ORECCA European Offshore Renewable Energy Roadmap

September 2011

The ORECCA Project

The ORECCA (Offshore Renewable Energy Conversion Platform Coordination Action) Project is an EU FP7 funded collaborative project in the offshore renewable energy sector. The project's principal aim is to overcome the fragmentation of know how available in Europe and its transfer amongst research organisations, industry stakeholders and policy makers stimulating these communities to take the necessary steps to foster the development of the offshore renewable energy sector in an environmentally sustainable way. The project brings together a combination of world class experts from a wide variety of multinational companies, research institutions, consultancies, utilities and project developers. The project's focus is pan European and pan technology, with a specific focus on revealing the opportunities that exist across Europe when the three offshore renewable energy sectors within the project's scope are considered together. Within the ORECCA Project, the scope of the offshore renewable energy sector ("offshore renewables") was confined to:

- ***Offshore wind;***
- ***Wave energy; and***
- ***Tidal stream.***

These energy sectors have been identified as those that are currently expected to make significant contributions to the energy system in the medium to long term. As a result, other sectors, such as tidal barrage and ocean thermal energy conversion (OTEC) were not covered in the scope of the project.

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EXECUTIVE SUMMARY & RECOMMENDATIONS

This document represents for the first time a combined roadmap developed for the offshore wind, wave and tidal stream energy sectors, focussed on the synergies, opportunities and barriers to development that are revealed when the sectors are investigated together in pan-technology and pan-European context.

The principal target audiences of the recommendations set out are policy makers at the EU and Member State level. However, the recommendations and the way forwards set out are also of high importance for other stakeholders to the offshore renewable energy sector.

The roadmap's vision is to guide policy makers to support the accelerated development of the offshore renewable energy sector (offshore wind, wave and tidal energy) in Europe:

To identify synergies;

To overcome barriers to the development of the sector;

To realise the large opportunities presented by the sector;

To facilitate significant, cost effective commercial scale deployments by 2030;

To do all of this in an environmentally sustainable way.

The roadmap is structured around five key streams which are essential to the development of the offshore renewable energy sector. Each of these streams has a dedicated chapter in the main roadmap document:

- Resource;
- Finance;
- Technology;
- Infrastructure;
- Environment, Regulation & Legislation.

Europe has a large amount of natural resource across the three offshore renewable energy sectors. Technically offshore wind, wave and tidal together could supply 100% of Europe's future electricity demand. These resources present significant opportunities with respect to increased energy security, emissions reductions, and economic benefits including job creation.

Before looking forward to where the offshore renewable energy sectors are heading in the future, it is important to consider where the sectors are now. For the offshore wind sector, there is currently approximately 4GW installed capacity in Europe, and over 100GW in the planning pipeline for 2020. In comparison, for the ocean energy sector (wave and tidal stream), no commercial farm scale deployments currently exist, and the amount of capacity in the pipeline for Europe by 2020 is approximately 2GW. It is clear that the ocean energy sector is at an earlier stage of development than the offshore wind sector and a deployment timeline for the two sectors is shown in Figure A below.

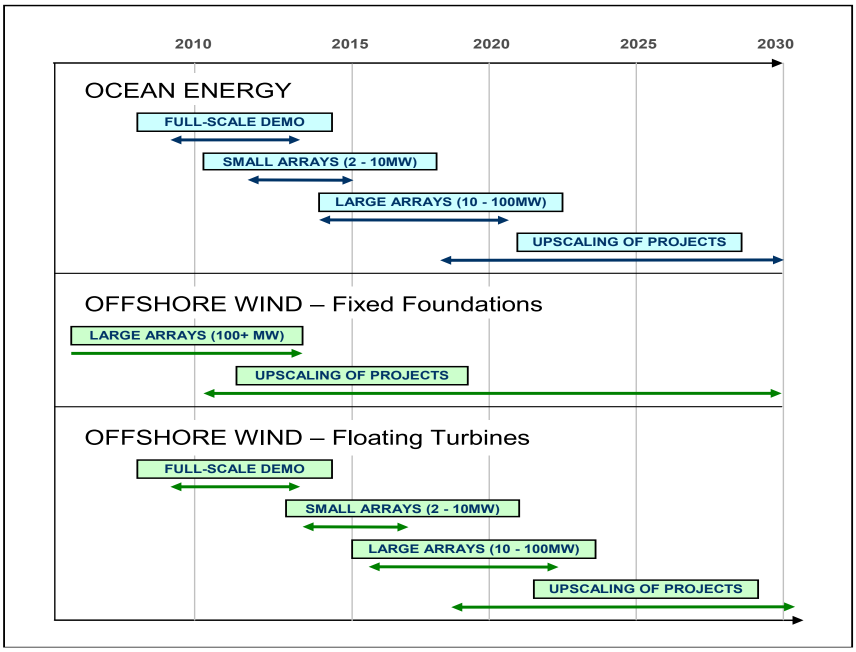


Figure A: Projected deployment timelines for the ocean energy (wave and tidal stream) and offshore wind sectors.
(Source: adapted from the DECC Marine Energy Action Plan 2010).

