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LOGISTIC BASE FOR WIND FARM BUILD AT SEA

In Poland wind electric turbines farm building on the sea is planned. It will be probably located on Lawica Slupska. Clean electric energy producing created lots of problems for marine environment and maritime users. In the paper some of logistics problems created by wind farm during building, exploitation and removal will be focused.

PODSTAWY LOGISTYCZNE BUDOWY FARM WIATROWYCH NA MORZU

W Polsce planowana jest budowa farmy elektrowni wiatrowych na morzu. Będzie ona prawdopodobnie zlokalizowana na Ławicy Słupskiej. Produkcja czystej energii elektrycznej stwarza wiele problemów dla środowiska morskiego i użytkowników morza. W referacie zostaną wskazane niektóre z problemów logistycznych stwarzanych przez farmę elektrowni wiatrowych w czasie budowy, eksploatacji i likwidacji.

1. INTRODUCTION

In March 2007 the European Council backed Commission proposals on energy and climate change, agreeing on an action plan to further develop energy policy by 2009. Key aspects of the agreement include a binding target to reduce EU emissions by 20% by 2020. For renewable energies a binding target is set to achieve 20% of the EU's overall energy consumption from renewable sources by 2020.

In this context, the use of energy from renewable resources plays an important role. Wind energy can contribute considerably to the national and international goals of CO_2 reduction and seems indispensable in this respect due to its potential to avoid substantial amounts of CO_2 emissions every year. As a consequence, the use of wind energy is expanding within the OSPAR Region, including making use of offshore wind energy potential. [1]

Whilst the associated reduction in CO_2 emissions from the use of wind turbines should be welcomed, the identification of suitable locations and the utilisation of suitable

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construction, operation, maintenance and removal techniques to ensure that adverse impacts to the marine environment are minimised, plays an important role for its expansion. The OSPAR Background Document on Problems and Benefits Associated with the Development of Offshore Wind Farms (OSPAR 2004) identifies some of the potential advantages and disadvantages of offshore wind farms. The OSPAR Review of the Current State of Knowledge on the Environmental Impacts of the Location, Operation and Removal/Disposal of Offshore Wind-Farms (OSPAR 2006) seeks to clarify between where information and understanding is good and where it is lacking. These two documents should be read alongside this guidance to assist in the determination of what does and does not constitute an environmental impact within the specific parameters of the potential sites under investigation.

Above mentionace question are very important and should be taken into account in the project phase of shore based radar control systems.Described analysis have been conducted in the scope of research work financed by the Polish Ministry of Science and Higher Education as developmental project No R00 0026 06pn realised in 2008-2010 years.

2. THE WIND TURBINES

Usually the turbines are the following parameters:

- The direction of rotation is clockwise seen from the windward side;
- The hub height is between 60 and 70 m;
- The rotor diameter (3 wings) is between 66 and 70m;
- All turbines must have the same color;
- The maximum height to the tip of the upper blade will be 110m; and
- The turbine has an electrical power output between 1.8 MW and 5.0 MW.

The foundation is a steel pipe which will be driven into the seabed up to 25 m.

The following risks to shipping were identified to be directly created by the proposed wind farm development:

- Passing powered ship collision with wind farm
- Drifting ship collision with wind farm,

and were identified to be potentially affected by the proposed wind farm:

- Ship to ship collision
- Grounding
- Foundering
- Fire/Explosion.

Additional Maritime Routeing Safety Measures to establish in association with wind farm are to be consistent with international standards contained in SOLAS Chaper V, IMO Resolution A.572(14) and Resolution A.671(16)

A – Lower risk wind farms

All of the structures situated in areas with less than 3 meters of water below chart datum away from all shipping routes, channels, recognized fairways and significant levels of other maritime activity including recreational craft and fishing vessels.

Associations Routeing Measures:

Dissemination and promulgation of information through radio-warnings and notices to mariners, including details of the nature of activities that should not be carried out within a specified range of the structures and any adverse effects upon navigational systems.

B – Medium risk wind farms

All of the structures situated in areas with less than 7 meters of water below chart datum away from all shipping routes, channels, recognized fairways, but may be associated with other maritime activity including recreational craft and fishing vessels.

Associations Routeing Measures:

Dissemination and promulgation of information through radio-warnings and notices to mariners.

Safety zones up to 50 meters from structures with monitoring by radar and a continuous watch by multi-channel VHF including DSC. Appropriate measures to notify and provide evidence of infringements of safety zones.

