FAME

Future of the Atlantic Marine Environment

Guidelines for a sustainable exploitation of offshore renewable energy

Account on seabird species

Lisbon, December, 2012

WavEC Offshore Renewables

ATLANTIC AREA Transnational Programme

INVESTING IN OUR COMMON FUTURE

European Union
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The FAME project is a partnership involving 5 countries and 7 partners: *Royal Society for the Protection of Birds* (RSPB), *BirdWatch Ireland* (BWI), Ligue pour la Protection des Oiseaux (LPO), Sociedade Portuguesa para o Estudo das Aves (SPEA), Sociedad Española de Ornitologia (SEO/BirdLife), Universidade do Minho (UMinho) and Wave Energy Centre (WavEC). There are also 3 associate partners: Sociedade Portuguesa de Vida Selvagem (SPVS), Agence des aires marines protégées and Martifer. The Project is co-funded by Atlantic Area Program.

LEAD PARTNER

ASSOCIATED PARTNERS

WavEC- Offshore Renewables

The WavEC, Offshore renewables is a private non-profit association created in 2003, and devoted to the development and promotion of offshore energy utilization thorough technical and strategic support to companies and public bodies. WavEC are currently part of a partnership with 13 associated industrial and public bodies, both from Portugal and elsewhere, all willing to develop wave energy and recognizing the need for more cooperation both on National and International level. WavEC was created to help overcome the lack of clear structures with respect to offshore energy implementation on a large scale, as well as insufficient information for decision-makers and the general public with respect to the potential and actual status of offshore energy.

www.wavec.org

www.fameproject.eu/pt

http://www.facebook.com/Wave.Energy.Centre

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Project Coordination: Royal Society for the Protection of Birds (RSPB)

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EXECUTIVE SUMMARY

The purpose of this report is to make recommendations on how offshore renewable energy projects can be best managed to reduce the potential negative impacts on marine fauna especially on seabirds. The guide is structured into four main sections.

Chapter 2 summarizes regulatory frameworks about birds' conservation. The protection of biodiversity is included in several Conventions and European Directives. Under this regulatory framework protected areas have been established for threatened species conservation. These must be taken into account in the implementation of offshore renewable energy devices (ORED).

Chapter 3 focuses on installations of ORED (Offshore Renewable Energy Devices): resource availability and diversity of technology types that can be installed. The process of Environmental Impact Assessment is also summarised under this chapter as a legal tool needed to ensure that environmental issues are taken into account during all phases of project development.

In Chapter 4 potential impacts of OREDs on birds are reviewed. The major impacts reported are collision risk, habitat modification/loss, entrapment and artificial reef effect. These are dependent of the species and on the technology type.

Chapter 5 presents recommendations for a sustainable exploitation of offshore renewable energy and different methodologies that can be used to quantify or asses the impacts of OREDs on seabirds. Guidelines for stakeholder involvement and public awareness are also discussed within this chapter.

At the end of the guide a chapter of conclusions is presented.

1 INTRODUCTION

Seabirds are a crucial element of terrestrial and marine ecosystems. As a conspicuous mobile marine species there is opportunity to study their behaviour and ecology. Such information can also offer insights into the condition of the wider marine environment. In this context, some top predator species have been proposed to serve as ecological indicators (Furness and Camphuysen, 1997; Boyd *et al*. 2006, Piatt *et al*. 2007, Gregory *et al,* 2008; Grémillet and Charmantier, 2010) and valuable information on the health of particular fish stocks, on the health of the ecosystem, and on environmental changes could be obtain when birds are included in monitoring programs (Einoder, 2009).

Seabirds are sensitive to anthropogenic changes and they have a resonance and connection with people and their lives (Gregory and Strien, 2010). Natural ecosystems have been critically altered by humans and a lot of attention has been paid to the progress of sustainable growth and development. Innovative technologies for harnessing renewable energy in the marine environment have been promoted by governments in an effort to contribute towards a reduction in greenhouse gas emissions. However, and as many other human activities, offshore renewable energy projects may also have direct and, potentially, indirect consequences on coastal ecology (Gill, 2005). Offshore renewable energy devices (ORED) encompass wind, wave, tidal and current power, and impacts of offshore wind power are considered the most studied.

The main objective of this guidance is to provide information and recommendations to stakeholders on the environmental management best practices of offshore renewable projects for the benefit of seabird species.

2 MARINE AREAS FOR BIRD CONSERVATION IN THE ATLANTIC AREA

The regulatory framework for habitats and bird conservation includes European legislation (Habitats Directive – 92/43/EEC and Birds Directive – 2009/147/EC), international conventions (e.g. Ramsar Convention, Bern Convention) and specific national environmental legislation (e.g. Habitats Regulations Appraisal in Scotland).

The Habitats Directive, together with the Birds Directive, forms the cornerstone of Europe's nature conservation policy.

2.1 Habitats Directive

The Habitats Directive was adopted by the European Union in 1992 to meet its obligations under the Bern's Convention (see "International Conventions" section). This Directive aims to ensure biodiversity protection through the conservation of natural habitats and wild flora and fauna in the European Union territory where the Treaty applies. Under this Directive, Member States were required to determine Special Areas of Conservation (SACs) in order to contribute to the maintenance or restoration of favourable conservation status of habitats or species listed in Annexes I and II of the Directive[1]. In addition to SACs, the Habitats Directive, also identify wild species that require a rigorous protection even if they are not included in SACs or Special Protection Areas (SPAs).

2.2 Birds Directive

The Birds Directive was adopted unanimously by the EU Members States in 1979 as a response of an increasing concern about the declines of wild bird populations in Europe resulting from pollution, loss of habitats and unsustainable use. It was also recognised that wild birds, many of which are migratory, were a shared heritage of Member States and that their effective conservation required international cooperation. It was also recognised that habitat loss and degradation were the most serious threats to the conservation of wild birds[2].

Under the Birds Directive Member States are required to determine Special Protection Areas (SPAs) and to implement special measures for the habitats conservation of certain rare or vulnerable species and for regularly occurring migratory species of birds. SPAs are considered important areas for rare and vulnerable birds because they are used by them for breeding, feeding, wintering or migrating to/from.

2.3 Natura 2000 sites

The Natura 2000 Network is an European Ecological Network which aims to preserve biodiversity by conserving natural habitats, wild flora and fauna in the European Union territory. It is the result of the establishment of SACs and SPAs under the Habitats and Birds Directives. In Natura 2000 sites, human activities must be compatible with the preservation of those natural values.

The Natura 2000 network is not a system of strict nature reserves where all human activities are excluded. The management of such areas must be ecologically, economically and socially sustainable. Whereas the network includes nature reserves most of the land is likely to continue to be privately owned and the emphasis is put on ensuring that future management is sustainable, both ecologically and economically. The establishment of this network of protected areas also fulfils an EU obligation under the Convention on Biological Diversity (see "International Conventions" section). The Natura 2000 network also applies in the marine environment. However, its

[1] The Habitats Directive can be found at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1992L0043:20070101:EN:PDF

[2] The Birds Directive can be found at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:020:0007:0025:en:PDF

implementation is difficult due to the lack of scientific knowledge on the distribution/abundance of species and habitat types.

As for the terrestrial environment, the marine network aims to protect European sites of conservation importance for (i) natural habitat types listed in Annex I and (ii) habitats for species listed in Annex II of the Habitats Directive. The marine component of the Natura 2000 network will also need to include a coherent network of Special Protection Areas (SPAs) classified pursuant to the Birds Directive. If a project is likely to have a significant impact on a Natura 2000 site, an Appropriate Assessment is required (see section 3.4).

2.4 International conventions

2.4.1 Convention on Biological Biodiversity[3]

Convention on Biological Diversity

The growing concern on biodiversity degradation promoted the need to create legal tools to regulate this situation. All countries recognized that the benefits from the utilization of genetic resources should be fair and equitable. The Convention on Biological Diversity (CBD) entered into force on 29th December, 1993 and has 3 main objectives:

- The conservation of biological diversity;
- The sustainable use of the components of biological diversity and
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

This is the first treaty that encompasses all aspects from biological diversity: genome, genes, species and communities, habitats and ecosystems. This Convention has been ratified by 168 countries.

2.4.2 Bern Convention

CONVENTION DE BERNE
BERN CONVENTION

The Bern Convention is a binding international legal instrument in the field of nature conservation, which covers most of the natural heritage of the European continent and extends to some States of Africa. This entered into force in 1982 and has been ratified by 50 countries. It aims on conserving wild flora and fauna and their natural habitats and to promote European cooperation in that field.

The Convention places a particular importance on the need to protect endangered natural habitats and endangered vulnerable species, including migratory species.

All countries that have signed the Bern Convention must take action:

- To promote national policies for the conservation of wild flora and fauna, and their natural habitats;
- To have regard to the conservation of wild flora and fauna in their planning and development policies, and in their measures against pollution;
- To promote education and disseminate general information on the need to conserve species of wild flora and fauna and their habitats;
- To encourage and coordinate research related to the purposes of this Convention;
- And also cooperate to enhance the effectiveness of these measures through:
  - The coordination of efforts to protect migratory species; and
  - The exchange of information and the sharing of experience and expertise.

The Birds and Habitats Directives provide the framework within which the provisions of the Bern Convention are applied. Under this Convention was created the Emerald Network to supplement Natura 2000 network. As the European Union is a Contracting Party to the Bern Convention, Natura 2000 is considered to be the EU contribution to the Emerald Network.

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[3] Please find detailed information on website's Convention: http://www.cbd.int/

2.4.3 Ramsar Convention - The Convention on Wetlands

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It came into force in 1975.

Sites are selected by the Contracting Parties, or member states, for designation under the Convention by reference to the "Criteria for Identifying Wetlands of International Importance"[4]. Among others, these take into account specific criteria based on birds such as:

"Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbirds."

Note that the referred criteria are out of their explanatory settings. For detail information about Ramsar sites it is recommended to review the Strategic Framework and guidelines for the future development of the List of Wetlands of International Importance of the Convention on Wetlands (Ramsar, Iran, 1971) available at www.ramsar.org.

2.4.4 Bonn Convention - Convention on Migratory Species[5]

The Convention on the Conservation of Migratory Species of Wild Animals (also known as CMS or Bonn Convention) aims the conservation of terrestrial, aquatic and avian migratory species throughout their distribution range. This Convention entered into force in 1983 and currently includes 117 parties from Africa, Central and South America, Asia, Europe and Oceania.

Migratory species threatened with extinction are listed on Appendix I of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States of many of these species.

Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional Agreements.

CMS acts as a framework Convention. The Agreements may range from legally binding treaties (called Agreements) to less formal instruments, such as Memoranda of Understanding, and can be adapted to the requirements of particular regions.

Agreements are the primary tools for the implementation of the main goal of the Bonn Convention. For the conservation of African-Eurasian Migratory Waterbirds, Albatrosses and Petrels, several agreements have been concluded under auspices of CMS.

2.4.4.1 African-Eurasian waterbird agreement

Waterbirds face a wide range of threats and cross several international borders during their migration. Without international cooperation, conservation efforts of one country can be nullified if the species is not protected in another country along the flyway. The threats that waterbirds face, such for example habitat destruction and lack of food, can be eliminated or mitigated through international cooperation across the flyway.

[4] http://www.ramsar.org/cda/en/ramsar-about-faqs-what-are-criteria/main/ramsar/1-36-37%5E7726_4000_0__

[5] To a detail information please consult the website http://www.cms.int/

This agreement, which entered in force in 1999 and includes, focuses on 255 waterbird species ecologically dependent on wetlands for at least part of their annual cycle including many species of pelicans, storks, flamingos, ducks, waders, terns, gulls and geese.

Of the 119 Range States 68 countries and the European Union (EU) are currently Contracting Parties of the AEWA.

More information on this agreement can be found at http://www.unep-aewa.org/about/introduction.htm.

2.4.4.2 Agreement on the Conservation of Albatrosses and Petrels (ACAP)

ACAP is a multilateral agreement which seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to their populations. ACAP came into force in February 2004 and currently has 13 member countries (include United Kingdom, Spain, France and Norway) and covers 30 species of albatrosses, petrels and shearwaters.

