Positive environmental impacts of offshore wind farms

Background

The offshore wind industry has grown rapidly over the last decade. The understanding of its potential impacts on the environment, positive or negative, needs to be carefully assessed. As knowledge and experience increase with the development of the sector, the understanding of environmental impacts will improve. This research note will address the positive impacts of offshore wind farms.

Firstly and foremost, wind power has a long-term positive impact on biodiversity by reducing climate change emissions, the major threat to biodiversity (EWEA, 2009) (Wilhelmsson D. M., 2010). By 2020, EWEA forecasts that 40GW offshore wind capacity will be online in European seas, which will offset 102Mt of CO2 emissions annually. By 2030, 150GW installed capacity will offset 315Mt of CO2 annually.

More locally, provided that offshore wind development is well planned, the local marine environment can benefit from the existence of wind farms in multiple ways (Wilhelmsson D. M., 2010). For example, a severe threat to fish and invertebrates is excessive trawling. Trawling, however, is prohibited or limited inside wind farms in most EU countries. Moreover, the wind turbine foundations, including the boulders that are often placed around them for scour protection, can function as so-called artificial reefs, locally enhancing biomass for a number of species. Furthermore, foundations and moorings can serve as Fish Aggregation Devices (FAD). This is also the case for floating foundations. Finally, wind farms can create or enhance natural habitat for organisms living on the seabed, provided they do not dramatically affect the initial conditions.

Trawling exclusion and impacts on fish

Ban on fishing, especially demersal trawling\(^1\) in the wind farm area is resulting in increased local fish populations.

In 2003, monitoring at two Swedish wind farms (Yttre Stengrund and Utgrunden) indicated that ‘total fish numbers were higher on the bottom in the vicinity of wind turbines than in surrounding areas’. Around the turbine structures, the composition of the fish community was different: fish abundance was significantly higher, whilst species richness as well as diversity was lower than on the seabed. During the operational phase, offshore wind farms can therefore positively affect the quantities of a number of species as the area will resemble fishing "exclusion zone". (EWEA, 2009).

Trawling exclusion does not apply, however, in Spain or the UK.

Artificial reef effects

Wind energy foundations, including the boulders that often encircle wind turbines for scour protection, are artificial reefs that may locally enhance the biomass of a number of sessile and motile organisms. Moreover, the parts of offshore energy devices that are surface-orientated or extended out of the water, such as moorings or foundations may function as Fish Aggregating Devices for large predatory and pelagic fish (Wilhelmsson D. M., 2010).

\(^1\) Trawling close to the sea bed.
On-going monitoring programmes in Horns Rev 1 offshore wind farm show that the stock of some fish species increased. Starting before wind farm construction in 2002, scientists from the Aquatic Department of the Technical University of Denmark mapped the fish life in the area. The biologists compared those results with the situation in the area seven years later. The survey showed that the offshore project had no negative effects on the fish life and that boulder structures functioned as artificial reefs, providing good breeding conditions with a wide selection of food and shelter from currents. The boulder structures attracted fish species that usually prefer rocky soils, and as such the wind turbines provided habitats for a range of new species (DTUAqua, 2012).

Suggested explanations for the increased fish population include enhanced feeding conditions and shelter opportunities, as well as increased recruitment rates potentially provided by the wind turbine structures.

The benthic biomass increase resulting from the construction of new foundations is a positive impact of offshore wind deployment. A more recent study on Germany's first offshore wind farm, the test site Alpha Ventus, confirms this finding. First results on environmental studies undertaken under the accompanying RAVE (Research at Alpha Ventus) programme showed that the foundation structure of the nearby research platform FINO 1 has been colonised by blue mussels, plumose anemones, and even oysters over a short period of time. First ‘reef’ species such as edible and velvet crabs have been observed on the fine sands surrounding the installations. This is evidence of a changing habitat (RAVE, 2012).

A study at the Nysted (DK) offshore wind farm investigated the local food dynamics around the turbines. The turbines seem to offer blue mussels favourable growth conditions. The blue mussels increase the local diversity of associated species by providing nutrient and energy to the surrounding benthic assemblages. Field sampling suggested high numbers of crabs around the wind turbines (Maar, Bolding, & et.al., 2009).

