

GREENING BLUE ENERGY : IDENTIFYING AND MANAGING THE BIODIVERSITY RISK AND OPPORTUNITIES OF OFFSHORE MARINE RENEWABLE ENERGY

An ecosystem approach in the energy decision making

Globally, our energy needs are increasing. 81% of these are currently addressed through the use of fossil fuels (oil, coal and gas) (Environmental Impact Assessment, 2011). Projections for the future are difficult, but it now seems inevitable that consumption will increase significantly in the coming decades. According to the CNRS, it is realistic to expect a twofold increase of the energy consumption by 2050. However, these fuels are not inexhaustible and their use is primarily responsible for, among other consequences, the climate change phenomenon, not to mention the social impact (local jobs), geopolitical (access to remote resources), economic (trade deficit), systemic risks, etc. which are not covered in this post. The IPCC believes that an increase in temperature of (simply) 2°C would jeopardize 30% of the world's species, making climate change one of the main threats to biodiversity in the decades to come. Between 1906 and 2005, an increase of the global average temperature of 0.74°C was recorded (IPCC, 2007). Its effects are already being felt, showing an impact on ecosystems (for example coral bleaching, acidification oceans, dying forest ecosystems, melting glaciers, changing ranges of some species, development of invasive alien species...). However, it is still difficult despite the different scenarios developed to estimate the intensity of the consequences on biodiversity, ecosystems and the services they provide.

Our societies, deeply dependent on imported, finite and polluting energy resources, must simultaneously meet both the challenges of climate change mitigation and conservation of biodiversity. It is therefore essential that this expected increase be addressed through the use of new energy sources. Our choices regarding future energy systems have major implications for ecosystems. The operational development of offshore wind farms has just started. Although today, they only account for 0.3% of the total electricity demand of the European Union (EU). According to the report "Oceans of Opportunity" of the European Wind Energy Association (EWEA), offshore wind could provide between 12 to 16% of the total electricity demand in the EU by 2030.



This represents more than 25,000 wind turbines in parks, covering some 20,000 square kilometers of the European continental shelf. On such a scale, the production of wind energy would prevent the emission of 200 million tonnes of CO2 per year (which corresponds to 200 million Paris-New York plane journeys or 7 million tonnes of petroleum). Many other marine energy resources could be harnessed in the next decades (waves, currents, thermal energy); these technologies are still in their infancy, but can be developed in a few years if sufficient support is given by states and industry. Taking biodiversity and the impact on ecosystems into consideration in energy decision-making is key to achieve a truly green economy.

Let's create another energy model (local, renewable, efficient, equitable...). For example, 500 offshore wind of about 6 MW deliver 8.7 TWh by year, using only 5 km² of sea surface, spread over 500 km².

Synergies and interactions with other users of the sea

We should not solely consider the impact of offshore parks but also take into account other users of the marine environment. Based on pertinent consultations made through a process of strategic environmental assessment, it is possible to identify potential threats and better manage opportunities, for example with fisheries, aquaculture, diving and leisure, tourism, etc.

The cumulative impact should be assessed on two levels :
 → the combined impact of an energy project with the existing anthropogenic pressures such as pollution, fishing, maritime traffic or extraction of sand or gravel.
 → consequences of the co-existence of several marine energy parks in an area or region in terms of barriers to migration and loss or fragmentation of habitat.
 Offshore parks mobilize vast marine areas where their combined effects may be more pronounced than the total impact of each system and each park. So we have to develop and standardize criteria and methods for assessing cumulative effects on appropriate space-time scales.

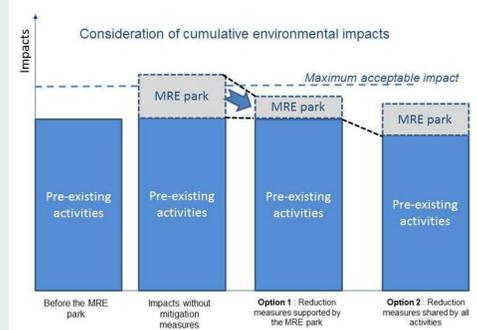
The MRE projects come in addition to pre-existing disturbances. It depends on the technique used, for example fishing gear can have an important effect. It is therefore important to remember that MRE project alone are not the sole source of the problems suffered by marine and coastal environments.

