, permitting, licensing and sea bed leasing**. Spot and encourage uptake of best practice, such as one-stop shops and streamlined processes.
- **Grid connecting early projects and planning for the future**. Deliver recommendations aimed at removing grid-based barriers to project delivery, including an assessment of the strategic value of integrating ocean energy supplies onto the European super-grid.
- **Infrastructure and supply chain planning**. Deliver key recommendations aimed at de-risking availability of key ports and harbour infrastructure and supply chain capacity.

The industry will invite chairs for these sub-groups from DG Mare, DG ENER/RTD and DG Enterprise in line with their remit and expertise in each of these areas.

3. Market Mechanisms and Finance Programme – Plans and Recommendations

The dual goals for this programme are to boost investor confidence and catalyse a step change in sector growth. Market penetration will require a policy framework which can address three key funding challenges: capital provision, revenue support and novel interventions such as soft loans, guarantees, etc. At the heart of overcoming these challenges is the need to encourage public-private co-investment and risk-sharing.

We recommend that that Commission and the European Investment Bank provide technical assistance to Member States and project developers:

- Designing pro-investment policy environments;
- advising on the impact of grid-access; planning and leasing policies on project bankability; and
- supporting developers to **develop "bankable" plans** to access project finance.

These steps will helpfully be complemented by promoting and enhancing market support mechanisms:

- **Promote the benefits** of low-carbon price signals and tariffs for ocean energy and advise on appropriate levels for Member States;
- create **a level playing field** using enhanced revenue support via the NER 300 second call - and consider introducing a follow-on mechanism specifically for ocean energy; and
- **leverage Member States and private sector capital** support for projects by signalling intent to provide EC support; and to develop novel interventions.

In the context of the investments that will be required to meet Europe's increasing carbon reduction targets and electricity demand; a relatively small amount of European support in the next 7 years would be game-changing for this sector, and will help Europe secure first mover advantage in what can become a substantial new global energy sector in the future.

The European Ocean Energy industry calls on the European Commission to respond to this Three Point Plan, and match the commitment already shown by private enterprise, with equivalent support to drive a step change in clean, sustainable energy supply derived from our oceans.

The Oster 800 wave power device in operation at EMEC - 2012

Thinking Big : Airbus – Lessons For The Ocean Energy Sector

On 25 July 1967, Britain France and Germany initiated the Airbus project. Their goal was to counter the global monopoly of the US Boeing company and secure expertise and jobs for Europe.

Airbus is a prime example of a successful venture that would not have taken off without transnational collaboration between industry and governments. Initial support provided core funding for research and development, followed by capital subsidies and soft loans to compete in the market.

Commercial scale achievement

Airbus is in tight competition with Boeing to this day. The competition stimulates research innovation and cost reduction. There are around 5,102 Airbus aircraft in service. In recent years Airbus has won over 50 per cent of global aircraft orders.

Innovative Financing and Return on Public Investment

The company financing agreement allows 33% of programme costs to be met from government loans to be repaid within 17 years with interest and royalties (at a minimum interest rate equal to the cost of government borrowing plus 0.25%).

Airbus now employs around 63,000 people at sixteen sites in four European Union countries. Final assembly production is based in France; Germany; Spain; and, since 2009, China. Airbus also has subsidiaries in the United States, Japan, China and India.

Airbus claims that since the signature of the EU-US agreement in 1992, it has repaid European governments more than U.S.D6.7 billion, and that this is 40% more than it has received. It is intended that the new A380 will be become cost competitive without the need for subsidies.

Conclusions for Future European support for Ocean Energy

With innovative support; ocean energy could complement the wind industry in energy contribution. Success in mastering the technology for Europe could realize significant job creation and first mover advantage. Similar to developing the European Aerospace industry, the European ocean energy industry requires:

- Very initial large capital investment, grant support and soft loans.
- Large R&D as well as engineering skill in manufacturing.
- Long investment cycle.

The Airbus success has shown that long term government support can establish a viable market sector which otherwise would struggle to deliver on its own.

Case study by Dr. Gordon Dalton Senior research fellow (Ocean energy economics engineer) HMRC, University College Cork.

The Strategic Initiative for Ocean Energy

At the European level, the Strategic Initiative for Ocean Energy (SI Ocean) has been conceived to strengthen Europe's wave and tidal energy networks. It will enhance collaboration across research and development and build on existing knowledge of technological, financial and policy barriers to identify solutions that will accelerate deployments of wave and tidal technologies.

The 2012-2014 project, funded by Intelligent Energy Europe, is being led by the European Ocean Energy Association and brings together a range of expertise from the European Commission's Joint Research Centre, the UK's Carbon trust, University of Edinburgh, Danish Hydrological Institute, Portugal's WavEC and RenewableUK.

The project focuses the 'Atlantic Arc' region, encompassing the territorial waters of Denmark, france, Ireland, Portugal, Spain and the UK.

Key SI Ocean deliverables are:

- Resource assessment encompassing both near and longer team projections for future energy generatin across the Atlantic Arc;
- Strategic Technology Agenda outlining actions for overcoming technological challenges and supporting comercialisation of wave and tidal devices;
- Market Deployment strategy which will integrate all resource, technology, policy and market information to deliver a strategy for uniting Europe's wave and tidal sectors behind a common agenda for commercialisation.

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