Albatrosses and petrels, throughout all stages of their life history, are subject to an array of human-caused threats that have the potential to reduce their reproductive success and/or survival. In combination, these factors are placing the long-term viability of many species at risk. The incidental catch of seabirds during longline and trawl-fishing operations is considered the most significant threat to albatrosses. The smaller petrels are also threatened by introduced predators at many breeding localities. Other threats include human disturbance at the nest, chemical contamination, marine pollution and over-exploitation of food resources.

International cooperation on albatross and petrel conservation enhances the prospects for successful conservation measures across their migratory ranges. As a CMS Agreement, ACAP focuses on any species, subspecies or population of the albatrosses and petrels listed in Annex I of this Agreement. It currently covers 19 species of albatrosses and seven species of petrels of the avian order Procellariiformes. More information on this agreement can be found at http://www.acap.aq/.

2.4.5 The OSPAR Convention[6]

The Convention for the Protection of the Marine Environment of the North-East Atlantic referred as OSPAR Convention was signed in 1992, by fifteen Governments of the western coasts and catchments of Europe, together with the European Community, in order to cooperate in the protection of North-East Atlantic's marine environment. A new annex on biodiversity and ecosystems was adopted in 1998 to cover non-polluting human activities that can adversely affect the sea.

This Convention has five thematic strategies:

- The Biodiversity and Ecosystem Strategy
- The Eutrophication Strategy
- The Hazardous Substances Strategy
- The Offshore Industry Strategy and
- The Radioactive Substances Strategy

And an extra Strategy for the Joint Assessment and Monitoring Programme, which assesses the status of the marine environment and follows up implementation of the strategies and the resulting benefits to the marine environment. These six strategies fit together to underpin the ecosystem approach.

The Biological Diversity and Ecosystem Strategy have four elements: species and habitats, marine protected areas (MPA), human activities and biodiversity monitoring and assessment.

2.4.5.1 Species and habitats

Under the Biological Diversity and Ecosystem Strategy is established a list of threatened and/or declining species and habitats in the North-East Atlantic. The list provides an overview of the biodiversity needing protection in the North-East Atlantic and is being used by the OSPAR

[6] More detail information could be achieved in http://www.ospar.org/

Commission to guide the setting priorities for further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention.

2.4.5.2 Marine protected areas

Related with marine environment an ecologically coherent network of well-managed marine protected areas is being created. This is one of the tools that can be used to ensure the sustainable use and protection and conservation of marine biological diversity and its ecosystems.

Within OSPAR, MPAs are understood as areas for which protective, conservation, restorative or precautionary measures have been established for the purpose of protecting and conserving species, habitats, ecosystems or ecological processes of the marine environment.

The main aims of the OSPAR network of MPAs are:

- To protect, conserve and restore species, habitats and ecological processes which have been adversely affected by human activities;
- To prevent degradation of, and damage to, species, habitats and ecological processes, following the precautionary principle;
- To protect and conserve areas that best represent the range of species, habitats and ecological processes in the maritime area.

2.4.5.3 Human activities

The OSPAR Biological Diversity and Ecosystems Strategy include a list of the human activities that can adversely affect the marine environment. The considered impacts are related with dredging, sand and gravel extraction, offshore wind farms, cables and pipelines and underwater noise. OSPAR assesses those activities and, if necessary, develops programmes and measures to control those activities and to restore adversely affected marine area.

2.4.6 Important Bird Areas (IBAs)[7]

The Important Bird Areas are not a legal tool for the conservation of birds despite have a significant importance on it. Nevertheless, IBAs are internationally recognised sites for the conservation of birds at a global scale.

BirdLife International aims to get all IBAs protected under national and/or international law in order to ensure their adequate legal safeguard. The level of protection is higher in some countries than in others. The designation of Important Bird Areas as SPAs under the EU Birds and Habitats Directives has been successfully accepted among European Union Member States and Accession Countries.

Important Bird Areas were selected based on internationally agreed standard criteria taking into account the existence of key bird species that are vulnerable to global extinction or whose populations are otherwise irreplaceable.

The aim of the IBA's Programme is to identify, monitor and protect key sites for birds all over the European continent. They rely on efforts of staff and volunteers at local, national and international level. In Europe, the criteria take into account the requirements of regional conservation treaties such as the Emerald Network under the Bern Convention and the Natura 2000 Network, under the Birds and Habitats Directives.

[7] To a detail information about a particular IBA please consult the website: http://www.birdlife.org/action/science/sites/index.html.

3 REVIEW OF MARINE RENEWABLE ENERGY IN THE ATLANTIC AREA

The European Union aims to get 20% of its energy from renewable sources by 2020. Renewable sources include wind, solar, hydro-electric, tidal and wave power as well as geothermal energy and biomass. More renewable energy will enable the EU to cut greenhouse gas emissions and make it less dependent on imported energy as well boosting the renewable industry technology, innovation and employment in Europe. Assuming that the majority of the investment on marine renewable energy will be on offshore wind, wave, and tidal and current stream energy, a review of the main projects installed or to be installed in the Atlantic area has been carried out and is presented below by sector.

3.1 Offshore wind

The development of wind turbines for generating electricity began at the end of the nineteenth century. However, it is only since the 1980s that the technology reached sufficient maturity to enable a large-scale onshore wind power industry to evolve.

In comparison to onshore wind power projects the use of wind turbines offshore requires significant extra engineering for installation, infrastructure, electrical connection, and the use of materials which resist to the corrosive marine environment. Although the offshore wind is steadier than in land these factors meant that wind turbines have only been deployed offshore since the early 1990s.

At the end of 2011 Europe was the world leader in wind energy market (GWEC, 2011) and at the end of the first half of 2012 had 1,503 offshore wind turbines fully grid connected in 56 wind farms across 10 countries with a total capacity of 4,336 MW. This installed capacity is sufficient to cover 0.4 % of EU’s total consumption of energy.

Offshore installations constitute a small part of the energy market in the European Union, about 1.8 % of the wind energy market (EWEA, 2011). Nevertheless, they are a vital component of the Europe’s wide objective to increase the proportion of energy derived from renewable sources (Drewitt *et al*., 2006).

In 2011, United Kingdom was the front runner on offshore wind energy implementation with 55 % installed capacity in Europe, followed by Denmark and Netherlands (Figure 1) (EWEA, 2011a). According EWEA statistics, in 2009, by 2015 it is expected that Germany will have 30 % of offshore wind farms operational, followed by United Kingdom (23 %) (Figure 2) (EWEA, 2011).

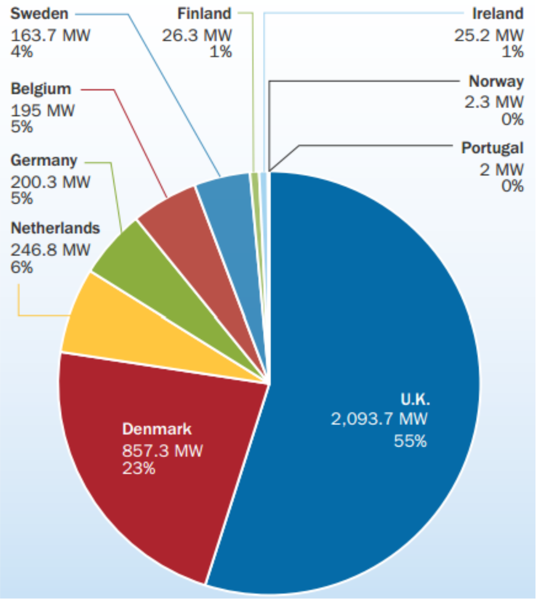


Figure 1- Installed capacity: cumulative share by country at end 2011 (Source: EWEA, 2011a).

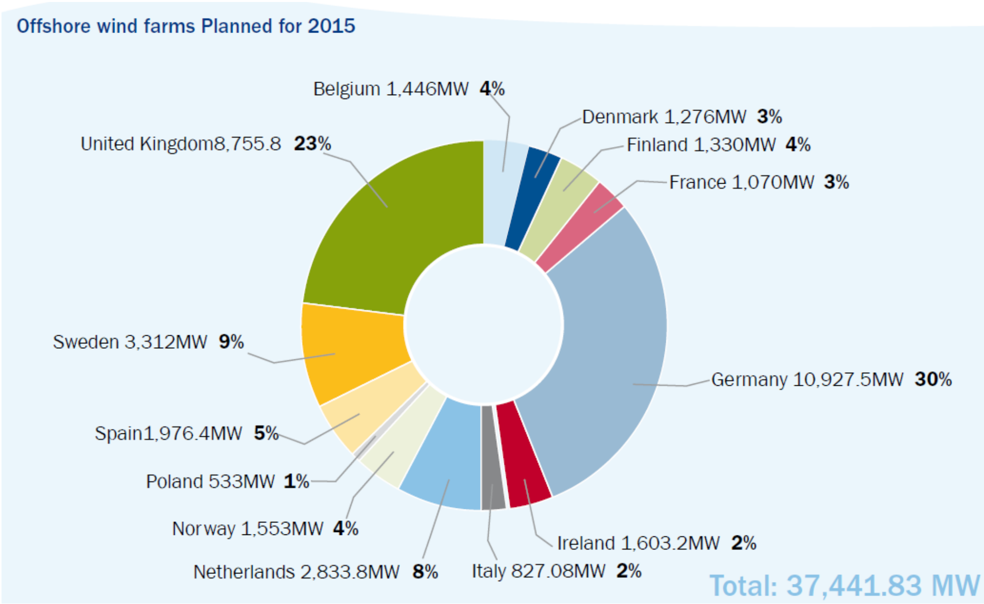


Figure 2- Offshore wind farms planned for 2015 (cumulative share by country) (EWEA, 2011).

3.1.1 Resource availability

The greater the wind speed, the greater the energy it contains. Offshore wind speeds are generally higher than on land. As wind blows over the water surface (generating waves) it loses some energy due to friction. In Europe the windiest zones are off the coasts of Ireland, Scotland, northern Denmark and Sweden (BWEA, 2004) (Figure 3).

The energy in wind is therefore usually higher further away from the coastline, and increases in strength with increasing height above the water surface which increasing the logistics related with construction and maintenance of offshore turbines.

Apart of it offshore renewable energy is competing with traditional sea users and other emerging activities such as shipping, cables and pipelines, coastal tourism and ecological and environmental protection. Another factor which may influence the siting of offshore wind farms - apart from offshore constraints - is adequate grid connection capacity, as offshore wind farms are likely to be several tens, or even hundreds, of MW in size (EEA, 2009).

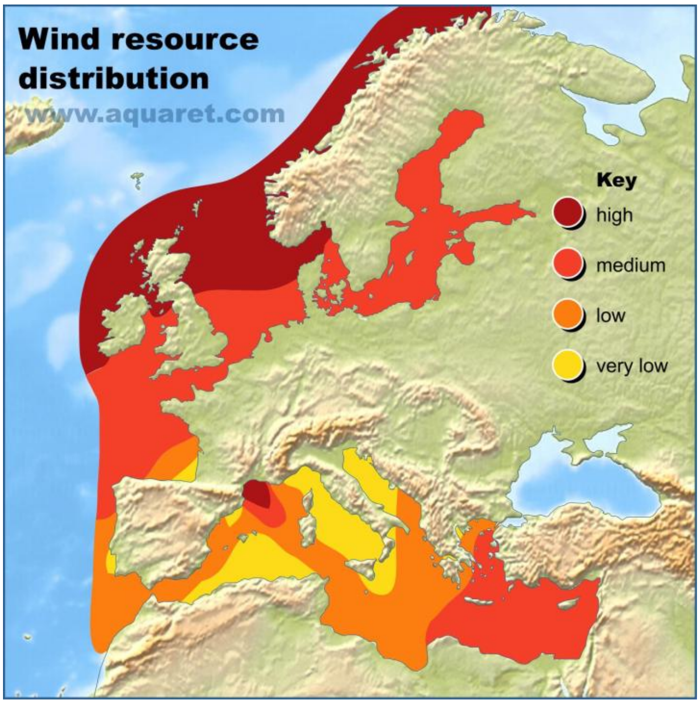


Figure 3 - Offshore wind resource in Europe (Source: http://www.aquaret.com).