		2050 Target
Offshore wind	European target [1]	460 GW
	International target [2]	1150 GW
Ocean energy	European target [3]	188 GW
	International target [4]	748 GW

Figure B: Some deployment targets which have been set out in the offshore renewable energy sector. [[1]EWEA (European Wind Energy Association), [2]IEA (International Energy Agency), [3] EU-OEA (EU Ocean Energy Association), [4]Greenpeace Advanced Energy [R]evolution]

The ORECCA project does not set out deployment targets for the offshore renewable energy sectors, but aligns itself with existing targets and aims to facilitate their achievement by identifying synergies and addressing barriers to the development of the sectors. Both European and International targets exist for the sectors, as illustrated in Figure B. All of these targets present an opportunity for the realisation of large economic benefits in the European Union (EU). The EU OEA envisage that the realisation of the European target of 188GW installed capacity of ocean energy by 2050 alone could result in the creation of over 450,000 jobs.

The offshore wind targets are higher than the ocean energy targets at both the international and European level, due to the fact that the ocean energy sectors are currently at an earlier stage of development and it will take longer to achieve large scale commercial deployments. A large portion of the global targets will have to be met by deployments outside Europe. This represents an important market and opportunity for the sectors, which are currently heavily concentrated in Europe, to export technology and expertise worldwide.

Combined Platforms & Co-location

In the short term, due to the relative immaturity of offshore renewable energy technologies (particularly wave and tidal technologies), it is generally seen as too early to deploy combined platforms. However, co-location of devices can realise large benefits with respect to infrastructure and represents an important opportunity over the short term with benefits from joint utilisation of electrical infrastructure and potentially of O&M teams, vessels and infrastructure. In the longer term, combined platforms should not be ignored (they present a large opportunity for the sector once significant further research and modelling is completed*), but the immediate opportunities for the sector remain focussed on co-location.

*Projects such as the European Commission funded MARINA Platform Project are already working in this regard.

RESOURCE

The level of natural resource which exists in a particular country or region is of critical importance when considering the potential impact which a particular sector or technology can have.

- The roadmap reports where offshore wind, wave and tidal stream resources exist across Europe, but importantly, also reveals the potential for combined resources. To provide context, a high level breakdown of Europe's resource is shown in figure C below, before the combined resource 'hotspots' identified across Europe are illustrated in Figures D and E below.

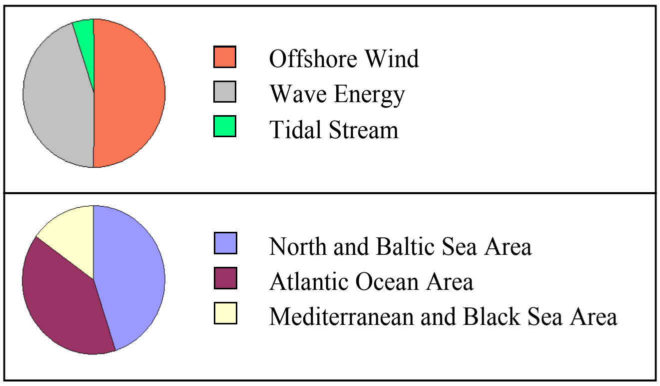


Figure C: Breakdown of Europe's offshore renewable energy resources across the three technologies and the three regions which the seas surrounding Europe were divided into.

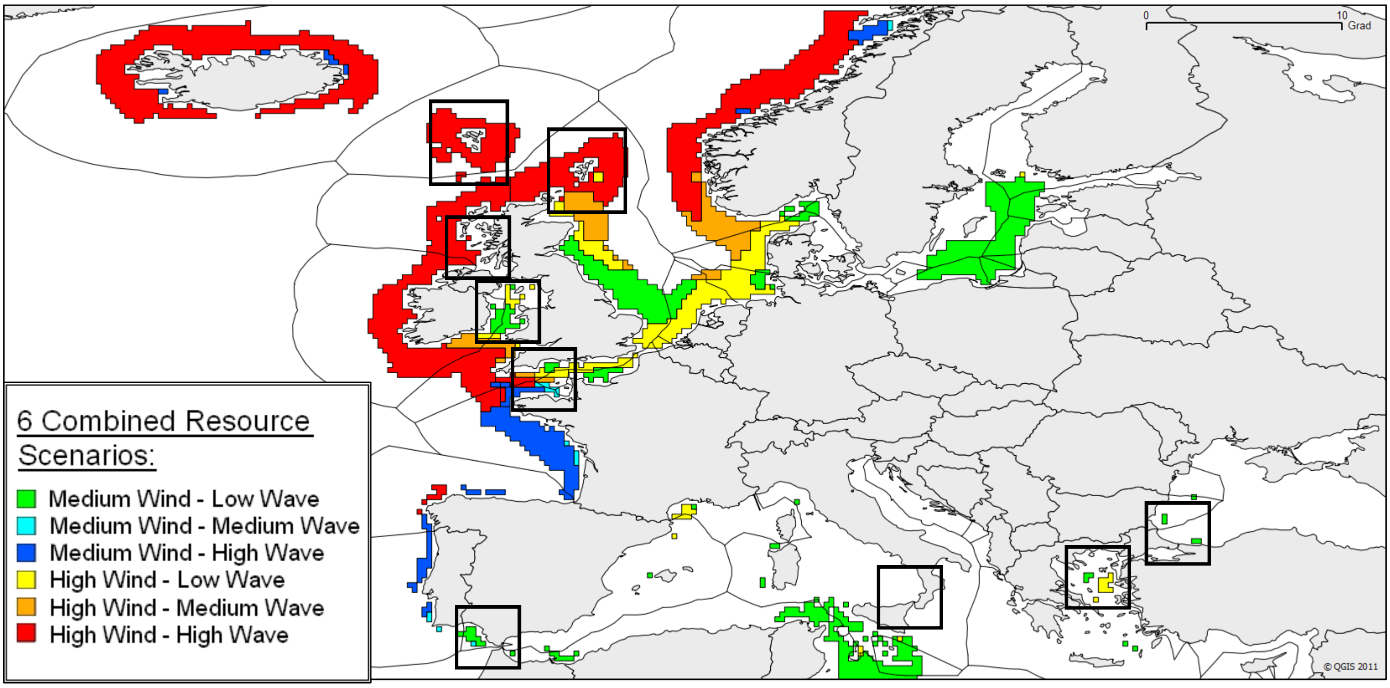
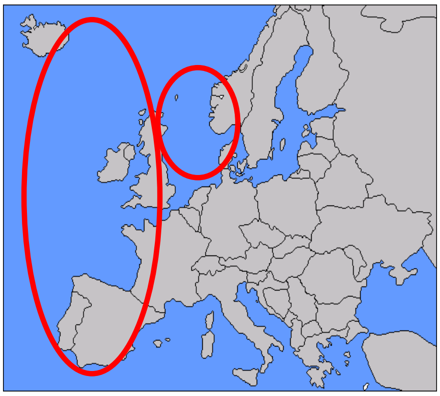