C – Higher risk wind farms

Structures situated in areas with more than 7 meters of water below chart datum close to or across shipping routes, channels, recognized fairways.

Associations Routeing Measures:

Dissemination and promulgation of information through radio-warnings and notices to mariners.

Safety zones up to 50 meters from structures with monitoring by radar, AIS transponders at the extremities and a continuous watch by multi-channel VHF including DSC. Use of a guardship or guardships to provide a visible indication of the limits of a safety zones, to alert other mariners when they may be running into danger and to share in the task of monitoring the safety of the wind farm.

Area to be avoided (ATBA) around the whole of the wind farm and up to 500 meters from the extremities preventing access to a range of craft (e.g. vessels of over 300 GT, of over 25 meters in registered length or carrying dangerous or polluting goods) and marine activities.

Continuous vessel monitoring service using radar or AIS and radar by appropriately training staff is necessary.[7]

2.1 Influence on shipping

During experiments and varied sample of commercial shipping, VTS (Vessel Traffic Services), small pleasures and commercial craft passing with contacts or close by the wind farm, it was seen that:

- The phenomena detected on marine radar displays in the vicinity of a wind farm can be produced by other strong echoes close to the observing ship, although not necessarily to the same extent. Trained mariners will recognize and understand the causes of these effects;
- Reflectors and distortions by ship structures and fittings created many of the effects observed leading us to conclude that the strong returns from the wind farm was highlighting some vulnerabilities in ship' radar scanner installations;
- The spurious echoes were frequently generated by ship's structures and fittings combined with the reflecting qualities of the turbines;

- In the circumstance in which these trials were conducted, navigators were able to effectively track other vessels from both within and behind the area of the wind farm;
- Selected small craft operating in and near the wind farm were detectable by radar on ships operating near the array. The return signals appeared to be relatively unaffected by passing through the array although normal or automatic gain level could eclipse very small targets;
- Echoes of small craft within the wind farm can merge with strong echoes generated by the turbines when the craft passing close to the towers making them invisible to radar observers or automatic plotting facilities;
- VTS static radars can be subject to similar phenomena as above if passing vessels provide a suitable reflecting surface; and
- AIS equipped vessels did not suffer loss of signal at any point outside or within the wind farm.

2.2 Influence on environmental

The Environmental Impact Assessment (EIA) is essentially a predictive tool involving the systematic assessment of a project's likely significant environmental effects. The purpose of the EIA process is to ensure that all the likely effects of a development are fully understood and taken into account before a development is permitted to go ahead. The approach to EIA should be to: [4]

- provide a complete and objective description of the development.
- provide as complete as is possible description of the existing environment.
- provide as systematic and objective an account as is possible of the environmental effects to which the project is likely to give rise.
- describe and present the data gathering and interpretation that underpins the assessment of the identified environmental impacts.
- formulate evidence based conclusions supported by the information gathered in the EIA process in line with a precautionary approach.
- provide an overview of knowledge gaps and clearly state what effect these might have on the certainty by which environmental effects can be predicted.

All these steps should be reported in an Environmental Statement to a level of detail sufficient to provide the public and competent authorities with a proper understanding of the importance of the predicted effects and the scope for reducing them.

2.3 Farm location

The first stage in developing an offshore wind farm is to find a suitable location for the turbines and the associated power cables. The choice of location strongly influences both the potential environmental impacts and economic considerations. For example, a wind farm located outside bird migration routes would generally have less potential for bird collision incidents than one located within such routes. If a wind farm is due to be constructed in deeper waters far from the coast, higher costs will be incurred for the installation of foundations and the power cables to shore. Therefore, careful selection of the location is important.

From the offshore wind farm developer's perspective, areas with a high wind resource, in shallower waters, with easy access to the shore and grid connections are the key drivers in site selection. However, in coastal and marine areas there may already be a number of uses and users within areas suitable for offshore wind farm development. Tools, such as constraints mapping, are useful to build a picture of the nature and scale of use at potential offshore wind farm locations. Where in place, Strategic Environmental Assessment (under the SEA for Plans and Programmes, Directive 2001/42/EC [2]) and/or Marine Spatial Planning can assist in identifying the nature, location and extent of these other uses, to aid in the process of selection of a suitable site and in conflict management. Besides the more common uses like navigation, fisheries, oil and gas production, telecommunications cables and sand and gravel extraction, novel uses like offshore renewable energy (wave and tidal devices) are growing in importance. Marine Protected Areas, or areas of nature conservation importance, may conflict or compete with offshore wind developments for space and should be considered when selecting a wind farm location.