3.1.2 Technology

Wind turbines are designed to extract the kinetic energy from the wind. This is achieved by allowing wind to blow past rotor blades, causing them to rotate and drive a shaft. Modern wind turbines come in two basic types: horizontal axis and vertical axis (Figure 4). However, horizontal axis is the only type of wind turbine currently being installed offshore mainly due to their market readiness and higher efficiency[8]. However, researchers find that vertical axis offshore turbine may perform even better than their horizontal axis counterparts and be more cost-effective in many locations like in deep water (Sun *et al*., 2012).

A B

Figure 4 - Horizontal axis turbine (A) (Source: http://www.aquaret.com and (B) Vertical wind turbines (Source: http://vertaxwind.com)

3.2 Wave energy

The possibility of generating electric power from the sea has been recognized for many years (the first patent on wave energy conversion was issued as early as 1799, and, already in 1909, a harbour lighting system in California was powered with a wave energy system). However, significant research and development of wave energy conversion began only rather recently: in

[8] www.aquaret.com

fact, although there was a renewed interest on wave energy after the oil crisis of 1973, it subsided again a few years later.

Some years ago, and especially in Europe, the sector experienced a resurgent interest. Today, wave energy conversion is being investigated in a number of EU countries; major activity is also ongoing outside Europe, mainly in Canada, China, India, Japan, Russia, and the USA. Nascent wave energy companies have been highly involved in the development of new wave energy converters such as the Pelamis, the Archimedes Wave Swing, AquaBuoy, Oceanlinx, Wave Star, Wave Dragon, etc.

Wave energy is a promising new method for marine energy generation, representing a widely obtainable and consistent energy source with a potentially low environmental impact, although this has yet to be quantified (Grecian *et al*., 2010). Particular advantages of wave energy are referred to be the limited environmental impact, the natural seasonal variability of wave energy, which follows the electricity demand in temperate climates, and the introduction of synchronous generators for reactive power control (CRES, 2002).

3.2.1 Resource availability

The best wave resources occur in areas where strong winds have travelled over long distances. For this reason, the best wave resources in Europe occur along the western coasts which lie at the end of a long fetch (the Atlantic Ocean) (Figure 5). Near the coastline, wave energy decreases due to friction with the seabed, therefore waves in deeper, well exposed waters offshore will have the greatest energy.

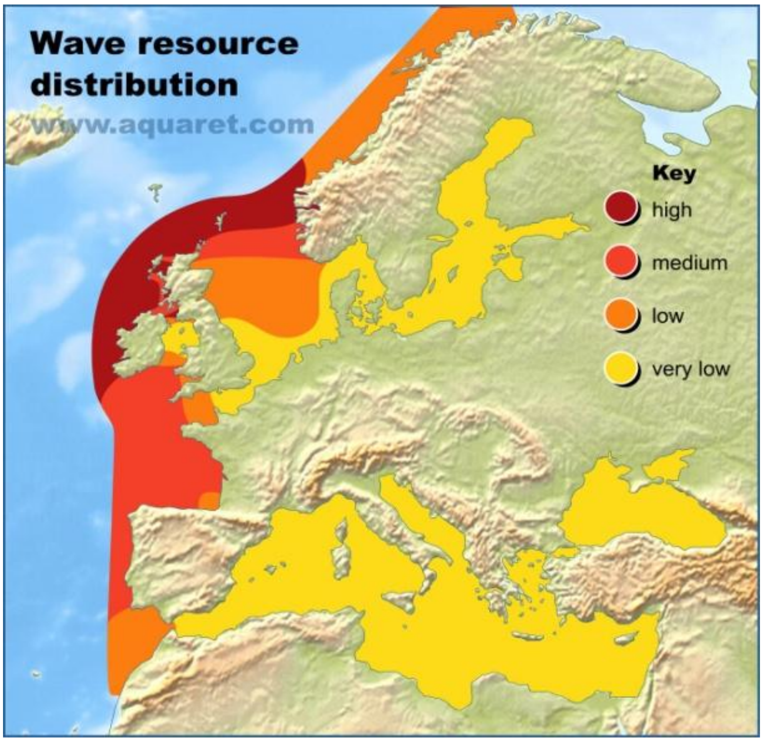


Figure 5 - Wave resources in Europe (Source: www.aquaret.com).

3.2.2 Wave energy projects in the Atlantic Area

Several test sites with different characteristics have been or are being implemented in Europe to allow the transition from research to demonstration to market penetration (Figure 6). It is expected that by 2020 United Kingdom is able to produce 2.0 GW of electricity from ocean energy, followed by France (0.8 GW) and Spain (0.6 GW). The target to Denmark and Ireland is 0.5 GW while for Portugal is 0.3 GW) (Figure 7) (SETIS, 2011).

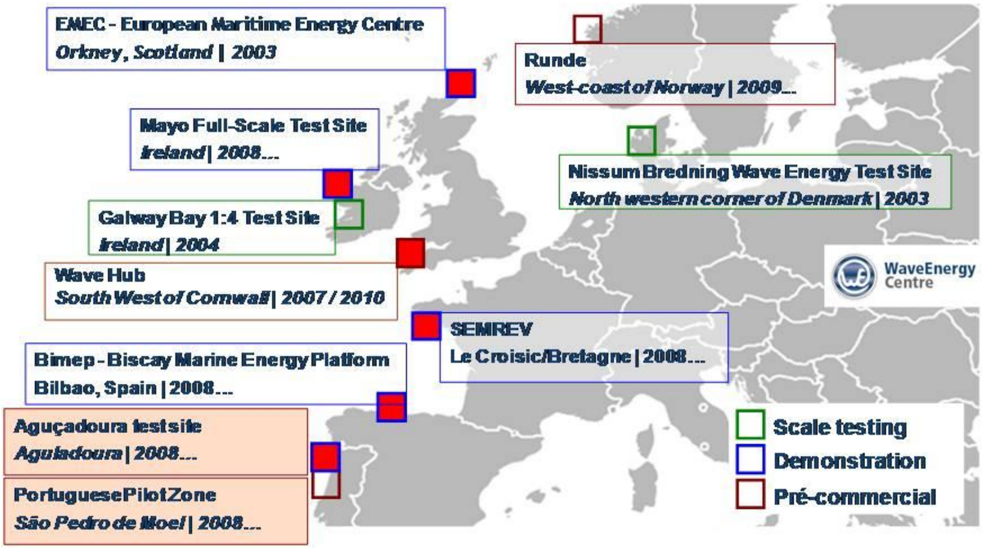


Figure 6 - Wave energy sites in Europe (source: http://www.waveplam.eu/page/default.asp?id=487).

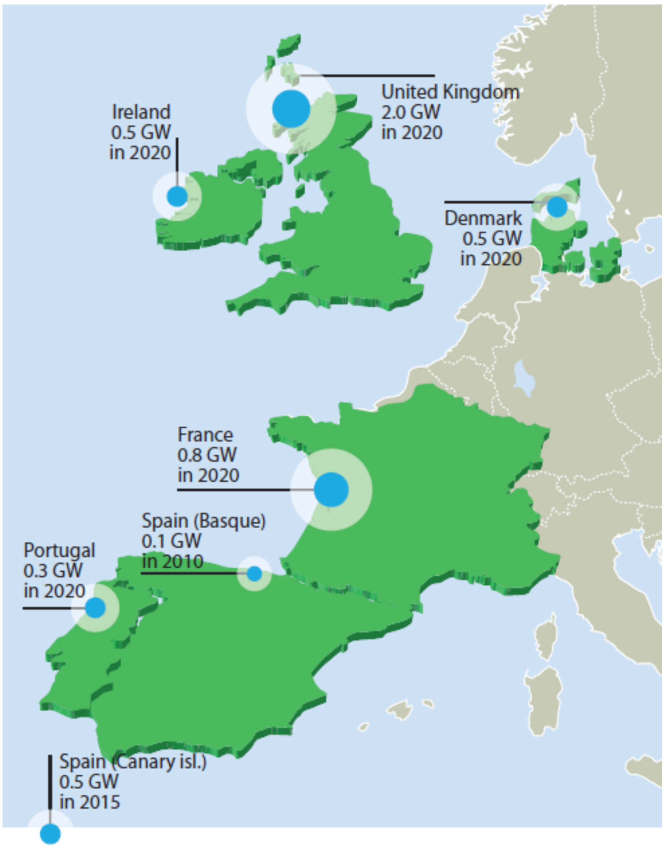
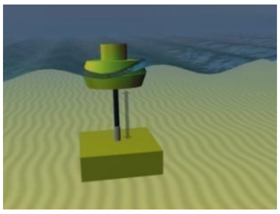
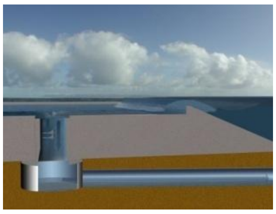
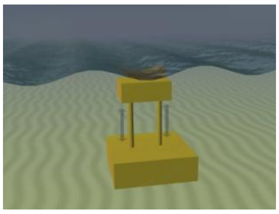
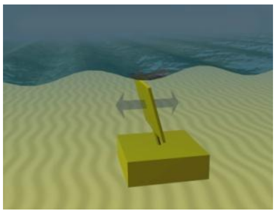
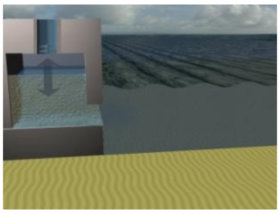


Figure 7 - Target by 2020 of ocean energy contribution (SETIS, 2011).

3.2.3 Technology

There are currently six main groups of wave energy converters, based on the wave energy conversion principle: point absorbers, attenuators, overtopping devices, submerged pressure differentials, oscillating wave surge converters, and oscillating water column devices (Table 1). All of them are designed to operate in different location and depth.

Table 1 – Main technologies of wave energy devices (source: http://www.aquaret.com/)

Device		Mechanism	Example
Point absober		Floating structures that absorb wave energy in all directions by virtue of their movements at or near the water surface.	Power- Buoy device from Ocean Power Technologies
Attenuators		Long floating devices which are aligned perpendicular to wave front. The device effectively rides the waves and captures the energy as the wave moves past it by selectively constraining the movements along its length	Pelamis
Overtopping devices		These devices consist of a wall over which the waves wash, collecting the water in a storage reservoir. The incoming waves create a head of water, which is released back to the sea through conventional low-head turbines installed at the bottom of the reservoir. An overtopping device may use collectors to concentrate the wave energy.	The Wave Dragon
Submerged pressure differential		These are submerged devices typically located near shore and attached to the seabed. The motion of the waves causes the sea level to rise and fall above the device, inducing a pressure differential which causes the device to rise and fall with the waves.	Archimede s Wave Swing
Oscillating wave surge converters		Near-surface collectors, mounted on an arm pivoted near the seabed. The arm oscillates as an inverted pendulum due to the movement of the water particles in the waves.	Oyster device
Oscillating water column		Partially submerged, hollow structures, which are open to the sea below the water surface so that they contain air trapped above a column of water. Waves cause the column to rise and fall, acting like a piston, compressing and decompressing the air. This air is channelled through an air turbine to produce power.	Pico Power Plant

3.3 Tidal Energy

Conversion of tidal energy into electricity has been widely investigated and can be compared to the technology used in hydroelectric power plants but the devices are placed directly “in-stream” and generate energy from the flow of water.

The Ocean energy sector is at an earlier stage of development than the offshore wind sector and has not yet achieved the commercial scale. The tidal stream resources make the smallest contribution to the total offshore natural resource in Europe (4%) (ORECCA, 2011). The investment in this technology tends to be in countries with a significant resource, especially in U.S., Canada and the UK. In the UK tidal stream energy has been recognized as a vital source in the future[9].

The analysis of six European Action Plans about renewable energy sources results that in 2020 tidal, wave and other marine energy are not yet likely to contribute significantly to the share of electricity production from renewable energy (Green European Foundation, 2010).