Figure D: Combined resource map showing the combined wind and wave resource across 6 scenarios with the tidal stream resources overlaid and highlighted with the black panes.



The roadmap identified two principal 'hotspots' where a large amount of high intensity combined resource (across offshore wind, wave and tidal energy) exists in Europe:

- The Western facing Atlantic coastline, off the coasts of Scotland, the UK, Ireland, Spain and Portugal.
- The Northern North Sea, off the coasts of Norway and the UK.

Figure E: Map of Europe showing the resource 'hotspots' identified.

In the short to medium term, all of the recommendations in the roadmap are focussed on these two principal 'hotspot' areas as they present the largest and most immediate opportunity. Whilst acknowledging that combined resource does exist in other areas, these areas are not an immediate priority. However, as the sectors develop, costs are reduced, and experiences gained, areas of less intense combined resource will form important secondary markets, and they should not be ignored over the longer term.

The areas where exploitable tidal resources exist are relatively limited in number but show high energy densities. Analysis revealed that tidal stream resources make the smallest contribution to the total offshore natural resource in Europe (as shown in figure 2 above).

Therefore, focussing on areas of wind and wave combined resource is the most important overlap between the three technologies in terms of exploiting combined resources. Exploiting combined wind and tidal resources is limited by the fact that 100% of the tidal sites identified are less than 20km from shore, a significant constraint for large wind turbines. However, this is not to say that there are not significant technology transfer and other synergies with the tidal stream sector. - It is also important to highlight that the data which underpins the tidal stream resource in the combined resource maps is different in nature to the data for the wind and wave resources. For the wind and wave resources, Europe wide grids of data are available. However, there is far less data available for tidal stream, and the data utilised is based upon measurements made at sites which have been identified as potential locations based on their geographic conditions.

Water depth and distance from shore

The water depth and distance from shore of the areas where resources exist are an important consideration. Analysis revealed the information in Figure F below.

	Distance from Shore	Water Depth
	% of combined resource further than 100km from shore	% of combined resource in water depths of greater than 60m
North and Baltic Sea Area	40 %	70 %
Atlantic Ocean Area	60 %	97 %
Mediterranean & Black Sea Area	30 %	94 %

Figure F: Breakdown of the resource in the three areas by distance from shore and water depth.
N.B. Current constraints for fixed foundation wind turbines are limited to 60m water depth.
It is envisaged that floating devices will be required to exploit resources in water depths of greater than 60m.

Across Europe approximately 80% of the combined resource is in water depths of greater than 60m and approximately 50% of the resource is further than 100km from shore. It is therefore clear that, to exploit a large proportion of the available natural resource in Europe, it will be necessary to develop technologies to facilitate deployments in deeper water and further offshore. This is particularly applicable to the Atlantic Ocean and Mediterranean and Black Sea areas, where only a very small proportion of the combined resource lies in water depths where current constraints for fixed foundation offshore wind turbines facilitate exploitation.

FINANCE

Without government support, the offshore renewable energy sectors are not currently cost competitive in terms of cost of energy alone. However, the sectors promise emissions reductions, increased energy security and economic benefits and there is therefore significant governmental interest in the sector and a large number of financial support mechanisms available across Europe.

Analysis revealed large variations in the financing landscape across Europe, with it being much more developed in some countries than in others. Figure G reveals gaps in terms of which countries have the funding and policies in place to make investment in the sector attractive.

