Environmental impacts of wind farms - DK

1. Policy Objective & Theme

- ADAPTATION TO RISK: Preventing and managing natural hazards and technological (human-made) hazards
- SUSTAINABLE USE OF RESOURCES: Preserving coastal environment (its functioning and integrity) to share space
- SUSTAINABLE ECONOMIC GROWTH: Balancing economic, social, cultural development whilst enhancing environment

2. Key Approaches

- Knowledge-based

3. Experiences that can be exchanged

Appropriate siting of offshore wind farms is an essential pre-condition for ensuring limited impact on nature and the environment and careful spatial planning is necessary to avoid damaging cumulative impacts. If placed correctly, offshore wind farms can be engineered and operated without significant damage to the marine environment and vulnerable species.

4. Overview of the case

The Danish energy and environment governmental agencies have completed an eight-year study on the impacts of offshore wind farms, at Horns Rev in the North sea and Nysted in the Baltic sea, on the aquatic ecosystem including bottom fauna and flora, fish, birds, and mammals. During 2009 a new programme has been initiated, as a follow up to previous one. Also for the two new large scale wind farms Horns Reef II and Rødsand II specific environmental monitoring programmes are being carried out.

5. Context and Objectives

a) Context

During the summer of 2002, the Horns Rev offshore wind farm was built 14–20 km off the coast in the North Sea. It has 80 turbines totalling 160 MW, equivalent to the electricity consumption in just over 150,000 Danish households. The Nysted Offshore Wind Farm was constructed in the Baltic Sea during 2002–03 and consists of 72 wind turbines placed in 8 rows of 9 turbines each, approx 10 km off shore with a total installed capacity of 165.5 MW. Each farm covers an area of ca. 24km2. These two wind farms have been the subject of an eight year study (1999-2006) looking at their impacts on bottom-dwelling flora and fauna, fish, birds and marine mammals. During construction, environmental management systems were established for both wind farms, including procedures for the handling of waste, noise and contingency plans in case of environmental accidents like oil spills. In connection with short-term noisy activities, actions had to be taken to ward off marine mammals likely to be affected by the noise. All transport to, and from, the wind farms had to take place in a special transportation corridor and access to nature protection areas was forbidden without prior approval.

Traditionally, the native fauna composition of Horns Rev has been associated with the sandy environment with a very variable and heterogeneous benthic fauna. The benthic fauna of Nysted is very homogeneous and the species found are typical of brackish water. It is estimated that ca.106 saltwater and brackish water fish species can be found in the Danish waters including commercial species such as cod, herring, plaice and flounder. Danish waters are of essential international significance as a winter refuge for several species of marine birds. Only three species of breeding marine mammals are found viz. harbour and grey seals and the harbour porpoise. Various large whales, such as the sperm whale and killer whale, are regularly observed in Danish waters. 13,000 km2 have been designated as SACs and SPAs in Danish waters and contribute

to the NATURA 2000 European ecological network.

b) Objectives

The monitoring programme was set up to chart the environmental conditions before, during and after the two wind farms were set up. The aim was to clarify the impacts of the technology in these specific areas and to try and draw general indicative conclusions that could apply to other areas.

6. Implementation of the ICZM Approach (i.e. management, tools, resources)

a) Management

The research was co-ordinated by the Danish Forest and Nature Agency, the Danish Energy Agency, and Vattenfall and DONG Energy, the companies that own the two wind farms. The World Wide Fund for Nature, the Danish Society of Conservation of Nature, the Danish Outdoor Council, Greenpeace, the Danish Ornithological Society and the Danish Organization for Renewable Energy were consulted annually and the results of the study were assessed by the International Advisory Panel of Experts on Marine Ecology (IAPEME).

b) ICZM tools

The studies and analyses consisted of three years of baseline monitoring, monitoring during construction and three years of monitoring during operation. Benthic community surveys included collection of species, photo-sampling and video. The spatial and temporal distribution of fish was monitored by use of hydro-acoustic equipment recordings. Birds were monitored by radar, infra-red video monitoring and visual observations. Because of limited experience studying the effects of offshore constructions on marine mammals, new methods had to be developed. The traditional visual surveys from ship and aircraft were thus supplemented, or in some cases replaced, by other methods, including acoustic monitoring by stationary data-loggers, remotely controlled video monitoring and tagging of animals with satellite transmitters. New statistical methods, including spatial modelling of survey data were also developed.

Bottom dwellers: The main effect of wind farms was the introduction of hard bottom structures onto sea-beds that had almost exclusively consisted of sandy sediments. This has increased habitat heterogeneity but changed the benthic communities. Overall abundance and biomass has increased by 50 to 150 times, most of which is available as food for fish and seabirds. Common mussels were found locally at Nysted are now in large numbers, up to 1,500/m2, constituting more than 35% of the total biomass. However, there were only negligible or no impacts detected on the seabed communities from the changes in the hydro-dynamic regimes.

Fish: the studies found few effects on fish, neither abundance nor diversity were higher inside the wind farms than in the areas outside the wind farms. Investigations into the effects on fish and fish behaviour from electro-magnetic fields were made at Nysted. Depending upon the species, some effects from the cable route indicated either an avoidance or attraction of the cable. As a part of the new monitoring programme, a follow up study on fish communities was carried out. Preliminary findings shows an increase in the diversity of species in the Horns reef park where the change in bottom habitat is of importance. The project will be finally reported in 2010.