For the assessment of potential environmental impacts, biotic and abiotic information on the "natural" (pre-construction) environment is essential. Where a planned project is likely to have a significant effect on Special Areas of Conservation (SAC) under the Habitats Directive (92/43/EEC [5]) or Special Protection Areas (SPA) under the Birds Directive (79/409/EEC [6]) an appropriate assessment of its implications is necessary in the light of the site's conservation objectives. If it is likely that a project will have significant effects on the environment of another state, this state should be notified about the planned activity and where required the state of origin shall enter into consultations with the affected state (Article 7 of Directive 97/11/EC amending the EIA Directive).

In order to assess the suitability of an offshore wind farm location with respect to the biological features to be protected, the relevant basic information should be made available for benthos (epifauna, infauna, macrophytobenthos), fish, mammals as well as resident, migratory, resting or feeding birds.

Through extensive preliminary surveying and/or the use of existing data for a location, the site characterization in terms of spatial and temporal distribution of habitats and species, especially Red List species, can be identified and mapped. Information on critical habitats, such as spawning grounds, breeding, molting and feeding habitats, and migration routes also needs to be gathered.

The preliminary surveys should in particular provide information on spatial and temporal distribution and habitat use of:

- marine mammals nursery grounds, haul-out areas etc;
- sea birds, wintering, resting, feeding and molting areas;
- migrating birds (especially species with high conservation status), migration routes and areas of high migration activity;
- bats, e.g. migration routes and areas of high migration activity;
- fish species, e.g. nursery grounds and spawning areas and protected and Red List species;
- macrozoobenthos and phytobenthos with special focus on protected habitats and protected and Red List species.

It is recommended that the preliminary survey for a location is set out in a way which will ensure that the collected data can be used as a baseline for subsequent monitoring of the effects of the construction, operation and removal phases of the offshore wind farm.

The approach to all monitoring should be to define a clear rationale on which the survey can be designed and to follow the Before and After / Control and Impact Analysis (BACI) approach. In this regard setting up and surveying reference or control areas is recommended.

Abiotic properties of a site for the assessment of environmental impacts and for engineering considerations in respect of the prospective location include, but are not limited to:

- the sediment characteristics (structure, topography, mobility, sediment transport) of a prospective location should be established since this is important basic information for characterisation and baseline surveys. The sediment characteristics can be ascertained by grab sampling and hydroacoustic methods;
- bathymetry and geomorphology need to be taken into account;
- information on the geological/geophysical structure at the site is important for an assessment of the general suitability of the location in the planning phase. The soil property data should be available well in advance of the beginning of turbine installation. Information on the soil properties is a technical prerequisite for the stable construction of the foundations of offshore wind turbines, thus ensuring the structural integrity and safety of the installation;
- for safety and environmental reasons information on the prevailing wind speeds, hydrographic conditions (e.g. currents, wave heights) and if applicable ice conditions should be assessed.

3. MINIMUM CRITERIA TO BE CONSIDERED IN ASSESSMENT

The objectives of an environmental impact assessment is to give the approval authority an information base for determining the consequences that a project might have for the environment, which have to be considered in granting an approval. The environmental features that may be affected are flora and fauna, water, soil, landscape, human-beings and cultural heritage. Therefore the applicant should investigate the area in order to:[3]

a) determine and assess the spatial distribution of such features, their temporal variability and their condition;

b) describe the effects that the construction, operation and eventual decommissioning of the wind turbines, cables, scour protection and all infrastructure might have on these features;

c) investigate and assess the actual utilisation/exploitation of the area and any conflicts that may arise;

d) investigate and assess the sensitivity of the natural resources of the area;

e) assess any cumulative effects and any impact interactions a project might have with other projects, whether wind farms or other types of construction or activity, that have been, or will definitely be, carried out in the near future;

f) consider alternative locations for the placement of the wind farm (or individual turbines) and cables.

Concerning the possible impacts of offshore wind farms on the marine environment, various risks during the construction and operation phases are relevant, e.g. bird collision, loss of habitat, disturbance of benthos, fish and sea mammals.