Figure G: Photograph of Hywind floating wind turbine under testing (designed for use in water depths of 120–700m), an example of the type of innovative technology which will need to be developed to facilitate exploitation of the extensive combined resource in deep waters. (Photo: Trude Refsahl / Statoil)

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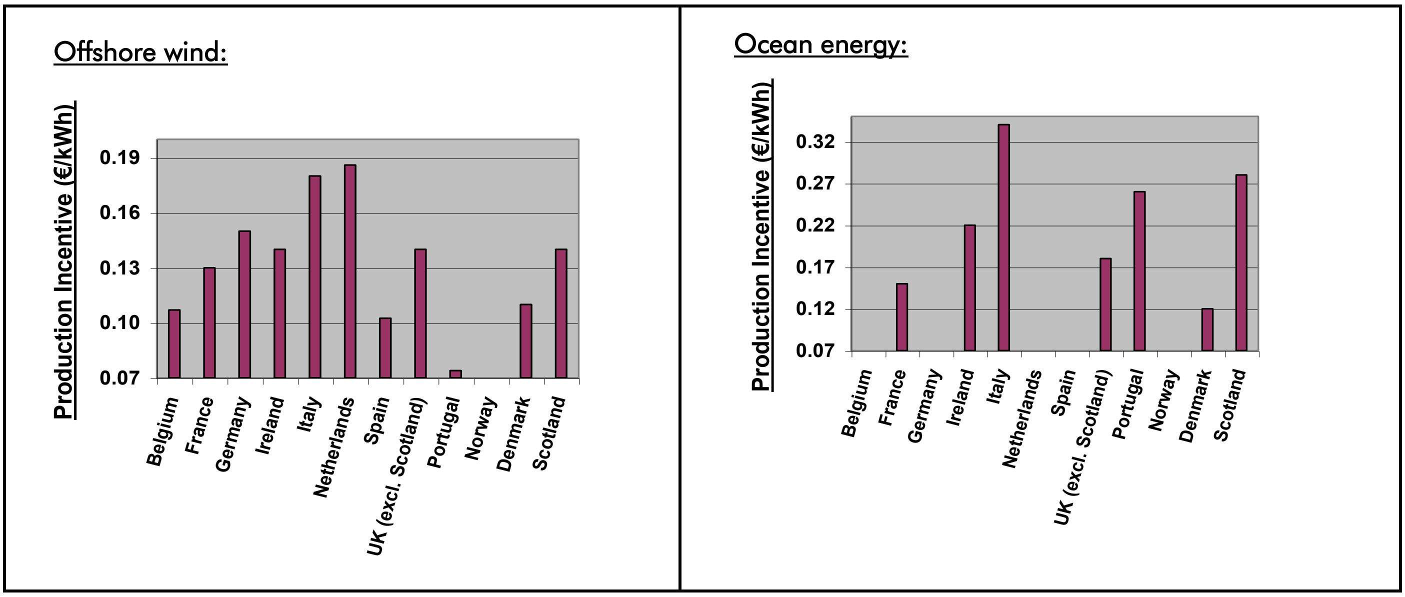


Figure H: Charts showing the Production Based Incentives (PBIs) in countries across Europe for both the offshore wind and ocean energy sectors respectively.

N.B. where appropriate, the data includes an assumed Europe wide wholesale electricity price of 0.07 €/kWh. Where there is no production incentive available above the wholesale price, the graphs report zero.

Offshore wind

The analysis revealed that all countries with the exception of Norway have a PBI in place for offshore wind. However, within this, there is large variation from 0.07 to 0.19 €/kWh. Spain, Portugal and Denmark all have attractive natural resources, but have lower PBIs than other countries with comparable resources. However, the largest discrepancy illustrated in the graph is in Norway which has an attractive resource but no PBI in place to support the sector. This large, currently unexploited resource in Norway represents a large opportunity if the necessary finance policies and technologies can be developed.

Ocean energy

Only 7 of the 12 countries analysed have a PBI in place for ocean energy. Of these seven, only four countries (Scotland, Italy, Portugal and Ireland) have a PBI in place which is significantly higher than the PBI for offshore wind in the same country, taking account of the high costs and emerging status of the ocean energy sector.
These four countries are setting a strong market signal for the sector which will help to attract investment and to accelerate development. The UK has one of the most attractive resources in Europe, but presently has only the 5th best PBI in place to support the sector, and Norway has no PBI for the ocean energy sector despite having a large ocean energy resource. The large amount of available resource across both the offshore wind and ocean energy sectors presents a major opportunity, particularly in the UK, Ireland, Norway, France, Portugal and Spain. However, the funding landscape will have to be advanced in all countries to increase the attractiveness of the sector as an investment target and to realize the opportunity presented.

Establishing the level the PBI should be set at in order to be effective is not something which can be done in this roadmap. The PBI needs to be high enough to give a positive return on investment for projects and to allow the correct technologies to be developed. Further research is required to determine the level of PBI required to be effective in each country, taking into account factors such as resource intensity, distance from shore and water depths.

Challenges to investment exist in the offshore renewable energy sector and a number of the finance recommendations are actions to address these. The most critical challenge to investment identified concerns difficulties associated with securing finance, especially to develop the first deployments of new technologies (when reliable data on investment returns and device performance is limited) and to complete the construction phases of projects (when investors are exposed to higher risks). Measures to mitigate this barrier are important and include soft loan programmes and government underwriting of project risk.