3.3.1 Resource availability

Tidal stream resources are generally largest in areas where a good tidal range exists, and where the speed of the currents are amplified by the funnelling effect of the local coastline and seabed, for example, in narrow straits and inlets, around headlands, and in channels between islands.

In Europe the resource are mainly distributed along the U.K. coast (Figure 8).

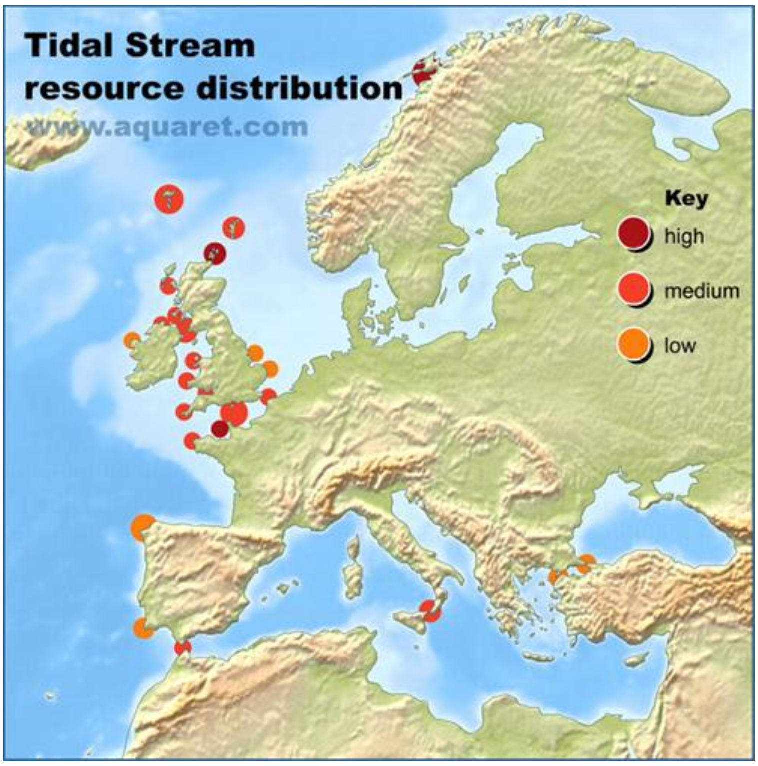


Figure 8- Tidal stream resource distribution

3.3.2 Technology

In order to harness tidal energy efficiently, two conditions must be fulfilled: the tidal range must be as high as possible, and there must be a sufficiently large bay or a sufficiently large estuary in which the water can be retained at low or high tide. To allow an economically viable project mean spring peak tidal currents should be faster than 2-2.5 m/s (Aquaret[10]).

Furthermore, a good in-stream tidal site is one that also will allow a tidal stream device to be sited, has minimum or no conflicts with other uses of the sea space, and is close to a load and grid interconnection.

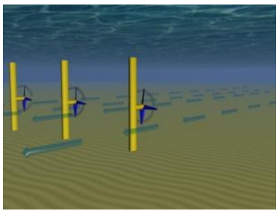
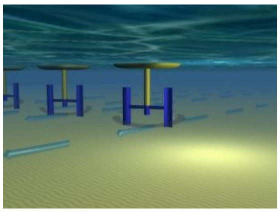
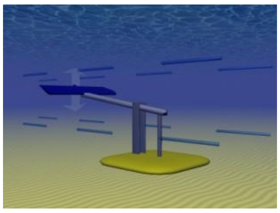
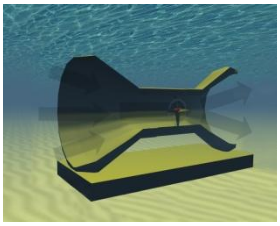
Tidal energy extraction is complex and a number of different technologies have been proposed. They differ in their physical arrangement and energy conversion mechanism. As wind energy

[9] http://www.greenrhinoenergy.com/renewable/marine/tidal_stream.php

[10] www.aquaret.com

designs horizontal and vertical-axis turbines also exist, as well as others such as venturis and oscillating foils (Table 2).

Table 2- Main technologies of tidal stream devices (source: http://www.aquaret.com/)

Device		Mechanism	Example
Horizontal axis		Horizontal axis turbines work in a similar manner to wind turbines. The turbine is placed in the water and the tidal stream causes the rotors to rotate around the horizontal axis and generate power.	Swan Turbines
Vertical axis		Vertical axis turbines work in a similar manner to horizontal axis turbines but the tidal stream causes the rotors to rotate around the vertical axis and generate power.	
Reciprocating Hydrofoils		Reciprocating Hydrofoils have a hydrofoil attached to an oscillating arm. The lift caused by the tidal stream causes the arm to oscillate and generate power.	
Venturi Effect Devices		Venturi Effect Devices are devices which funnel the water through a duct, increasing the water velocity. The resultant flow can drive a turbine directly or the induced pressure differential in the system can drive an air turbine	Lunar Energy Openhydro

3.4 Environmental Assessment approaches

The environmental assessment of wave and tidal projects is a process that is carried out by project developers to inform stakeholders and regulatory bodies in their assessment and decision making process from concept to decommissioning (EquiMar, 2010).

Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) are the legal tools used for conducting impact assessment at different levels. EIA is the traditional approach that has been widely used to address environmental impacts of a given project. SEA is a more recent mechanism for identifying and assessing the likely significant environmental effects of a plan or programme and its alternatives. SEA and EIA are tools that share a common root - impact assessment, but have different assessment foci: strategies for future development with a high level of uncertainty in SEA; proposals and measures, concrete and objective, for the execution of projects in EIA (EquiMar, 2010).

3.4.1 Environmental Impact Assessment

In the European context, the EIA concept was established in the Directive 85/337/EEC (the so called EIA Directive). Amendments to this Directive have been introduced (Directive 97/11/EC and Directive 2003/35/EC) and a consolidated version is currently available on the EU website[11]. The EIA Directive refers to the two Directives mentioned above (Wild Birds Directive and Habitats Directive) on nature conservation policy in the European Union. All areas classified under these Directives form an ecological network known as Natura 2000.

Although the EIA Directive has been reviewed, it does not specifically address marine renewable energy projects due to the relatively recent development of these technologies. The EIA Directive outlines which project categories shall be made subject to an EIA, which procedure shall be followed and the content of the assessment. Project categories are split between Annex I for which EIA is compulsory and Annex II for which EIA is dependent on whether significant environmental effects may occur. Although a number of energy project categories are included in Annex I, wave and tidal energy projects could only be within Annex II under the category of “Energy industry: (a) Industrial installations for the production of electricity (...)”. Projects outside Annex I may still be subject to EIA depending on their nature, size and location either in accordance with (nationally) pre-determined thresholds or on a case-by-case basis (Article 4, number 2). For such pre-determined thresholds or case-by-case examination, the developer should include the criteria set out in Annex III of the EIA Directive.

The proximity to the coast or to a site designated under an EU Directive on Wild Birds or Habitats will be significant factors in assessing the impact of the proposed activity and whether EIA is required. The protected offshore habitats are those in Annex I of the Habitats Directive that occur beyond 12 nautical miles offshore. Under this situation, there are at least two classified offshore Habitats: “Reefs” (Natura 2000 Code 1170)[12] and “Submerged sandbanks” (Natura Code 1110)[13]. The Habitat “Sub-marine structures made by leaking gases” (Natura 2000 Code 1180)[14] can also occur beyond the 12 nautical miles. It is also important to note that several marine species, including the harbourporpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*) and monk (*Monachus monachus*), common (*Phoca vitulina*) and grey (*Halichoerus grypus*) seals are listed in the Habitats Directive for potential site selection. Bird species listed in the Birds Directive may also qualify.

Recommendations made during the EIA process may include project components re-design and/or deletion, or, changes of site location and may require further studies which can interfere with costs and delays on project implementation.

According European Legislation when adverse effects of the project or plan on the Natura 2000 site are predicted an appropriate assessment should be carried out. The potential to affect any Natura sites will be communicated to the developer through the scoping during the EIA process.

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[11] Environmental Impact Assessment. Environment. European Commission. http://ec.europa.eu/environment/eia/eia-legalcontext.htm

[12] Reefs: submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the seafloor in the sublittoral zone but may extend into littoral zone where there is an uninterrupted zonation of plant and animal communities. These reefs generally support a zonation of benthic communities of algae and animals species including concretions, encrustations and corallogenic concretions.

[13] Sandbanks which are slightly covered by seawater at all times: Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20m below Chart datum. Non-vegetated sandbanks or sandbanks with vegetation belonging to the *Zosteretum marine* and *Cymodoceion nosodae.*

[14] Submarine structures made by leaking gases: Spectacular sub-marine complex structures, consisting of rocks, pavements and pillars up to 4 metres high. These formations are due to the aggregation of sandstone by carbonate cement resulting from microbial oxidation of gas emissions, mainly methane. The methane most likely originated from microbial decomposition of fossil plant materials. The formations are interspersed with gas vents that intermittently release gas. These formations shelter a highly diverse ecosystem with brightly coloured species.

An example of an appropriate assessment applied to marine renewable energy is the Habitats Regulations Appraisal (HRA)[15] that is applied in Scotland and Great Britain. Note that “significant impact” under the EIA Regulations implies an impact of a certain magnitude and/or one that exceeds a certain threshold or meets certain criteria. However, when associated with the HRA process the term “likely significant effect” refers to any potential connectivity or interaction with Natura sites which has the potential to affect the qualifying interests of the sites in terms of its conservation objectives. Briefly, to prepare an Appropriate Assessment a stepwise process is followed. During the process, in the case of offshore wind, European/ Ramsar sites and features to be considered are identified, interest features sensitivities are reviewed as well the draft Offshore Wind Energy (OWE) plan activities to which features are sensitive and at the end an assessment of draft OWE plan effects on European/ Ramsar sites is done.

The EIA is a stepwise approach that requires continuous reappraisal and adjustment. The EIA process steps are briefly described below and its application to wave and tidal energy projects has been discussed elsewhere (EquiMar protocol, 2011).

Screening: it is the process by which a decision is taken on whether or not an EIA is required for a particular Project. In Figure 9 the steps of the screening process are presented. Note that Annex III of the Directive sets out the criteria that must be considered in the screening process. This process is carried out by the Competent Authority designated in each Member State.

Scoping is defined as “the process of determining the context and extent of the matters which should be covered in the environmental information to be submitted to a competent authority for projects which are subject to EIA”. The scoping step is essential to ensure that environmental studies provide all the relevant information on the impacts of the project, focusing on the most important impacts, project alternatives and any other matters to be included.

The specific procedures to carry out the scoping exercise vary among different EIA regimes among Member States. However, they are based on two basic models: 1) undertaken by the competent authority; 2) undertaken by the developer. In the first situation the developer is required to provide information to the competent authority about the project and after consult with environmental authorities and other interested organizations issues a Scoping Opinion to the developer. In the second situation the developer prepares a draft Scoping Report and submits it to the competent authority for review, the competent authority consults with other environmental authorities and other interested organisations and the final Scoping Report is agreed (European Commission, 2001). Tools like checklists can help on the scoping exercise development.

Prediction and mitigation: during this step the magnitude of adverse effects is determined and mitigation measures are defined to avoid, minimize, remedy or compensate these effects.

Management and monitoring: during this step the predicted adverse effects are compared with the real impacts of the project analysed through monitoring results.

Audit: this step includes an analysis of the technical, procedural and decision-making aspects of the EIA. The audit will determine whether recommendations and requirements made in earlier EIA steps were incorporated successfully into project implementation.