Examples of potential impacts include:

- The interaction of the foundation and hydrodynamics may lead to modifications in seabed morphology, sediment dispersion and movements.
- The subsurface structures and the scour protection can increase the habitat heterogeneity and change the native benthic communities at the turbine sites, The construction and operation of an offshore wind farm can create noise that may impact benthic organisms.
- The establishment of an offshore wind farm can lead to changes of natural habitat for fish communities by the introduction of artificial physical structures. The new structures can also attract fish species, the precise reasons are unclear but could include: food or shelter against predators and strong water currents. This can have long-term effects on the distribution and composition of the fish communities and the abundance and diversity of different fish populations within and around the wind farm.
- The power from the offshore wind farms is transported from each turbine by an array of cables and to the shore through a series of power cables, whilst the shielding for such cables prevents any losses the operational cables do emit magnetic induced electric fields. These electromagnetic fields are sensed by some fish species and as such the power cables may have an impact on the behaviour and migration of the fish fauna in the areas traversed with cables.
- The construction and operation of an offshore wind farm can create noise that may impact marine fish, of particular concern are pile driving noise effects on fish spawning and other sensitive life cycle stages.
- The construction and operation of an offshore wind farm can create noise that may impact marine mammals. The potential for offshore wind farms on birds and bats are broadly synonymous. Offshore wind farms may present hazards to birds at sea. They may represent a barrier to movement of migrating or feeding birds and may potentially result in displacement of migration routes and displacement of feeding birds. Such displacements may incur heavier energetic costs, which may ultimately affect survival or breeding success. The behavioural avoidance of the wind farm area could also potentially result in effective habitat loss.

3.1 Landscape and risk analysis

A visualisation of the impact of the wind farm on the landscape should be prepared for projects planned within a range visible from the coast (e.g. by computer simulation or photomontage). Experience has shown that offshore wind farms can be visible over 20 miles away but that such visibility is wholly dependant on weather and light conditions.

A risk-analysis assessing the probability of a ship collision with a wind farm, both with and without accidental pollution (worst case scenario), should be carried out and presented to the approval authorities as part of the ES. This would only be necessary where, due to specific conditions (*e.g*. navigable water depth, usage), there may be a risk of such an incident.

Main requirements to be fulfilled by an offshore wind farm

When considering an application to construct an offshore wind farm the approval authority should pay due regard to the following: [7]

The safety of shipping and aviation should not be compromised by wind farms and the impact of wind farms on the efficiency of shipping and aviation should be minimised. Therefore the approval authority should develop requirements to be met by, and measures to be applied to, the project, such as regulations or guidance on lighting requirements for wind farms, safety distances to shipping routes, safety zones around the turbines / wind farm, activities permitted within wind farms etc., that are appropriate to reduce the risk of possible collisions of vessels with wind turbines as well as the risk of other possible damage.

The erection, operation and removal of wind turbines should not endanger the quality of the water and air or the conservation of the species using the impacted area as their habitat. This also includes cumulative effects and any impact interactions a development might have with other projects. Disturbances of sedimentary or hydrodynamic processes that have a significant impact should be prevented.

The threat of marine pollution that might be caused by any hazardous substances originating from the construction or operation of wind turbines should be prevented. The risk of the release of pollutants caused by the collision of a ship with a wind turbine should be reduced to an acceptable minimum. Provision, therefore, has to be made to prevent collisions and for minimising the impact of pollutants on the sea and coastline.

The construction and operation of a wind farm should not endanger birds. Birds may be affected by loss of habitat, e.g. in connection with resting and foraging, in areas where wind farms have been constructed. They may also be killed or injured by collisions with the installations. Wind farms may be a barrier for birds on their long-distance migrations or on their flight from feeding grounds to resting or breeding grounds.

3.2 Involvement of other authorities

The approval authority should forward the application and supporting documents to the full range of other authorities who, by reason of their specific responsibilities, are likely to be concerned by the project (e.g. local authorities, authorities responsible for safety of navigation, nature conservation, cables and pipelines, military, fisheries, submarine exploitation of the seabed etc) and should ask them for their comments within a reasonable timeframe. [1]

Where the approval authority considers that the implementation of a project is likely to have significant effects on the environment of the territory of another state the latter should be notified of the project. The potentially affected state should respond to the approval authority acknowledging receipt of the notification and indicate whether it intends to participate in the procedure.