Figure I: Photograph of a tidal stream device currently being tested in Northern Ireland. (Source: Marine Current turbines)

Finance Recommendations

The ORECCA roadmap recommends that EU and member state administrations:

- **Maintain a careful balance between market-pull and technology push support measures for the sector** to ensure that both large scale deployments and research into technologies which could realise large cost reductions for the sector are supported.
- **Maintain technology-push capital support measures** to ensure step change cost reductions and performance improvements.
- **Ensure a long term market signal in relevant countries** to increase investor certainty.
- **Develop funding opportunities (particularly production incentives) in line with countries which are current leaders, in countries which have a less developed funding landscape, but where a large resource exists.**
- **Set up specific grant schemes for offshore renewable energy investments.**
- **Recognise within funding programmes the emerging stage of development that the wave and tidal stream energy sectors are at,** and provide targeted funding to accelerate their development.
- **Develop new risk sharing mechanisms to facilitate investment in the sector**, particularly in the construction phases, such as government underwritten guarantees and using public funds as a guarantee for private financial bodies.
- **Continue to encourage cross border collaboration on projects** in the sector to drive costs down and promote knowledge transfer.
- **Increase funding for demonstration projects** to accelerate the development of the sector by 'learning by experience'.
- **Provide targeted financing to support the development of the necessary technologies** (such as floating wind turbines and HVDC transmission) **to facilitate deployments in deeper waters and further from shore.**

Figure J: Photograph of Pelamis Wave Power device (Source: Pelamis Wave Power)

TECHNOLOGY

Technology poses a number of challenges and opportunities for the offshore renewable energy sectors. Many factors such as the affordability and reliability of the technologies and devices will have a critical impact on its development.
The emerging status of offshore wind and ocean energy technologies creates considerable challenges for their development. There is a need to strike a balance between trials and deployments of advanced full scale devices whilst also developing emerging designs and sub components to ensure efficient and effective long term cost reduction as well as achieving high levels of reliability and survivability. This is true across offshore wind wave, wave and tidal technologies and across European member state countries.

Summary of the technology challenges

- At present, offshore renewable energy development activity is spread over a wide variety of platform and foundation concepts and components, and at the highest level, offshore wind, wave and tidal current have distinctive development needs. Across the three sectors, there is a need to strike a balance between design variety and consensus, and the development of supply chain commonality.
- A number of generic technology areas and components – such as foundations, moorings, power take off (PTO), marine operations and resource assessment – offer important opportunities for collaborative development, although the transfer of generic knowledge and components within the developer community may be limited by commercial competition.
- There is a need for more performance data and operating experience to feed into the overall development cycle, particularly for the wave and tidal stream sectors which have relatively limited full scale experience in open sea operating conditions.
- There are significant opportunities for knowledge transfer from other sectors, such as offshore engineering. Enabling this transfer will involve a better understanding of the 'adaptation costs' of transferring components and methods to the marine environment, and identifying opportunities for collaboration with other industries and supply chain partners to ensure the availability of cost effective solutions.

At the highest level, offshore renewable energy technology development and deployment will require measures to address the underpinning generic technical challenges of predictability, manufacturability, install-ability, operability, survivability, reliability, and affordability.

Figure K: Photograph of the Oyster 1 wave energy device under testing at EMEC
(Source: Aquamarine Power)

Figure L: Artist's impression of an array of Hammerfest Strom tidal stream devices. (Source: Hammerfest Strom)

Highest priority technology development activities:

The technology challenges and associated technology development activities within the offshore wind and ocean energy sectors were prioritised according to the assessed level of industry need. Nine technology development activities within the offshore wind sector and sixteen within the ocean energy sector were identified as the highest priority for the sectors, and these are outlined in Figure M below.

Figure M: Table outlining the technology development activities for the offshore wind and ocean energy sectors respectively that have been prioritised as the highest priority for the sectors.

OFFSHORE WIND SECTOR:	OCEAN ENERGY SECTOR:
• Offshore dedicated turbine system demonstration; • Ultra reliable turbine demonstration; • Large blade rotors (>150m); • Deep water jacket foundations; • Deep water gravity foundations; • Design standards (structural, mechanical, electrical, control etc); • Testing and installation standards; • Health and safety standards; and • Advanced drive train research for lighter designs.	• 1st generation device and array trials; • Performance data collection; • Installation methods; • Recovery methods; • Cost effective O&M techniques; • 2nd generation device development; • Control systems; • Energy conversion systems (PTO); • Foundations and mooring systems; • Wet HV connectors; • Performance guidelines/specifications; • Design of installation tools; • Device modelling tools; • Array design and modelling tools; • Resource analysis tools; and • Reliability modelling tools.

Offshore wind

These activities will ensure the development of highly reliable, large rotor, specifically dedicated offshore turbines with cost effective foundations suitable for deeper waters and are extremely important to facilitating large deployments in the coming years. The three sets of standards set out in Figure L (design, testing, health and safety) are important to build upon the existing IEC TC88 standards and will help to ensure that international best practice prevails. The advanced drive train research activity is also important and will facilitate step change improvements in turbine design and structure.

Ocean energy

The first ten of the technology development activities identified in Figure L above reiterate the importance of testing devices, developing efficient and low cost installation, O&M and recovery techniques, and developing sub-components critical to these devices

The high priority of these activities is necessary due to the fact that no significant deployments beyond full scale prototype testing currently exist, and there is relatively little design consensus around the leading technologies to move the sector forwards. The development of performance specifications will allow international best practice to be established in terms of device performance in the sector. Designing tools to make installation of devices more efficient has the potential to have a large impact on installation and O&M costs. A number of the activities relate to developing tools for modelling devices, arrays, resource and reliability. Modelling these four aspects will be crucial to further increase the understanding of the complex interactions involved and then incorporate this knowledge into future device and system designs.