Usually the developer requests the competent authority to say what should be covered by the EIA information to be provided by the developer (scoping stage). After providing the information on the environmental impacts of his project (EIA report – Annex IV), the developer should inform and consult with the environmental authorities, the public and, if applicable, affected Member States. Then, the competent authority makes the decision upon the EIA and consultations' results. The public is informed of the decision afterwards and can challenge it before the courts.”[16]

The EIAs should include proposals for a dynamic programme, monitoring positive and negative impacts on the environment, in both the construction and the operational phase, which should continue during 2 to 3 years after construction (Fox *et al.*, 2006). This would enable a comparison between the predicted effects arising from the initial EIA, and the observed effects post-

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[15] More detailed information about the Habitats Regulations Appraisal can be achieved in http://www.snh.gov.uk/planning-and-development/environmental-assessment/habitat-regulations-appraisal/

[16] http://ec.europa.eu/environment/eia/eia-legalcontext.htm

construction. However, it is important that baseline monitoring programme was of sufficient duration to comprise natural variability.

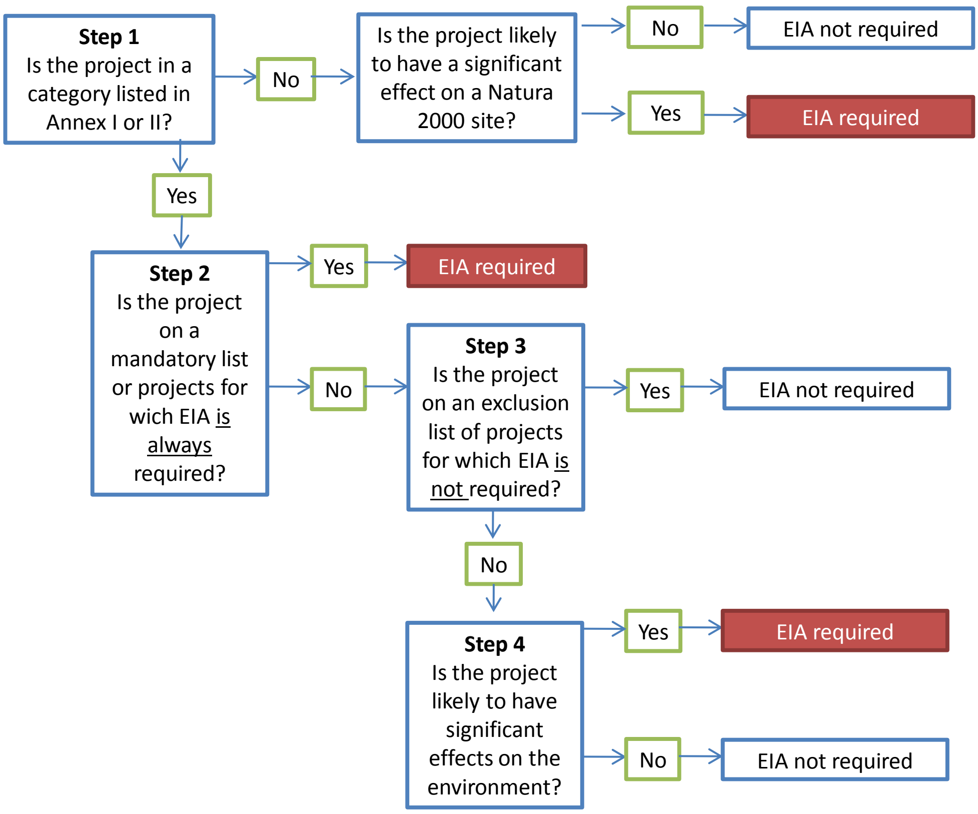


Figure 9 - Screening steps (adapetd from European Comission, 2001).

3.4.2 Strategic Environmental Assessment (SEA)

In the European context, the SEA was established by the SEA Directive (2001/42/EC) which aims to provide a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation of projects, plans and programmes with a view to reduce their environmental impact. It also aims to ensure public participation in decision-making and thereby strengthen the quality of decisions. The SEA is a crucial tool for sustainable development.

A SEA is mandatory for plans or programmes prepared for agriculture, forestry, fisheries, energy, industry, transport, waste and water management, telecommunications, tourism and spatial planning or land use. The SEA is supposed to set the regulatory framework for future consent of projects listed in the EIA Directive or projects requiring an assessment under the Habitats Directive.

The steps involved in the SEA application are similar to the steps involved in the EIA:

- **Screening**: determining whether or not SEA is required;
- **Scoping**: determining the range of environmental issues to be covered by the SEA;
- The preparation of an **Environmental Report**;
- To carry out **consultations**;
- The integration of environmental considerations into the Plan or Programme;
- The publication of information on the decision (**SEA Statement**).

The SEA procedure can be summarized as follows: an environmental report is prepared in which the likely significant effects on the environment and the reasonable alternatives of the proposed plan or programme are identified. The public and the environmental authorities are informed and consulted on the draft plan or programme and the environmental report prepared. As regards plans and programmes that are likely to have significant effects on the environment in another Member State, the Member State in whose territory the plan or programme is being prepared must consult the other Member State(s).

For the plans/programmes not included above, the Member States have to carry out a screening procedure to determine whether the plans/programmes are likely to have significant environmental effects. If there are significant effects, an SEA is needed.

4 REVIEW OF MARINE RENEWABLE ENERGY IMPACTS ON SEABIRDS

The European coastal and offshore waters are of great importance for several species of resident and migratory birds. Most of them use European waters for passage, breeding and resting (Desholm *et al*., 2006). Therefore migratory birds often figure in the EIAs associated with wind farm developments.

Due to the lack of information and limited data, impacts of wave energy devices are mostly extrapolated based on impacts observed in offshore wind farms and other human activities, such as shipping (McCluskie *et al*., 2012). They depend on different factors: species behaviour, season and site among others (Langton *et al*., 2011; Lindeboom *et al*., 2011).

The implementation of offshore marine renewable energy projects implies the installation of rigid structures in the marine environment. Depending on its characteristics they can impact marine life in many different ways. Concerns over the potential adverse impacts of marine renewable energy projects on seabirds include: species and habitat disturbance, collision risk, barrier effects and entrapment (Inger *et al*., 2009). However, potential positive impacts, such as the creation of artificial reefs, which promote resting and feeding grounds for seabirds, are also assigned to these kinds of projects.

4.1 Potential negative impacts

4.1.1 Disturbance

Different types of disturbance can occur at different steps of implementation of renewable energy projects. Acoustic and seabed modification are frequently referred as disturbing agents, mainly during the construction phase. During operation, the presence of the structures themselves can be considered disturbing agents. The presence of vessels involved in surveys, construction and/or maintenance might also contribute to disturbance

Acoustic disturbance is mainly considered to be an issue during construction, for example due to pile driving operations to provide turbine foundations. Devices with subsurface moving parts, such as underwater turbines or hydroplanes, are assumed to be the noisiest (Boehlert and Gill, 2001) during the operational phase. The main perceived impact of anthropogenic underwater noise is currently focused on fish (Hastings and Popper, 2005) and marine mammals (Southall *et al*., 2007). The effects on these groups could have indirect effects on birds: if preys move for another place birds move with that or lose food. However, high levels of acoustic disturbance are temporary once occurs during the noisiest phase of the projection which is installation.

The works carried out on the seabed can result in sediments re-suspension which can increase the turbidity of the water, smother benthic communities and increase the risk of collision mainly to diving birds. Furthermore, the reduced visibility caused by increased turbidity could have adverse effects on foraging success; marine birds are thought to have a high sensitivity to reductions in water visibility (Strod *et al*., 2008 *in* McCluskie *et al*., 2012).

During the operation phase the physical presence of structures above water are more likely to interfere with the flight path of some species of seabirds (Christensen *et al*., 2004) while underwater structures are more likely to interfere with diving behaviour.

Researchers verified that a high number of aquatic birds, such as sea ducks, swans and geese avoid wind farms at the large scale and modify their flight paths (Lindeboom *et al*., 2011; de Lucas *et al*., 2004). This avoidance has been observed, for example, through a reduction of flocks entering in a wind farm (Desholm and Kahlert, 2005). One consequence of this disturbance could be a reduction on breeding and foraging success (Dahl *et al*., 2012; Drewitt and Langston, 2006).

However, not all seabird species have negative reaction to the wind farm presence. Some of them, like gulls, do not react in the presence of a wind farm (Christensen *et al*., 2004). Others like the common scoters, common eiders, migrating great cormorants and terns show a clear, yet not complete avoidance to the offshore wind farms (Christensen *et al*., 2004).

Wave energy generating devices may indirectly disturb marine birds by altering oceanographic processes and food availability, with implications for trophic cascades (Grecian *et al*., 2010).

4.1.2 Collision

Collision risk is enhanced due to the presence of structures in the marine environment and is expected to vary with device type (Brown *et al*., 1992; Garthe and Hüppop, 2004: de Lucas *et al*., 2008). Collision can occur with rigid structures, like tower or rotating blades, as well as less rigid structures such as mooring cables.

The avoidance behaviour is likely to vary according to species (Christensen *et al*., 2004) and body size, activity pattern (Larsen and Guillemette, 2007) or age and reproductive stage (Henderson *et al*., 1996).

The collision risk is reduced in species that change their flight path by detecting the presence of wind turbines (de Lucas *et al*., 2007 *in* Farfán *et al*., 2009). Christensen and Hounisen (2004) observed that birds, such as divers, gannets and common scoters, actively avoid the wind farm area changing their flight orientation at a distance of approximately 400-500 m from the wind farm. This suggests a visual recognition of the structures. In the same study, gulls and terns, despite higher flight intensities outside the wind farm did not exhibit marked behavioural reactions. Occasionally, they may use the turbines for loaf or rest or even for foraging. However, during the breeding season any avoidance action implies greater costs of displacement. In a previous study, carried out in the same wind farm area, eiders and geese exhibit avoidance behaviour to wind turbines within a range of 100-500 m distance from them (Noer *et al*., 2000). Therefore, some bird species generally exhibit avoidance reactions to the wind turbines reducing the probability of collision.

The relation between collisions and daylight/light intensity is a little controversial. Some studies reveal that collisions may occur more with diurnally active birds and with birds foraging in the area of wind turbines rather than nocturnal migrant birds (Krijgsveld *et al*., 2009). This information contrasts with the results of Christensen *et al*. (2004). They noticed that birds entering in a wind farm pass along the open corridors between turbine rows more accurately during day than at night.

Although the artificial reef effect could be positive, since it provides additional feeding resources for seabirds, if structures serve to aggregate prey for diving birds and other species the risk of collision could be enhanced (Witt *et al*., 2012). This response may potentially serve to aggregate prey for diving birds and other species, with a concomitant chance of increased interactions between WECs and mobile species

Wave energy devices have a much smaller profile so they may represent a much lower collision risk when compared with wind energy devices (various *in* Grecian *et al*., 2010). Nevertheless, wave energy devices may represent greater underwater collision risk to diving birds than surface feeding species (Wilson *et al*., 2007) and those with rotating turbines likely to pose a greater threat.

4.1.3 Barrier effects

As mentioned previously wind energy devices have higher potential to form barriers to the movement of birds. The presence of such structures at sea might force birds to navigate around them. Research has shown that fewer birds pass between turbines (Noer *et al*., 2000) with many choosing to fly around the outside (Desholm and Kahlert, 2005). This indicates that wind farms can act as a barrier to seabirds.

4.1.4 Habitat modification/loss

Implementation of renewable energy devices can result in a temporary or permanent habitat loss. Some physical changes of the habitat include 1) the loss of the seabed area which supports the turbine foundations, 2) the provision of new underwater substrate for the settlement of larvae of marine invertebrates, and 3) the provision of platforms for birds to sit or perch on (Noer *et al*., 2000).

Mobilization of sediments results in re-suspension of organically rich sediments. This is likely to reduce oxygen availability, at least temporarily, and water quality due to pollutants (e.g. heavy metals) desorption and dissolution from contaminated sediments. The disturbance may be similar to that from fishing and dredging, which has been shown to alter the local biota, both in terms of diversity and density (Blyth *et al*., 2004; Witt *et al*., 2012) altering dynamics of existing populations.

On the other hand, structures can produce modifications to the water circulation pattern, energy and turbulence and alter vertical movements of marine organisms resulting in prey and predator aggregation (Boehlert and Gill, 2010). The buoys, cables, turbines, spars, and vertical pillars associated with most renewable energy devices will modify pelagic habitats by creating structures where none existed.