Comprehensive monitoring programmes during construction and operation will provide information on effects and thereby help future developers minimise potential impacts. However, it is important that all such monitoring has a clear purpose in order to provide answers to specific questions where significant environmental impacts have been identified. Such questions are most likely to derive from the environmental impact assessment. The data requirements for any monitoring programme should be agreed with the competent authority. The collection of data should provide the competent authorities with the

information necessary to carry out an appropriate level of assessment. Monitoring should follow clear standards with regard to parameters, methods etc. and testable hypotheses in order to generate comparable sets of data for both authorities and industry.

3.3 Disturbance from construction vessels and equipment

Movements of vehicles, vessels, machinery and personnel during construction could have a disturbing effect on the resident biota or human population. If the level of disturbance is likely to have a significant effect on birds or marine mammals, management rules should be considered to schedule the timing and routes to avoid sensitive locations and times. Helicopters, in particular, can have a large disturbing effect on biota and if used special rules on their operations should be agreed with the regulatory authorities.[3]

Shipping and aircraft traffic associated with the construction works also has the potential to interfere with ordinary shipping and aircraft routes. Therefore, accident and collision risks with ordinary shipping and aircraft traffic during the removal phase should also be considered.

To avoid accidents/collisions with ordinary shipping, the position and co-ordinates of the construction area should be announced officially in good time before taking up the work. In addition, during construction and activities, the area should be made safe, e.g. by means of illumination at night. Keeping a permanent watch on shipping in the vicinity of the wind farm area (both visually and by radar) can reduce collision risks. This may be done (for example) by using a traffic-security vessel throughout the entire construction phase.

All chemicals, paints, coverings etc used in the construction should be approved for use in the marine environment and their ecotoxicological properties known. It is important that all storage areas for chemicals (whether on land, vessels or other structures) are appropriately bunded (such bunds should be a minimum 10% greater than the volume of all chemicals to be stored

Aspects of the construction works are known to be noisy (e.g. pile driving) and at levels detectable by certain species of fish and marine mammals. In order to protect the populations of species that may be adversely affected by such noise certain activities should be scheduled to avoid these sensitive times, e.g. fish spawning, seal pupping etc.

In addition, before carrying out activities resulting in sound levels likely to be harmful to marine mammals, appropriate measures should be taken to minimise any effects on marine mammals that may be present in the work area.

Contingency plans should be drawn up in order to permit rapid and adequate responses if there is a breakdown, accident or other emergency during the construction phase.

There is a possibility that the electric and magnetic fields associated with offshore wind farm power cables may affect some species of fish. Research into these effects is ongoing, current mitigation measures include appropriate choice of cable types, separation and burial depths.

3.4 Removal and Decommissioning

The removal phase normally starts at the end of the lifetime of an offshore wind farm or offshore wind turbine (OWT). OWT may also have to be removed when they are no longer operational for example due to damage. Also the expiry or withdrawal of an approval or its premature termination (e.g. due to insolvency of the developer) may require

the removal of a wind farm if no alternative operators are forthcoming. After the wind farm components have been removed, one has to care about their subsequent disposal (in the sense of re-use, recycling and final residue disposal on land) - so both phases are in close connection.

For removal and subsequent disposal of a wind-farm, the following main components should be addressed:

- wind installation comprised of rotor (with blades and hub), nacelle (containing e.g. rotor shaft, gear, generator, cooling units), tower and foundation;
- scour protection materials;
- interconnecting power cables within the wind-farm;
- power cable to shore;
- converter stations with technical equipment and foundation.

The operation of offshore wind farms often has just started or is still in the planning phase and the operational life-span of a wind farm is estimated to be in the order of some decades.

Potential environmental impacts are strongly dependent on the removal techniques. It is expected that techniques to remove offshore installations will evolve over the coming decades, in particular in context with the removal of disused offshore oil and gas installations. The removal of offshore wind farms will certainly benefit from such experiences.

4. CONCLUSIONS

Offshore wind farms may have adverse impacts or interfere with other legitimate uses of the sea, e.g. recreational beaches, human divers, sailing, navigation routes, fishing, military activities etc. It is therefore essential that the type, scale, frequency and location of such activities are identified in the EIA procedures and that the impacts on these from all aspects of the construction and operation of the offshore wind farm are assessed.

Wind generator construction increases marine navigation risk.

In small distance from wind farm disturbances in communicational and navigational systems work can occur.

Clean energy produced on wind farm on sea created lot of ecology problems which are to be solved.

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