Synergies and Commonalities

Five principal areas have been identified where immediate technical synergy opportunities exist between the offshore wind, wave and tidal energy sectors:

- **Foundations:** common foundation types to be used.
- **Array layout:** sharing of lessons learnt for effective array design.
- **Mooring/fixed connection points:** common mooring/fixed connection points to be used.
- **Grid connection and integration.**
- **Power take off:** common power take off technologies to be used.
- **O&M:** sharing of lessons learnt for effective design and technology development to reduce the need (and associated cost) for O&M (remote monitoring is a good example of this).

Technology Recommendations

The ORECCA roadmap recommends that EU and member state administrations:

- **Create policies to develop design consensus within the ocean energy sector.**
- **Design policies which ensure that all possible subcomponent development activities are developed in a way so as to provide common solutions across the three offshore renewable energy sectors.**
- **Ensure that policies are in place to provide guidelines for funding bodies** to ensure that allocation of development funding is in line with the technical timelines and priorities set out in this roadmap.
- **Ensure that, for the offshore wind sector, policies and support are put in place to concentrate technology development activities on the nine high priority areas** in table 3 above.
- **Ensure that, for the ocean energy sector, policies and support are put in place to concentrate technology development activities on the sixteen high priority areas** in table 3 above.
- **Ensure that a mature, coherent and adaptive approach to policy is taken with regard to technology** developments internationally, to provide an appropriate combination of support mechanisms, and ensure effective distribution of investments as the sector matures.

INFRASTRUCTURE

For the full commercialisation of the offshore renewable energy sector, a wide range of facilitating infrastructure is necessary.

This roadmap focuses on:

1. **Ports & Offshore Supply Chain** infrastructure;
2. **Vessels** infrastructure; and
3. **Grid** infrastructure.

There is an opportunity for infrastructure developments to be clustered in the 'hotspot' regions identified in the resource section where a large amount of high intensity combined resource exists. - Mobilising the necessary facilitating infrastructure surrounding these areas of intense resource presents an immediate opportunity for combined wind wave and tidal infrastructure development and this should be acted on accordingly.

Figure N: Picture of an offshore wind construction port at Belfast, Harland and Wolff.
(Source: UK Offshore Wind Ports Prospectus).

Ports

A number of ports, primarily in the Southern North Sea and the Irish Sea, have already been used for offshore wind and ocean energy. The port requirements (in terms of draft, length of quayside, gantry cranes, overhead clearance etc.) are highly dependent on factors such as the size and weight of the devices, and the type of foundations used. Despite the fact that it is too early to define some of the detailed port requirements (especially for the wave and tidal sectors where design consensus has not been fully achieved), the development of ports represents an immediate opportunity. These developments require further research to consider where ports need to be developed to support the exploitation of the 'hotspot' areas in the most efficient possible way. For example, the most cost effective development path for the Northern North Sea resource 'hotspot' is likely to be to further develop existing manufacturing facilities in the Southern North Sea, and to develop clusters of assembly and O&M port facilities around the Northern part of the North Sea, closer to the 'hotspot' natural resource.

Irrespective of whether combined platforms or co-location of devices, combined infrastructure represents an immediate opportunity. - This approach to thinking about port infrastructure in a coordinated way, aiming to develop clusters of port infrastructure to facilitate the exploitation of 'hotspots' of resource identified, is new. This is an important approach to ensure that the necessary infrastructure is developed in the most cost effective and efficient way possible.

The concept of offshore service hubs represents a significant opportunity as a large proportion of Europe's offshore renewable resource exists far from shore (50% > 100km from shore). To exploit this resource, cost reductions could be achieved if different functions such as O&M accommodation, housing of equipment and spare components, and even some elements of construction could be housed as part of an offshore service hub.

Vessels

Important synergies between the offshore wind, wave and tidal sectors exist in the area of cable installation vessels, foundation installation vessels, and O&M vessels. Cable installation vessels represent an immediately exploitable synergy and similarly, synergies exist where similar foundation types are used across the three sectors (these synergies will increase as the sectors progress into deeper water and the mooring technologies become increasingly common).
Depending on design, O&M vessels (typically very versatile and able to adapt to roles across a number of sectors) will also have significant synergies across the sectors.

A further synergy exists with regard to device transport and installation vessels. Multipurpose vessels continue to lead the market. Vessels such as jack up barges and heavy lift vessels are flexible and can be used by a number of sectors as well as having geographic flexibility to travel. Installation vessel synergies are specific to two distinct categories:

1. Shallow water installation vessels.
   Fixed structure offshore wind turbines, tidal devices, and shallow water wave deployments all have similar requirements, and can therefore utilise common installation vessels.