In the North Sea, offshore oil platforms were found to attract more cod and haddock than previously thought. This effect was originally believed to be very site specific, depending on the local environment and conditions but as indicated from a 2-year research, the estimated aggregated fish around these structures were much higher than the surface area. The scientists confirmed that the reason for higher numbers of fish was that pipelines and subsea structures were acting as reefs. Therefore, wind farm installations could be designed with reefs in mind to help attract fish, if required. If a certain design attracts more fish than another and creates habitats as nursery or spawning grounds, this could potentially serve as a basis for foundation redesign (Reuters, 2011).

The increased concentrations of benthos, providing food for benthic fish coupled with trawling restrictions (discussed above) have a positive effect on fish populations, including certain commercial fish species.

**Habitat enhancement**

At Thanet (UK) offshore wind farm, marine research suggests that offshore wind farms could have a positive impact on species living beneath the waves. Certain fish species, such as cod, were found to shelter inside the farm. Moreover, the new hard substratum and the scouring protection led to the establishment of new species and new fauna. It is indicated that the wind farm acts as a new type of habitat with a higher biodiversity of benthic organisms (see above). The study speculates that there may be an increased use of the area by fish, marine mammals and certain bird species (Cox, 2011).

Other studies confirm that a number of commercial species would benefit from enhanced habitat opportunities and design measures, while at the same time highlighting the variability of effects between sites (physical and ecological conditions) and types of construction (Linley, Wilding, & et.al., 2008).

Studies at the Egmond aan Zee wind farm off the Dutch North Sea coast confirm that wind turbines provide natural habitat for organisms living on the seabed and enhance the local environment for fish and marine mammals thanks to the new hard substratum of the monopiles and the scouring protection. Fish communities are highly dynamic around the turbines structures. The research
demonstrated that the presence of the 108 MW project has little negative effect on local wildlife and may have, indeed, a positive long-term impact. As at Thanet, species, such as cod, find shelter inside the farm and more porpoises were recorded inside the farm than outside. Overall the wind farm provided ‘an oasis of calm in a busy coastal area’ and acted as a new natural habitat with more species of benthic organisms.

Wilhelmsson et al. (2010) suggest that additional safety zones could be set-up around wind to secure and enhance the benefits to the local marine environment. Wind farms could also be strategically located to protect marine organisms and natural habitats (Wilhelmsson D. M., 2010). The SEANERGY2020\(^2\) project also encourages coordinating conservation and environmental protection measures with wind farm sites through Maritime Spatial Planning (MSP).

The effects wind farms have on their surrounding environment and their ability and predisposition to attract marine flora and fauna are, however, site-, season- and species- specific. Further research in this domain is required (Lindeboom H.J., 2011).

**Synergies with aquaculture**

Ecofys is experimenting seaweed cultivation at an offshore wind farm off the Dutch island of Texel. The aim is to harvest biomass for producing fish and animal feed, biofuels and energy. Since the offshore wind farm area is closed for shipping and commercial fishing, there are favourable conditions for aquaculture and it can be used as a sort of marine conservation area. Fish are likely to be attracted to the seaweed fields and use them for shelter or as a nursery. In addition, the seaweed will provide nutrients and energy (Ecofys, 2012).

In the North Sea, joint development of offshore wind farms with open ocean aquaculture could be a solution to minimise potential spatial conflicts and explore interactions with other sea users. Systems are already being tested for extensive culture of bivalves and seaweed. Hydrodynamic and environmental conditions are essential for such projects (AWI, 2012).

**Conclusions**

Offshore wind farms have a positive impact on the marine environment in several ways. First of all, they contribute to reduce CO2 emissions, the major threat to biodiversity. Secondly, provided that offshore wind farms do not dramatically affect the initial environment conditions, they provide regeneration areas for fish and benthic populations. This can be explained not only because of reduced trawling activities but also because offshore wind farms foundations function as an artificial reef encouraging the creation of new habitats.

As a consequence, building on the positive impacts offshore wind farms have on the marine environment, it would be suitable to envisage synergies with local fisheries and species conservation initiatives. Furthermore, joint offshore wind farms development with open aquaculture fields could also help minimising spatial conflicts which could arise in the longer term.

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