Logically, this may lead to the consideration of the impact on other activities in order to evenly distribute the burden of reduction on all maritime activities, taking into account the environmental effects and benefits. Environmental and socio-economic impact should be assessed in its entirety according to the project's area of influence, and not solely for the project so as to be able to develop an overview of the cumulative impact. MRE projects often involve extensive maritime zones, and become structuring elements of the area.

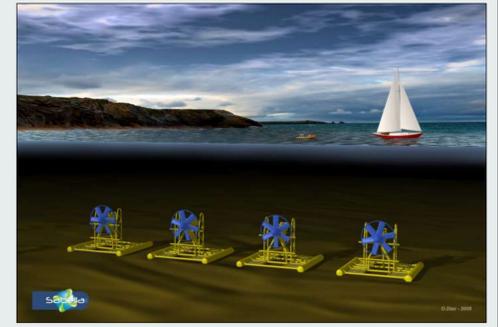
It might be relevant in terms of environmental and economic benefits to maintain the cumulative impact to an acceptable level by imposing limitations to existing other maritime activities rather than on MRE parks.

The figures below illustrate this approach : if the initial park project leads to exceed acceptable limits in environmental terms, two approaches are possible :

→ either focus on the reduction of the impact of the last activity (MRE), with the risk of substantially increasing production costs,

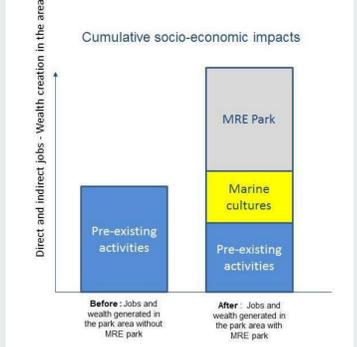


For the same result in terms of environment, this type of strategy can maximize socio-economic benefits. The figure below illustrates the potential impact in terms of employment and wealth generated in the area before and after implantation of a wind farm (allowing the development of a new offshore aquaculture activity). Such an approach of the cumulative impact requires that all maritime activities implement SEA and EIA, which is now required only for newcomers.



Beyond reduction of the impact by new activities (which should be as low as reasonably possible), it is important to address the issue of the cumulative impact and synergies
 Source : Sabella SAS

→ or distribute the efforts on all activities impacting the environment (with limitation of certain fishing techniques, or the movement of merchant ships in the area, or attendance by pleasure craft...).



Managing the impact of energy sources on biodiversity and ecosystems

Quantifying ecosystems and biodiversity in energy systems

As all energy systems impact on ecosystems and biodiversity, trade-offs are necessary. Renewable energy is sourced from nature, but these "nature-based solutions" can impact negatively on ecosystems and biodiversity. Of course, when considering the impact of marine renewable energy, it is important to consider the global context. MRE can prevent a substantial amount of greenhouse gas emissions and can help fighting climate change, but these potential benefits must be weighed against the potential negative effects on marine life on a local and on a larger scale.

This study draws some general conclusions on the impact of different sectors, and provides some useful guidelines for the development of different MRE sectors, in terms of effects on biodiversity. Indeed, all MRE projects do not produce the same impact. At this stage of the evaluation, specifically from the point of view of biodiversity issues, it seems essential to support :



Source : floating wind turbine HYWIND (STATOIL) en 2010

→ the development of floating wind turbines, minimizing the deterioration of the seabed and mobilizing remote offshore space, therefore minimizing use conflicts;
 → the development of the large scale exploitation of ocean currents and wave energy in offshore areas, reducing the potential damages to coastal environments.

During construction but also throughout their lives, coastal tidal power plants cause major disturbances on coastal and estuarine ecosystems of great value in terms of biodiversity. In comparison, even developed on a large-scale, floating wind or wave energy would probably have a lower impact on biodiversity. These technologies are indeed not the most advanced, and several years will be needed before developing them into French waters.