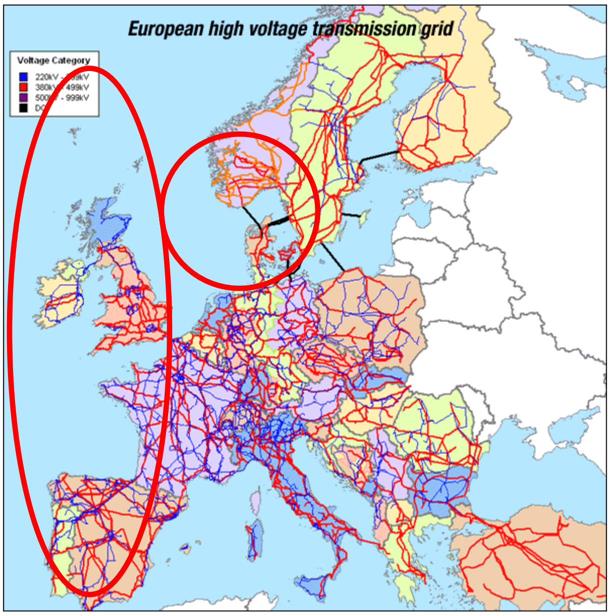
2. Deep water installation vessels. Floating offshore wind, deep water wave and floating tidal devices will have similar installation vessel requirements (dealing with anchors and mooring deployments etc.) and therefore can utilise common installation vessels.

It is important to highlight that, in contrast to the installation vessel synergies identified above, for a range of offshore wind and ocean energy technologies, specialised installation techniques and vessels are under development. Such solutions are very efficient for the designated purpose but cannot be used to install other technologies and consequently, there is a higher commercial and technological risk involved in using such specialised equipment.

Whilst the vessel synergies identified above mean that vessels can be shared across sectors and across countries, they also mean that there will be competition. It is important to ensure that useful synergies do not manifest themselves as detrimental competition. For example, the sectors will have to compete with the offshore oil and gas industry, not only for vessels, but also for the expert crew required to operate these vessels. This may have time and cost implications, and it requires careful consideration to ensure that it does not present a significant barrier to development. Factoring installation requirements into device designs is an important way to reduce the need for large installation vessels and therefore manage the competition (and associated cost implications).

Figure O: Photograph of a heavy lift barge installing an offshore wind turbine.
(Source: Saldis Salvage and Marine Contractors)

Grid



Grid developments to facilitate the exploitation of the 'hotspot' areas where large amounts of resource have been identified are twofold:

1. **European level grid developments**, to develop a more advanced and interconnected grid between countries and European level planning to ensure that offshore grid developments are optimised to support the sector, particularly in areas such as the North Sea which is bordered by a large number of countries.

2. **Nation state level grid developments**, to increase the grid capacity in regions where 'hotspots' of resource have been identified, but the current grid infrastructure is inadequate. The four priority areas in this regard are located in **Ireland, Scotland, the UK, and Norway.**

Figure P: Map of Europe showing the high voltage transmission grid across Europe, with the Resource 'hotspots' highlighted.

Infrastructure Recommendations

The ORECCA roadmap recommends that EU and member state administrations

1. **Develop clustered** port and offshore supply chain infrastructure to facilitate the exploitation of the two key resource 'hotspots' identified.
2. **Prioritise further detailed studies to plan the finer details of how the clustering of ports and offshore supply chain infrastructure should be optimised**.
3. **Prioritise important National level grid reinforcements** (particularly in Norway, Ireland, Scotland and the UK) **to facilitate large scale deployments of offshore renewable energy in the 'hotspot' regions identified**.
4. **Prioritise important European level grid developments** to optimise the exploitation of the resource 'hotspots' identified. European level planning is required to ensure that offshore grid developments are optimised to support the sector.
5. **Take a coordinated approach, at the European level, when considering the development of grid, ports and offshore supply chain infrastructure.**
6. **Provide the necessary infrastructure to facilitate the progression to deployments further from centres of population, further offshore, and in deeper waters.** - This is vital to ensuring that a large portion of Europe's resource is potentially exploitable.
7. **Focus on co-location of technologies to exploit areas of combined resource in the most efficient way** (joint utilisation of grid and O&M infrastructure).
8. **Encourage the development of 'offshore service hubs'** to realise synergies from co-location and reduce the costs associated with deployments far from shore.
9. **Focus on** developing important infrastructure subcomponents common to all three offshore renewable energy sectors (such as offshore substations, submarine cables, technologies for electrical connections to floating platforms and HVDC systems).

ENVIRONMENT, REGULATION & LEGISLATION

Legal and regulatory issues surrounding environmental protection will have a large impact on the rate of development and sustainability of offshore renewable energy.

Each Member State is responsible for transposing EU level legislation into their respective legal system, as well as implementing their own licensing processes for the consenting of projects. Therefore, the regulatory and legislative landscape varies largely across countries. The National legislative frameworks reflect the EU Directives which apply to offshore wind, wave and tidal energy, but often there is variation between how countries administer such legislative requirements and many associated policies are at different stages of development in different countries.

Three principal factors are identified in Figure Q next page which are illustrative of how developed the regulatory/legislative frameworks are in each country:

1. **Is a Strategic Environmental Assessment (SEA) in place (for wind, wave and tidal)?**
2. **Is a Maritime Spatial Plan (MSP) in place?**
3. **Does the country have a streamlined or one-stop-shop system for marine consenting?**

Some countries (such as Scotland and Ireland) are at further stages of putting an MSP in place, implementing a 'one stop shop' for marine consenting, and putting SEAs in place for each of the offshore wind, wave and tidal sectors. These are important factors for facilitating the development of the offshore renewable energy sector, and other countries, especially the UK, France, Norway, Portugal and Spain (which have been identified in the Resource chapter as having a large amount of combined resource) need to continue to progress in this regard to realise the large opportunities presented by the sector.