Still there are claims that renewable energy devices are distorting the seabed and giving rise to sites for the colonisation by alien (hard substratum, epifaunal) species (Elliot and Cutts, 2004). The area of seabed directly impacted during the construction of wave energy devices will be small, limited to impacts from cabling and anchorage (Langhamer and Wilhelmsson 2009 *in* Grecian *et al*., 2010). However, devices requiring fixed bases could have similar effects to wind turbine construction.

The installation and decommissioning of wind and wave devices differ substantially among technologies and sites, however habitat loss throughout these phases for wave devices is likely to be less extensive (reviewed by Gill, 2005 *in* Grecian *et al*., 2010). The seabirds displacement by habitat disturbance may occur simply by individuals' avoidance of such sites or by modification of hydrological processes which may have interference e.g. on prey species availability (Kaiser *et al*. 2006a). Thus the avoidance effect may be more responsible for the seabirds' habitat loss than the spatial occupation of a given site with e.g. turbine foundations (Noer *et al*., 2000). Effective habitat loss can be measured using bird densities as a proxy measure of bird habitat (Fox *et al*., 2006).

Note that a well designed project should not result in loss of valuable habitat or adverse impact on protected species.

4.1.5 Entrapment

Entrapment is a potential impact usually assigned to wave energy devices particularly to those that use pressure differentials to drive internal turbines such as oscillating water columns or overtopping devices. These will contain enclosed chamber sections that are partially exposed to the open ocean where marine birds are capable of entering (Grecian *et al*., 2010).

Figure 10 represents a summary of the main impacts of offshore renewable energy devices on birds. Note that all of them lead to changes in overall population size, in a long-term analysis.

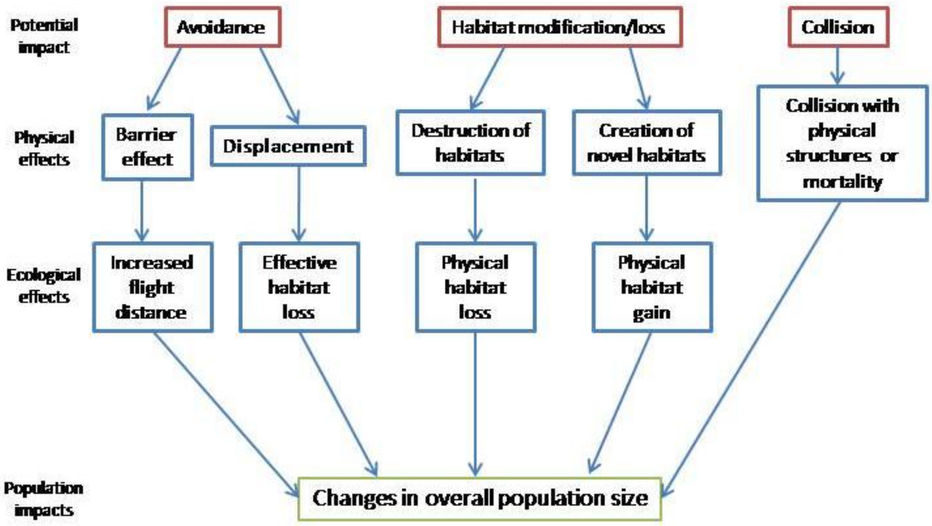


Figure 10 - Flow chart representing the principal impacts of wind turbines on birds (adapted from Desholm, 2006).

4.1.6 Cumulative effects

As pointed out in previous paragraph offshore devices may have impacts on birds by means of collision, disturbance and barrier effects at a short-time European Union legislation requires cumulative impact assessment as part of Environmental Impact Assessments but detailed guidance and definitions were available. Frameworks to assess the cumulative impacts of offshore devices have been developed (Masden *et al*., 2009).

Currently, the question is at what level the previous impacts affect birds' population in long-term. If no mitigation measures are adopted potential impacts can result on a lowered survival or reproduction and consequently in a reduction of population size (Poot *et al*., 2011)

4.2 Potential positive impacts

Marine renewable energy devices have the potential to attract mobile organisms and to increase the area of habitat hence they have the potential to act as artificial reefs and as fish aggregating devices (Inger *et al*., 2009; Linley *et al*., 2007) attracting also large predatory birds that feed on the concentrated prey resources (Witt *et al*., 2012). Furthermore, the installation of marine renewable energy devices cannot only introduce new roosting and foraging sites (e.g. great cormorant and gulls; Grecian *et al*., 2010) but also relieve the site from other human pressures such as military activities, recreation and fishery activities.

From this point of view renewable energy projects have the potential to act as *de facto* marine protected areas (MPAs). Providing such a refuge from intense fishing pressure these restricted areas may have the potential to protect and enhance fish stocks in the area; the implementation of marine renewable energy projects may also contribute to protect benthic habitats and fauna, by eliminating the damage caused by fishing gear towed along the seabed (Kaiser *et al*., 2006). However any such positive benefits are likely to be small in already degraded habitats.

5 RECOMMENDATIONS FOR A SUSTAINABLE EXPLOITATION

In order to reduce the negative impacts of marine renewable energy devices in the marine environment some mitigation measures can be adopted. These should be considered first to avoid the impacts and then to reduce or halt the impacts (European Comission, 2001a).

5.1 Before marine renewable energy projects' implementation

Along with economic and technical requirements, environmental aspects are also relevant when planning the implementation of offshore renewable energy devices since the installation of a project might be a compromise between technical and environmental considerations.

Besides optimal conditions to install the offshore device it is also important to define if the site overlaps or is closed to a designated area. The greater the overlap the higher the potential for impacts of marine renewable energy devices. Therefore, it is essential to **define the range of seabird species occurring within the area for a proposed project.** It is important to know how and when the species use the site during breeding, moulting, staging or wintering periods, if it is a site of an important migration corridor. It is also important to understand the distribution and behaviour of prey species in response to the installation of these projects. This will allow a better understanding of the potential conflicts between marine birds and renewable energy devices (Grecian *et al*., 2010). If the site where the device is to be installed overlaps with a relevant site for seabirds, project relocation, rezoning or no action options should be considered.

To determine the potential risk of marine renewable projects for species it is necessary to take into account the following elements: geographic location of seabird species in Atlantic offshore waters (distance offshore, migratory pathways), water depth, species distribution and abundance, seasonal variation, behavioural characteristics and physical characteristics of the offshore structures (turbine number, layout pattern, turbine size, air-gap characteristics). A helpful scientific tool for identifying bird species which may be at risk is the Species Sensitivity Index (SSI) (Garthe and Hüppop, 2004). An example is "Jacob Selectivity Index" that can be calculated to describe the birds preference for the construction site compared to the surrounding area (Christensen *et al*., 2002).

Since seabird distribution is stochastic, densities and behaviours are highly variable and therefore need to be surveyed with a high spatial and temporal resolution. Understanding the mechanisms of natural variability is vital for any assessment of whether a development has caused change in bird behaviour or distribution. Therefore, the minimum of two years pre-construction data are recommended.

At the preliminary stages of the project planning, it is very important to use existing information to determine the likelihood of impacts and to develop a monitoring programme in order to assess the environmental status before the construction or installation of ORED. This baseline study will be useful later to compare data before and after the construction of ORED.

Some mitigation measures are highlight below:

- To **reduce barrier effect**: avoid aligning turbines perpendicular to the main flight direction of birds and to provide corridors between clusters;
- To **reduce collision risk**: the structures should be designed to avoid providing resting places for birds;
- To **minimise habitat loss/modification**: in sites where artificial reef effects are unwanted protected material should be used to minimise organisms' settlement.

When great overlap exists with sensitive areas and mitigation measures are not sufficient to minimise the impacts of ORED project changes including redesign or relocation of devices should be considered (European Commission, 2001a). Moreover, placing the turbines closer together might minimise the development footprint (however it can be subject to technical constraints such as the need for greater separation between larger turbines).

It is also important to promote communication between stakeholders through workshops and meetings (See “Stakeholders involvement and public awareness” section).

5.2 During construction / installation phase of OREDs

Much part of the ecological damage usually occurs during the construction / installation phase of OREDs. Despite of impacts are often considered temporary, full recovery might take several years and it is important to ensure that adequate mitigation measures are carried out.

Acoustic disturbance and vessel traffic are the major potential impacts of ORED. Together they contribute to the displacement of fish and consequently potential displacement of birds. However, habitat recovering is possible when construction is concluded.

There are some measures that can be adopted to mitigate the impacts of construction works or devices’ installation on seabirds. Operations should be timely planned to **avoid sensitive periods** such as reproduction, moulting or migration periods. These are dependent on species potentially affected and thus it is important to know which species use the site. When works on sensitive periods cannot be avoided (for example for essential maintenance) the duration of work and extent of work area should be kept to a minimum. Another measure can be to designate protected zones. The mitigation of the risk of entrapment (mainly in wave energy devices) is recommended by the use of protective meshes in order to cover openings. However, this application should be monitored to control the debris accumulation. This mitigation measure can also be used during the operation phase of devices.

The best noise mitigation measures are those considered during the project design. Control of noise at the source can take a number of forms. One example to minimise acoustic disturbance resulting from pile driving is to use bubble curtains around the pile driving site (Lucke *et al*., 2011; Reyff, 2009; Würsig *et al*., 2000). Another example is related to the selected methodology for pile driving activities: rotator methods should be used whenever possible in preference to percussive techniques (Cruz, 2008). This will avoid the excessive energy and noise generation. One best practice that can also be adopted to reduce the noise produced by ships is restricting the number of travels to the minimum necessary.

5.3 During operation phase of OREDs

To assess the impacts of OREDs on seabirds, long-term impact studies should be carried out (Carrete *et al*., 2009; Farfán *et al*., 2009). These are important in order to assess if other environmental factors contribute to modify the flight path rather than the ORED. On the other hand monitoring programmes are essential to determine the effectiveness of mitigation measures’ application or if it is necessary to suite measures.

Impacts on seabirds related to collision and habitat modification are expected during operation. To **minimise the risk of collision**, lights can be used to signal the presence of the structures. However, some studies indicate that some species are attracted by permanent light. To solve this problem permanent light can be replaced by intermittent light (Bruderer *et al*., 1999; EEA, 2009). Carefully scheduled shutdown may be a valuable mitigation measure for certain species, during critical periods of time such as migration and breeding activity , to **minimise the potential barrier effect** of offshore energy devices on birds (Hüppop *et al*., 2006). On the other hand, this turn-off reduces acoustic detection of rotors which can, increase the risk of collision (Langston and Pullan, 2003).

5.4 Monitoring methodologies

The species mentioned in Annex I of the Birds Directive shall be subject to special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. Even if a species is not listed but is important at a local level, similar measures of protection should be taken.

The monitoring plan should be built according to the seabird species distribution in the area and a minimum of two years of baseline data collection, before project installation, are recommended to support the selection of the best monitoring methodologies. Before start a monitoring programme, its goal should be well defined: it is necessary to know what type of information is required (collision rates, modification of flight path, disturbance, etc.). For example, whilst land-based radar may be useful for recording migration and other bird movements in inshore waters, problems of wave clutter are likely to reduce the value of radar in the case of wave and tidal stream developments. The use of different monitoring techniques allows to accurately plotting migration trajectories and flight paths of birds.

According to Desholm and Kahlert (2005) remote techniques have clear advantages since it is possible to collect data during darkness or low visibility, across extended time periods over a large spatial extent, and remotely in offshore regions.