Of course, these results should cautiously be taken into consideration, and confirmed by SEA (strategic environmental assessment). Beyond strategic considerations, the level of the impact is very much project-dependent, and must be addressed through project EIA. In addition, knowledge is still limited and some technologies are not well-developed, which may distort the evaluation of their effects.

Only biodiversity has been taken into account ; but IUCN French Committee is well aware that assets other than biodiversity (such as maturity of the sector, potential energy production and costs in the short and long-term...) should be taken into account in political decisions, including the need to first promote established solutions on the short term, in order to create a dynamic industrial and energy sector.

Manage the impact throughout the life of the project

It seems essential to match the type of funds according to the impact. They will be very different depending on whether you are : on a muddy sandy fund or on a rocky reef type.

We emphasize in particular the role and interest of macroalgae, especially kelp : help forests are described as one of the most dynamic habitats and the highest biodiversity on the planet.

It is essential to identify and minimize all negative effects on the marine environment. It is also essential to ensure that MRE parks are locally well accepted.

The potential impact of the development of marine renewable energies on the marine environment include : piling noise/construction activities; habitat loss for marine and air species; migration barriers for birds, sea turtles and whales; bird collisions; seabed changes; navigational hazards/oil spills... This also includes disruptive noise, electromagnetic fields, or changes in hydrodynamic conditions and water quality.

However, various mitigation measures can be implemented during the construction, operations, maintenance or the dismantling phases, to reduce the risks to local biodiversity, such as changing the timing, avoiding sensitive sites, intelligent designing using the means to disperse temporarily affected species, and proposing compensation for any residual impact.



For example, kelp forests -which play an irreplaceable role in the sequestration of CO2 and represent a wealth of exceptional biodiversity- are habitats which may be endangered by some of MRE projects
 Source : D.Blin, Agence Française des Aires Marines Protégées

The effects on a rocky area may be important during the installation: it depends on the type of foundation chosen, which also depends on the type of soil. But, of course, digging foundations excavations of 8m in diameter and 20-30 m deep, and trenches about a hundred miles-long to bury cables, will have more damages on rocky ground than on sandy-muddy soil. This may lead to destruction of habitats, turbidity (reduced photosynthesis), clogging and choking sites.



Remarkable habitats may be replaced by opportunistic species (for example: mussels, brittle stars, Halydris siliquosa and other Cystoseiracées), or, like here : Japanese sargasso weed
 Source : <http://www.mer-littoral.org/>

On the contrary, if the project is well planned and coordinated, the local marine environment can benefit from these projects in various ways. Trawling is both for fish and invertebrates; one of the most serious threats to the marine environment, and is generally limited or prohibited within the parks. Moreover, foundations, including rocks that are often placed around it for protection, could play the role of artificial reefs to increase the biomass of a number of species. It is also suggested that energy devices oriented to the surface may act as fish aggregating devices (FADs). This can benefit both the local fishing and the conservation of certain species.

Residual impact

Even if the technical operator of a park really works following the mitigation hierarchy and identifies, prevents and minimizes the impact of the project, the residual impact can be important. Operators are increasingly trying to consider measures that can mitigate or compensate for these residual effects.



A wildlife will move around structures ... What will there be at the end of the operation?
 Source : <http://www.mer-littoral.org/>

Biodiversity offsets are a way to ensure that the development of the project avoids a net loss of biodiversity or to result in a net gain. But offsets must be quantifiable, and we have to anticipate probable losses in biodiversity and set them against the benefits provided in species composition, habitat structure, ecosystem functions and use of biodiversity by others.



MRE projects may represent opportunities for aquaculture because of the support that are the foundation
 Source : <http://www.mer-littoral.org/>

A solution : Raise awareness of energy actors about biodiversity issues

Existing commitments put forward a production target of 6 GW in 2020. This production capacity is about 1000 to 1200 wind turbines on the French coasts. The objectives are mainstreaming environmental issues into the overall planning through education, providing clear, relevant and accessible information for government officers and energy operators. We encourage considering biodiversity in all solutions and policies on energy and climate change.