Figure Q: National policy landscape across Europe: matrix showing three important factors for supporting the development of the offshore renewable energy sector analysed across Europe.

Country	Is there an SEA in place:			Is there an MSP in place?	Is there a 'one stop shop' marine consenting process?
	For offshore wind?	For wave?	For tidal?		
Belgium	Yes	No	No	Yes	No
France	Yes	No	No	Partially	No
Germany	Yes	Partially	Partially	Yes	Yes
Ireland	Yes (provisionally)	Yes (provisionally)	Yes (provisionally)	Preparatory steps	Pending
Italy	No	No	No	No	No
Netherlands	Yes	No	No	Yes	No
Spain	Yes	No	No	Preparatory steps	No
UK	Partially, Pending	Pending	Pending	Partially and pending	Partially
Portugal	Under Development	Partial	No	Under Development	No
Norway	Yes	No	No	Partially	No
Denmark	Yes	No	No	Partially	Yes
Scotland	Yes	Yes	Yes	Partially	Yes

[Green: Yes. Orange: Partially/pending. Red: No].

Differences across countries and across offshore wind, wave and tidal

Some issues are entirely transferable across countries and across the three sectors, whilst others, such as public perception are very different across countries and sectors and experiences cannot be easily transferred. Some important differences between offshore wind, wave and tidal stream devices (which mean that many issues are not transferable between the sectors) are displayed in Figure R below:

	Offshore Wind	Wave	Tidal stream
Rotating parts subsurface:	✗	✗	✓
Moving parts above surface:	✓	✗	✗
Remove hydrokinetic energy from the oceans:	✗	✓	✓
Remove kinetic energy from the atmosphere:	✓	✗	✗

Figure R: Differences between the offshore wind, wave and tidal stream sectors which have a significant impact on their environmental impacts and the applicable legislation and regulation.

There is nevertheless transferable knowledge on environmental impacts. While species, devices and sites vary, it has been identified that issues surrounding piling, EMF effects of cables, the effects of flow alteration, and the way in which large organisms behave near devices, as well as surveying and monitoring techniques will be highly transferable across technologies and countries. Co-location of devices could also allow cost reductions, reducing the need for completing multiple EIAs for separate sites.

Time Evolution of Priorities

It is important to prioritise issues according to how critical they are to the development of the industry. These issues will change as the industry develops, and are different across the offshore wind and the ocean energy sectors, largely due their different stages of development. The wave and tidal energy sectors are currently in the relatively early stages of development where the only deployments are prototypes undergoing testing, whereas the offshore wind sector is at a later stage of development, with some very large (> 100 MW) wind farms already in existence. As the sectors develop, changing technologies and methods, the move to new development sites (such as deeper waters and sites further from shore), and the increasing importance of cumulative effects will govern how the priority of environmental issues will evolve. In the initial stages of development, the environmental effects will be principally related to individual devices. However as the sectors reach the later stages of development (and the energy extracted becomes a significant fraction of the energy in the winds and the oceans), cumulative impacts will become progressively more significant, particularly for the wave and tidal stream sectors which will have significant cumulative impacts in terms of flow alteration, sedimentation etc.

Environment, Regulation & Legislation Recommendations

<u>The ORECCA roadmap recommends that EU and member state administrations</u>

1. **Harmonise legislation and regulation across Europe, as far as practical.**
2. **Focus research into the environmental impacts of offshore renewable energy devices into seven priority areas** set out in this roadmap, including cumulative effects, EMF effects of sub-sea cables, flow alteration, sedimentation and habitat change near devices and mitigating actions for the effects of piling.
3. **Implement streamlined one-stop-shop marine consenting systems for countries which haven't already implemented these.**
4. **Develop Maritime spatial plans in countries where these are not already in place.**
5. **Conduct an SEA in each country, for each of the three technologies**, preceding commercial-scale development.
4. **Ensure that appropriate national authorities issue guidance necessary to ensure compliance with current legislation and regulation.** This includes ensuring that EIA requirements are clearly defined and communicated to developers.
7. **Encourage and facilitate developers and authorities to share experiences on EIAs** and develop mechanisms to avoid commercial issues over information sharing.
8. **Promote and encourage an "adaptive management" or "deploy and monitor" approach** and ensure that this is facilitated within legislation and regulation. This approach allows valuable learning by implementing.
9. **Ensure that legislation and regulation evolve and anticipate the growth and trends of the industry, such that the industry has foreknowledge of the requirements facing them.** This includes ensuring that there is recognition that scientific understanding is incomplete and therefore protocols may require alteration as understanding improves.
8. **Consider competing pressures** (such as climate change, fishing and marine transport) **when assessing environmental impacts of developments.** There should be recognition that the positive impacts of developments might outweigh some localised environmental impacts.
11. **Encourage the use of test sites for demonstration and development as an important opportunity to investigate potential environmental impacts** and further increase understanding of environmental issues. Test centres should have a comprehensive environmental baseline and EIA in place to allow them to become not only R&D centres for devices, but also for environmental effects.

Figure T: Picture of the 60 turbine Robin Rigg offshore wind farm in the UK. (Source: e.on UK)

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