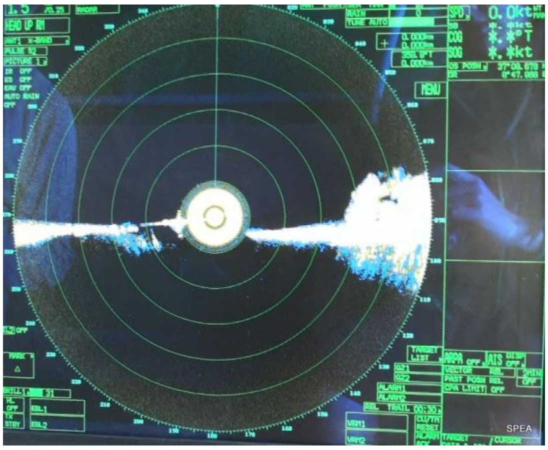
5.4.1 Using radars

Before start using radar systems to monitoring bird activities it is important to understand the principles of radar operation. All radars function on the same principle: they transmit a radio signal, and then listen for the signals that reflect back, returning the position of a target in two dimensions of space. These devices can be horizontally or, in an adaptation commonly found in radar ornithology, vertically. In the last, the antenna's axis is turned through 90º allowing the return of seabird's altitude. The typical horizontal radar returns the movement of birds over the seascape. They can also be used for recording flight lines, patterns of movement and range of avoidance behaviour. The data acquired is recorded into a database and can be analysed through GIS or statistical software.

Among the available radars, the X-Band (3 cm wavelength) and S-Band (10 cm wavelength) radars are the most used in ornithological research. However, bird reflectivity is stronger for S-band radars than for X-band radars (Geo Marin Inc., 2004).

Surveillance radar can be ship based or platform mounted. Nevertheless better quality data is likely to be obtained using a platform based setup. Additionally, the operation time of a platform mounted system will be less than of the ship based system (Walls *et al*., 2009).

A radar study has the potential to show the overall volume of birds' movements (number of flocks) through time and how seabirds might have preference for different geographic areas. Note that it is unable to count birds within flocks and to get precise counts it is necessary calibrating counts with the use of other methods, such as visual observations, to estimate densities (Walls *et al*., 2009) and to qualitatively inform a radar study and therefore, it is important that these are carried out by trained field observers on seabird species.



During the calibration process it is often assumed that the number of radar echoes seen on a radar PPI screen matches the number of birds present within the area defined by the screen. Actually, estimates of the numbers of birds are only available by performing calibration exercises. Sometimes the marine type radar is difficult to calibrate and when two objects are close they could not appear as separate targets; in fact it is not possible to distinguish flocks from individuals (Geo-Marine Inc., 2004). Radar system is not a good way to assess collision of seabirds with devices too (Brabant and Jacques, 2009).

On the other hand, using radar it is possible recording in daylight and darkness over long periods of time. Data acquisition will be affected by rain and sea clutter particularly during severe weather. However, good quality data can be returned by horizontal mounted radar up to sea states three to five (Beaufort Wind Scale). Vertically mounted radar is not affected by the sea clutter at higher altitudes, but data from near the sea surface can be difficult to collect due to wave and spray clutter.

The radar systems such as Marine Doppler radar are better to operate in high sea clutter environments. This is more expensive than the standard radar but the ability to collect data in higher sea states makes this a valuable technology for future consideration. Nevertheless, if the collection of data during periods of precipitation is important S-band radar could be a good option. This is less susceptible to rain clutter than X-band radar.

For a better understanding of radar alternatives the read of “Revised best practice guidance for the use of remote techniques for ornithological monitoring at offshore wind farms” of Walls *et al*. (2009) is recommended.

5.4.2 Thermal Animal Detection System (TADS)

Thermal cameras detect radiation in the infrared range of the electromagnetic spectrum (wavelengths between 2 to 15 µm). Thermal techniques include active and passive thermography. They differ on the need for an external energy source to light the target.

In passive animal techniques it is purely the heat radiation from a target that creates a thermal image. As the radiation reaches the detector via the thermal camera, it is transformed into an electrical signal, amplified and transmitted to an array of light-emitting diodes that produce the final visible image.

An advantage of thermal cameras is that they can detect a target in complete visual darkness and can see through light fog, rain and smoke (Walls *et al*., 2009). Therefore they can be successfully used as tools to collect information on bird flights and behaviour in conditions of limited visibility (Brabant and Jacques, 2009). However, infrared camera systems have a relatively low optical resolution which is a limitation in bird monitoring. Therefore the operational distance is limited to 1- 2 km. Currently thermal imaging has limited use for surveying wave and tidal stream farms, although for above surface activity at single deployments and small arrays it will have some utility.

5.4.3 Radio-telemetry

Radio telemetry is a useful technique for determining bird’s movements. This technique covers areas ranging in size from the restricted breeding territories of resident seabird species to migratory destinations, covering the movement patterns of international migratory species.

The radio tracking of birds using VHF transmitters is a well established technique and can be operated from boats and aircraft. The transmitters and receivers are relatively low cost, and with adequate survey effort can generate accurate location data with potential for identifying the individual tagged seabirds during other surveys.

For all tags there is a trade-off between battery life and detection range, which are both constrained by limits on tag size (Walls *et al*., 2009). However, alternative techniques are increasingly available and reduced in size, ranging from data loggers that required recapture of the bird to obtain data, to satellite or GMS transmission of data from tagged birds.

On the other hand, the necessity to attach the transmitter to the bird has a number of welfare implications: firstly the bird must be caught, and then handled, a process that can vary greatly in complexity with species, life stage and location. It is necessary to take into account the mass of the tag as a proportion of the bird body mass. This disturbance must be carefully minimized and monitored. There are considerations in terms of the size and weight of any device and how it may affect the bird as an irritant or as nuisance object which interfere with the birds aerodynamic, or in addition hydrodynamic (in the case of diving seabirds) movements.

Radio telemetry can provide a useful means of identifying key foraging areas for birds from a particular colony (Perrow *et al*., 2006). This technology may be of particular utility in the case of near shore wave devices.

5.4.4 Visual observation

Visual observation can be used during day-light periods to a distance of at least 5 km for larger birds such as ducks and geese (Kahlert *et al*., 2000, 2002). This distance is highly weather dependent and may be widely reduced and also depends on the height above sea level at which the observer is sitting. However, visual observation can be used to complement "high-tech" techniques previously referred, for example the radar technique.

Through visual observations it is possible to identify which species fly in the area, at what altitudes (dependent on distance from the observer in the absence of reference structures) and how their behaviour varies. To access these information observations should be made by researchers with thorough knowledge on field ornithology. For certain conditions and some species the results of aerial surveys, particularly digital aerial surveys, may provide more accurate density estimates than do boat-based survey (Henkel *et al*., 2007).

5.4.4.1 Boat-survey

Standardised survey methods for census of seabirds from ships have been described in Tasker *et al*. (1984), and updated in Webb and Durinck (1992), Camphuysen *et al*. (2004) and Maclean *et al.* (2009). Originally these were carried out with a 300m recording band on one side of the boat, used subsequently to calculate bird density, and a scan ahead of the boat to pick up easily disturbed birds, such as divers and seaduck, and to watch for rarer birds. Counts are carried out over short periods, usually one, five or ten minutes.

The ship onboard sensory equipment allows to record additional data, such as water depth, temperature, salinity, that can be used in the ecological interpretation of the census.

Fishing boats should not be used for boat surveys since seabirds can be attracted altering density estimates. Furthermore, obvious ship attraction or ship following, in any type of ship/boat, should not be considered in the counts to avoid an overestimation of densities. To detail information about suitable survey boats characteristics see Camphuysen *et al*. (2004).

5.4.4.2 Aerial survey

Aerial surveys allow a rapid, near-simultaneous coverage of large areas in order to provide a snapshot of distribution and density of birds. If simultaneously, these aerial surveys are complemented with video recording since permits rapid coverage of large areas, data reanalysis and provide an auditable record. Although some species identification remains problematic, digital aerial surveys are being designed to permit statistical analysis sometimes particular behavioural observations may be limited too.

5.4.5 Avian acoustic monitoring

The use microphones in the vicinity of turbines can be useful in two ways: (1) it is possible identify calls from bird species (at least those that call in flight) and (2) monitor the sound of birds colliding with e.g. wind turbines as a means of measuring collision rate. In large turbines the signal from avian collisions cannot be separated from background mechanical sounds. However, it can complement data collected with other techniques like radars or TADS (Desholm *et al*., 2006).

5.4.6 Laser range finder

A laser range finder can be used to measure the distance and vertical angle to an object and thus can be used to estimate the altitude of birds. Results can be displayed on a screen or recorded in a database. Due to the short distances of range finder operation and the small size of the target it is often difficult to "fix" on a bird when it is flying and the amount of data collected can be low.

Like other methods this one had disadvantages too: it can only be used during the daylight period and have poor spatial resolution. Nevertheless, it can be a good alternative to radar measurements of flight trajectories at short distances from the observer and during daylight periods (Desholm *et al*., 2006).

5.4.7 Ceilometers

Ceilometer surveys involve direct visual observation of night-migrating birds using a high-powered light beam directed upward from a study site. Birds will appear as white streaks as they pass through the beam and must be viewed through a spotting scope or binoculars. With this technique, birds can be detected and counted up to a distance of up to 400 m from the observer.

The main inconvenient of this technique is that the human presence on the offshore platform is needed during night periods. This is a serious limitation on grounds of health and safety, especially in some member states, requiring dedicated research platforms or other structures designed to provide refuge among others (e.g. oil and gas platforms).

5.4.8 Moonwatching

Moonwatching is a technique similar to the ceilometers where the light beam is exchanged by the full or nearly full moon (Liechti *et al*. 1995). This technique follows the procedures used in ceilometer surveys.

For a better identification of an appropriate remote technique it is recommended to follow the “Best practice guidance for remote ornithological monitoring techniques” of Walls *et al*. (2009). It is important to retain that remote techniques should be used as a complement of visual observations.

5.5 Stakeholders involvement and public awareness

During implementation of wind farms and ocean energy (tidal and wave) projects many stakeholders should be offered the opportunity to participate in the decision-making process. A stakeholder can be any person, group, or organization that has a stake in the development (in the case of marine renewable this could include statutory agencies, fisherman, tourists or tourist operators, conservation organisations and shipping). Stakeholders involvement and engagement during project implementation is important and should accompany the project design, site selection, pre-construction monitoring/impact assessment, construction, operation and any decommissioning phases (Witt *et al*., 2012). This is achieved through public participation and consultation.

5.5.1 Stakeholders identification

Stakeholders are usually split into three main groups:

- Statutory consultees: usually public entities with which developers are ‘required’ to consult; they include Government agencies and local authorities. While developers will need to ensure they follow the correct statutory processes for these organizations, they can also be included in non-statutory consultation.

- Strategic stakeholders (non-statutory consultees): people who represent organizations, whether at a national, regional or local level whose support of or opposition to a development would be significant, or who have particular information or expertise to offer;

- Community stakeholders: includes individuals or organizations that live in the community and could be directly affected by the development, interested individuals, representatives of residents associations, clubs, church groups etc;

During the identification of stakeholders it is better to involve too many than to miss out some who are crucial. In some situations it is important to consider that stakeholders can be fitted into more than one category.

The following questions can help identifying stakeholders (BWEA, 2002):

- Who will be affected, positively or negatively, by the development?
- Who supports or opposes the changes the development will bring?

- Who holds official positions in the area likely to be affected by the development?
- Who is influential in the local community?
- Who runs local organisations with economic, environmental or social interests?
- Who has been involved in any similar issues in the past?
- Who may not be affected by any immediate development, but may be if there are other similar developments in the area?

Table 3 shows some of the most common stakeholders.

Table 3 - Identification of stakeholders (note this is not an exhaustive list of stakeholders).

Statutory consultees	Strategic stakeholders	Community stakeholders
Governmental organizations; Maritime Coastguard Agency; Local Authorities	Non Governmental Organizations on nature conservation and protection Universities Research centres Energy utilities Local companies sharing the same marine space	Educational interests Local companies Sailing clubs Recreational groups

5.5.2 Public participation

The definition of Public Participation in the International Association for Public Participation is as follows: "Public participation is the process by which an organization consults with interested or affected individuals, organizations, and government entities before making a decision. Public participation is two-way communication and collaborative problem solving with the goal of achieving better and more acceptable decisions. Public participation prevents or minimizes disputes by creating a process for resolving issues before they become polarized. Other terms sometimes used are "public involvement," "community involvement," or "stakeholder involvement"

Public participation is safeguarded in European Community by the Aarhus Convention that entered into force on 30th October, 2001. Member States "shall guarantee the rights of access to information, public participation in decision-making and access to justice in environmental matters" (The Aarhus Convention, 1998). Although ORED are not listed in this Convention shall be provision of this Convention to apply it whenever a project may have a significant effect on the environment.