Birds: Water bird collisions were rare events as many species tend to avoid the wind farm, changing flight direction some kilometers away to deflect their path around the site. Birds flying through the wind farm tend to alter altitude to avoid the risk of collision. Under adverse weather conditions, which were thought to be likely to increase collision risk, results showed that water birds tended to avoid flying altogether. At both sites, many birds entering the wind farms re-orientated to fly down between turbine rows, frequently equi-distant between them. Responses were highly species specific. Some species were almost never witnessed flying between turbines despite their abundance outside (e.g. divers and gannets), others rarely did so (e.g. scoters) or generally avoided flying far into the wind farm (e.g. terns), whilst others (e.g. cormorant and gulls) showed no sign of avoidance at all. Neither of the wind farms lies close enough to nesting areas to affect reproduction. Post-construction studies from the general environmental monitoring programme showed almost complete absence of divers and scoters within the Horns Rev site and significant reductions in long-tailed duck densities within the Nysted site. Other species showed no significant change or occurred in too few numbers to permit statistical analysis. Newer studies on the changes in bird habitat utilisation around Horns Reef I from 2007 concluded that Common Scoter may indeed still occur in high densities between

newly constructed wind turbines at sea but this may only occur a number of years after initial construction. An interesting finding was also that it could not be excluded that the explanation for the change reflects changes in food supply rather than a change in the behaviour of the birds themselves. With the new follow up environmental monitoring programme, new studies on divers, common scoter and long tailed ducks have been initiated.

Mammals: There is no simple conclusion but in general studies showed smaller effects on seals than on porpoises and smaller effects at Horns Rev than at Nysted. Both wind farm areas were found to be part of much larger foraging areas used by seals and no general change in behaviour at sea or on land could be linked to the construction or operation of the wind farms. There was a reduction in the number of seals on land during pile driving operations at Nysted. There was only a slight decrease in porpoises at Horns Rev during construction and no effect during the operation of the wind farm. A clear decrease in the abundance of porpoises was found at Nysted during construction, up to 15 km away, and operation although there are signs of a slow recovery. In general, there are fewer porpoises in the area than at Horns Reef and although the reason for this unexpectedly slower recovery is still unknown, a possible explanation could be that the wind farm area is of less importance to the population. A newer study from 2007 carried out for the German Federal Ministry for the Environment concludes that the harbour porpoises at Nysted are equally abundant within, and outside, the wind farm and also equally abundant whether the park was in operation or shut down. Another interesting finding for consideration of similar studies was that the results were very different depending on where the data-collectors were placed in the park – hence that the porpoises activity in the park is very heterogeneously distributed. Three new studies on harbour porpoises have been initiated under the Follow Up Environmental Monitoring program.

Although these results are site-specific, the general conclusion from the environmental monitoring programme is that it will be possible to construct off shore wind power facilities in many areas in an environmentally sustainable manner. As a result of the work, a committee on future offshore wind farms is currently updating the Danish action plan from 1997.

7. Cost and resources

The work of the General Environmental Monitoring programme was financed by electricity consumers via the ordinary public service obligation with a budget of DKK 84 million (approx EUR 11 million).

The new Follow Up Environmental Monitoring Program has a budget of 8 DKK million.

8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)

Of 235,000 common eiders passing Nysted each autumn, predicted modelled collision rates were 0.02% (45 birds). The low figure was confirmed by the fact that no collisions were observed by infra-red monitoring. Although bird displacement represents effective habitat loss, it is important to assess this loss in terms of the proportion of potential habitat affected relative to the areas which remain available outside the wind farms. For most of the species studied, that proportion is relatively small and therefore was considered of little biological consequence.

9. Success and Fail factors

The Danish research has developed valuable knowledge and new tools for study of marine mammals, birds and fish in relation to marine wind farms and has provided insights into the flexibility of water bird behavioural responses to the hazard of turbines. The increased knowledge level with regard to several environmental issues has contributed to reduce risk for project developers in Denmark.

Denmark has, until the end of 2009, the chairmanship in the group of signatories of the Joint Declaration on Cooperation in the Field of Research on Offshore Wind Energy Deployment. The focus of the work under the declaration has so far primarily been on common projects and knowledge sharing within the field of environmental issues.

10. Unforeseen outcomes

The cumulative impacts of many wind farms in the same area may constitute a more significant effect in the future although collision rates are likely to be less of a problem than often suggested. However, habitat loss may potentially be a greater

issue if numerous sites are developed along an avian flyway or key winter range. The exclusion of trawling activities might be beneficial to the benthic communities by increasing prey species populations and reducing disturbance by fishing gear. This would enable the species to mature to their natural sizes and allow very sensitive and long-lived species to establish populations. Constraints on fishing efficiency in areas between two or more wind farms might further be beneficial and contribute to a cumulative impact on the benthic communities. It is evident that ecological changes will probably take many more years to reach equilibrium. Birds, in particular, may respond to these changes e.g. the wind farm may become more attractive if food stocks increase.

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13. Sources

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