On land and at sea, the significance of damages is directly related to the choice of the implantation zone. This objective requires a consultation on areas to not exploit : the development of MRE projects cannot be achieved in some areas due to very sensitive marine habitats, with little or no resilience : seagrass, coral, field of algae and maërl... We therefore recommend the identification of these sensitive areas, usually coastal, and to clearly prohibit the development of MRE projects inside. An efficient mapping of marine and coastal habitats and ecological issues would allow the exclusion of these particularly affluent areas prior to the diagnosis.

Strategy and governance issues

Ocean resources are limited. This is why comprehensive integrated approaches are essential to manage human activities. The large scale offshore renewable energy installations are a relatively new challenge for integrated strategies for Integrated Coastal Zone Management (ICZM) and Maritime Spatial Planning (MSP), in appropriate spatial planning instruments.

For example, the impact of construction activities on marine mammals and fish depend heavily on the availability of alternative suitable habitats. In order to minimize the cumulative effects of simultaneous development activities, it is necessary to coordinate at a central level both timing and construction zones of different operators! In addition, the coordination of conservation measures and the development of marine renewable energy politics should be facilitated by a better exchange of information between authorities.

Finally, because of the impact of the construction of offshore parks can be felt several kilometres away from the area in question, using spatial planning allows, for example, the application of security zones in order to avoid high places of biodiversity.



The operation raises other questions: maintenance, cables connection, dismantling... Any consideration of biodiversity then?
 Source : E.ON

Uncertainties, research needs and necessary improvement of the impact studies

Research effort is needed on the distribution and abundance of species on annual cycles, on the structure and status of populations, but also analytical tools for assessing ecosystems and cascading effects. It will be also necessary to study the effects of noise on different species, as well as the mechanisms and evidence underlying avoidance behavior of birds, in order to develop the need of appropriate mitigation strategies. This is also the case with regard to the impact of electromagnetic fields which act as barriers to fish migration. In addition, it should further explore the potential benefits of the closure of the fishery and the provision of artificial habitats.

Two principles should guide the MRE projects :
 • The implementation of EMR in France will participate in the acquisition of knowledge about the ecological services provided by coastal and marine ecosystems
 • The technologies best able to preserve the ecosystem services provided by coastal and marine environments should be promoted.

Guides to conduct strategic environmental assessment currently don't exist. To avoid arbitrary or lacking prudence approaches, it would be necessary to develop and harmonize protocols for assessing the impact. The assessment should also analyse cumulative effects, and synergies should be considered at an appropriate scale : plan, policy and program.

It is possible to find information, for example from the oil and gas sector, on the nature of environmental disturbances and lessons for mitigation and restoration process ; but marine parks differ from other marine engineering industry in scale, area of coverage and particular combinations of stressors. Uncertainties about the expected consequences also increase with the size of installations, both in terms of size and number. Currently, effective assessment of effects of MRE projects is not easy because of the lack of knowledge. So, if we don't adopt a cautious approach, this could endanger habitats, species and ecosystems, including those of great interest for conservation.

The number of ecological studies will increase and, with efficient and continuous monitoring, in all phases of the project life, this will generate more reliable data on the effects, positive and negative, of MRE projects. The ability to reach consensus between stakeholders on project areas, methods and measures, will be facilitated. Pending, caution is recommended when, for example, data or research results generated in temperate regions are extrapolated to other regions such as the overseas regions. Indeed, there are major differences between the regulatory factors, species and habitats under different latitudes.

The presentation in a few words...

MREs are a large potential source of renewable energy, and can contribute to make another world energy model possible. As all human activities, they can result in serious consequences on biodiversity both at local and global scale. Policy decisions should take into account cost-benefit analysis in all sectors, including marine biodiversity: the development of impacting techniques should not be allowed in fragile and/or high value areas, and decisions should support on the long term and large scale only MREs with important energy potential and low global effects on biodiversity. This is possible only through strategic environmental assessment, fully taking into account marine biodiversity. If trade-offs are needed to keep the cumulative impact under control, this should be done after (re)assessing the environmental impact of other maritime activities: in some areas, this is possible through reduction of some existing activities without reduction of the overall socio-economic benefits from maritime activities, new energy activities producing more jobs and economic benefits with less negative damages.