Public participation shall be planned. Firstly it is necessary to identify the stakeholders that would potentially be involved in the process particularly in the various stages of the Environmental Impact Assessment. We will consider that "public" is any person, or group of people, that has a distinctive interest or stake in offshore renewable energy projects.

For a better management it is useful to split the public according to their goals, ideals and values. Therefore, it will be possible to ensure that no group of persons is excluded from participating and also to select the most appropriate technique for each one. This categorization in groups could be done with different schemes, such as their activities, their proximity to the project and democratic societal decision making (see Canter, 1996). Anyone who expresses an interest in any way should be placed on a mailing list and kept continually informed of the EIA progress.

Nevertheless, public participation has advantages and disadvantages. On one hand, it may encourage the exchange of information, a source of information on local values and trust enhancement between stakeholders. On the other hand, the tendency is each group to defend their interests. Therefore, the potential for confusion of the issues can increase when the involvement of stakeholders is not well planned. Even so, stakeholder engagement should be associated with all stages of an EIA for major undertakings (projects, plans, programs, or policies).

During scoping, public-participation is essential to inform the public about the project and to determine what specific groups feel about the need of being addressed. It is also important that they could follow the project impacts evaluation. In some situations, comments from the public can be useful in establishing project-specific criteria or maximum tolerable levels of change.

During the prediction and mitigation phases, one of the major inputs is ensuring that mitigation measures are acceptable. During the comparison of alternatives local values could be used to weight the importance of environmental factors.

Notice that a good public participation programme is achieved through the delineation of objectives for EIA different steps. This will allow choosing the best public participation technique for each group as well as for achieving particular objectives and to develop a practical plan for implementing public participation (Canter, 1996).

According to the group an involvement technique for communicating could be better than others. Some examples of the most frequently used communicating techniques are public meetings, informational brochures, advisory committees, media content analysis, public speeches and newsletters. Table 4 summarizes some examples of the effectiveness of several techniques that can be used with different groups.

Planning for public participation should address the following elements (Canter, 1996):

- Delineation of objectives of public participation during the pertinent EIA stages;
- Identification of publics anticipated to be involved in pertinent EIA stages;
- Selection of public participation techniques which are most appropriate for meeting the objectives and communicating with the public. It may be necessary to delineate techniques for conflict management and resolution.
- Development of a practical plan for implementing the public participation program.

Table 4 - Effectiveness of different communication techniques on various "publics" (adapted from Canter, 1996).

	Communication techniques		
Public	**High**	**Medium**	**Low**
Individual citizens	Radio and TV programs and news Newspaper articles	Public hearings and meetings Motion picture, film Slide-tape presentation	Printed brochures Magazine articles Direct mail and newsletters Telelecture
Conservation-Environment groups	Magazine articles Direct mail and newsletters Motion picture, film Slide-tape presentation	Public hearings and meetings Printed brochures Radio and TV programs and news Newspaper articles	
Business-industrial	Direct mail and newsletters	Radio and TV programs and news Newspaper and magazine articles Motion picture, film Slide-tape presentation	Telelecture
Professional groups and Organizations	Direct mail and newsletters	Radio and TV programs and news Newspaper and magazine articles Motion picture, film Slide-tape presentation.	Printed brochures Public hearings and meetings Telelecture
Educational Institutions	Direct mail and newsletters	Public hearings and meetings Newspaper and magazine articles Motion picture, film Slide-tape presentation Telelecture	Printed brochures Radio and TV programs and news
Governmental organizations	Public hearings and meetings Direct mail and newsletters	Printed brochures Motion picture, film Slide-tape presentation Telelecture.	Radio and TV programs and news Newspaper and magazine articles

During the EIA process conflicts can occur due to numerous possible causes which can arise over particular situations. Four types of conflicts can be delineated (Creigthon, 1981 *in* Canter, 1996):

- Cognitive conflict: when people have different understandings or judgments as to the facts of a case;
- Values conflict: is a dispute over goals;
- Interest conflict: due to the unequal distribution of costs and benefits.
- Relationship conflict: when, for example, a decision-making process favour groups which are well enough financed and organized to present scientific supporting data over those which primarily argue from a values base.

Such as existing communication techniques conflict management techniques exist too. Whenever a conflict occurs face-to-face meetings should be promoted so that parties share information. During the meeting it is important that a neutral person highlights interests of the parties rather than the positions that parties have since the final objective is to achieve a mutually acceptable solution.

However, some requisites are needed to use these techniques. All parties involved should be motivated to solve the conflict; no one should think that has the political or legal power to "win" outright; accept a minimal risk of failure; a conciliator must usually speak for an organization that possesses authority and credibility; negotiable issues should be identified and is also necessary a experienced conciliator to maintain the control over the communication process.

5.5.3 Consultation methods and procedures

Consultation is an integral part of the EIA process and it is a key part to engage stakeholders and public on the decision-making process; it provides a mechanism for interested parties to express their opinions and share information about the project.

Good practices usually involve early consultation with statutory consultees and other stakeholders. When a good consultation process is carried out and all stakeholders are engaged the probability to accept solutions will be greater than if the decisions are imposed without any consultation reducing the risk of potential conflicts.

The extension of the consultation process varies according to the situation and required stakeholders. Despite the consultation process being specific to each situation a general process can be carried out as follows (see also Figure 11):

- Identify the stakeholders and the issues that are important to each one. Consultation should begin as soon as possible and, whenever possible, should take place during project site selection or during the scoping step of the EIA process. It should be bear in mind that stakeholders' list is never closed.
- When stakeholders are identified the consultation process is designed (agreeing objectives and outputs, select techniques, key events, etc.).
- Information about the project, characteristics and potential impacts should be sent to all stakeholders so they can give their opinion. It is a best practice to produce a consultation process report. This will allow checking how stakeholders were engaged in the process, if the stated objectives have been achieved and if stakeholders feel that the consultation has been conducted in a way that has enabled them to contribute fully and freely to the process.
- The consultation process should continue during the entire lifetime of the project. So that if any new concerns or opportunities arise a forum exists in which they can be discussed.

A wide range of techniques can be used in the consultation process. Some of them can include the local, regional or national media, individual or group meetings, academic events, public exhibitions, liaison groups, workshops, written communication and the internet which allows a real time exchange of information. If methodologies are adapted to stakeholders and to the steps of consultation process, this can be more inclusive and all can be treated equally. The choice of a technique depends on each situation. For further reading on this subject the report produced by BWEA (2002) as well as the study conducted by Westholm (2008) are recommended.

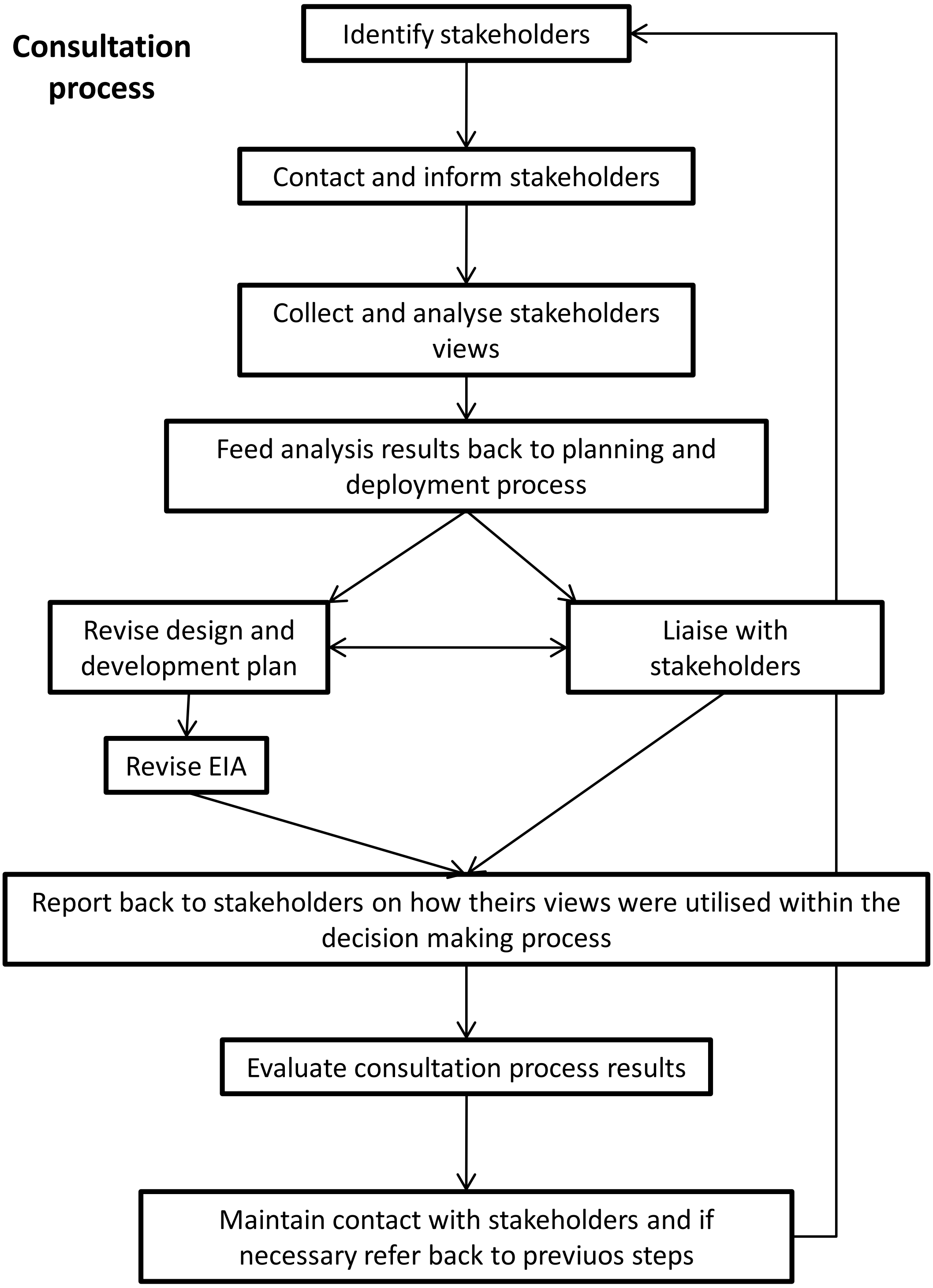


Figure 11- Consultation process (adapted from EquiMar, 2011a).

6 CONCLUSIONS

Birds play a key role in ecosystems and as a research topic provide opportunity for establishing our understanding and interpretation of changes in the marine environment . Furthermore, they have a connection with people and their lives. The protection of bird fauna biodiversity is widely recognised and a number of International Conventions, European Directives have been signed and adopted.

The need and interest on offshore renewable energy implementation, including wind, wave and tidal energies, is increasing and places with the greatest potential to develop wave energy, in Europe, are located in the western coast (Atlantic region area).

So far wind resource is the most exploited so mostly available information about potential impacts is related to it. Potential impacts from offshore renewable energy projects on seabirds include species and habitat disturbance (avoidance; barrier effect), habitat modification and collision risk. The risk of entrapment is also a potential impact from wave energy devices.

However, OREDs can also have positive impacts acting as artificial reefs or resting areas (particularly in the case of wave energy devices). Furthermore, due to the implementation of marine renewable energy parks, the pressure of other activities (such as fishing and maritime traffic) are reduced in the area and thus, if mitigation measures are efficient, marine renewable energy parks can play a role as refuges, feeding and resting areas.

Whenever possible, OREDs should not be installed in sensitive areas. However, when it occurs, developers should adopt suitable mitigation measures that reduce to a minimum the impacts of installed devices.

Stakeholders' involvement during all project phases (before, during and after installation) is considered a best practice and should be implemented as a matter of project social acceptability, sustainability and responsibility. This can be done using different techniques and will allow all interested parties to express their opinion and to identify issues to be considered on ORED installation.

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