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Anholt Offshore Wind Farm

Method for impact assessment

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RAMBØLL

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Table of contents

1. Introduction

ENDK wishes a memo elaborated, defining method for the impact assessment.

In this document the criteria for assessment including cumulative effects are presented. The memo will work as a common reference for the project team. Based on the technical design memo the potential environmental impacts will be assessed.

In a separate memo the structure and the defined set-up for the background memos is worked out.

2. Description of methodology used for the impact assessment

The assessment of the environmental impacts from the construction, operation and decommissioning of the planned off-shore wind park will be based on:

- Description of the project with 2 park layouts;
- 2 types of foundation (mono pile and gravitation);
- 2 size of wind mills (2,3 MW and 5 MW);
- Worst-case for the studied area;
- Description of the existing environment/baseline;
- Methodology for environmental impact assessment;

The methodology used to assess the environmental impacts associated with the planned off-shore wind park in Kattegat between Anholt and Grenå/Djusland will include:

- Definition of the project area and the possible impact area;
- Description of the different project activities and the associated sources of impacts (impact parameters) that may affect the environment;
- Description of environmental parameters that will be affected by the sources of impacts (impact parameters) from different project activities during construction and operation;
- Description of criteria for categorising the environmental impacts;
- Description of methods used for assessing specific impacts.

2.1 Definition of the project area and possible impact area

The impact assessment is carried out within the project area (144 km^2) reflecting the specific environmental conditions and the different construction works that will be conducted within the project area for the off-shore wind park. Some of the activities during construction and operation of the wind park however may potentially result in impacts outside the project area. When assessing the potential impacts from the wind park it will thus be of importance to define the potential impact area, e .g. for birds and marine mammals the potential impact area is extended to Kattegat area.

2.2 Project activities, sources of impacts (impact parameters) and potential environmental impacts during construction, operation and decommissioning

Table 2-1 shows the potential project activities and the sources of impacts during construction, operation and decommissioning of the planned off-shore wind park that may result in impacts on the environment. This table serves as *inspiration* and will be revised based on the technical description and the pre-determined design guidelines.

Table 2-1 Project activities during construction, operation and decommissioning of the planned off-shore wind park, sources of impacts and potential environmental impacts.

Project activity	**Source of impacts (impact parameter)**	**Potential environmental impacts**
Construction		**Environmental parameter affected / Target of impact**
Construction works (general)		
- Construction works	Noise - vessels - seabed intervention works -	Fish, birds, marine mammals, people, tourism, fishery
- Physical activity	Physical disturbance during construction - Cables-laying – lay vessel, support vessels, etc. - Jack- up- vessel - Anchor handling - Visual effects/light	Fish, marine mammals, birds, people, tourism, fishery, cultural heritage
- Energy consumption	Emission of CO2 and air pollutants (construction including surveys)	Air quality (local, regional, global)
- Waste generation	Construction activities (industrial and household waste)	Water quality
- Ballast water	Flora and fauna contamination	Non-indigenous species
Seabed intervention works	- Sediment spreading and sedimentation Spreading of nutrients, inorganic and organic contaminants. Trenching.	Fish, birds, marine mammals, people, -
Substructure - gravitation	Spreading of sediment	Fish, birds, marine mammals, people,
Substructure mono-piles	Noise from ramming down	Fish, birds, marine mammals, people,

Project activity	Source of impacts (impact parameter)	Potential environmental impacts
Construction		**Environmental parameter affected / Target of impact**
Laying of cables directly on seabed	Sediment spreading from laying of cables and from anchor-handling	Surface sediment, water quality, benthic flora and fauna, plankton, fish, marine mammals, birds, tourism, fishery, eutrophication, cultural heritage
Pipe-laying	Protection zone around lay vessel	Surface sediment, water quality, benthic flora and fauna, plankton, fish,
Activity	**Source of impacts (impact parameter)**	
Operation		
Wind park on seabed/in water	Noise from the wind park	Marine mammals, birds, people
	Restriction zones around the wind park	Maritime traffic, fishery
	Occupation of area on seabed	Fish, marine mammals, fishery
	The wind park itself	Maritime traffic (anchoring), fishery
	Changes in bathymetry	Sediment conditions, benthic flora and fauna, fishery, non-indigenous species
	Blocking effects	Marine mammals, birds
	Contaminants from ?	
Maintenance and repair	Noise and physical disturbance from vessels	Marine mammals, birds
	Air emissions from vessels	
Activity	**Source of impacts (impact parameter)**	
Decommissioning		
Decommissioning	Method used depends upon practice / methodology available at that time	

2.3 Criteria for categorising environmental impacts

2.3.1 General

The overall purpose of the environmental impact assessment is to describe the aspects of the environment which potentially can be affected by the proposed project. This includes the physical and chemical environment (geology, air, water, etc.), the

biological environment (flora and fauna) and the socioeconomic environment (fishery, tourism, archaeological heritage, etc.).

The impact assessment methodology serves to provide a means of characterising identified impacts and their overall residual significance. In this EIA the residual significance is the significance of an impact upon the receiving environment *before* the implementation of mitigation measures.

Two different forms of impacts are assessed within the EIA:

- *Planned impacts* – impacts that result from a planned event. Such impacts are expected to occur during the course of the project (e.g., a temporary and local increase in turbidity levels in the water column due to disruption of seabed sediments).

- *Unplanned impacts* – impacts that result from an unplanned or non-routine event. Such impacts are not expected during the project, but the probability and the consequences of the impact (e.g., a fuel spill during construction) nevertheless are assessed. The environmental risks of unplanned impacts are described and evaluated.

The impact assessment methodology for planned impacts takes into consideration the probability of a given impact, its nature, type and degree of reversibility, its intensity, scale, duration and sensitivity, and its overall significance. As mentioned, unplanned impacts are assessed specifically. Residual risks are assessed before the implementation of mitigation measures. These are to be listed as proposed measures.

2.3.2 Probability, nature, type and reversibility of impact

Impacts are initially classified according to the probability of a given impact to happen, their nature (either negative or positive), their type and their degree of reversibility. Type refers to whether an impact is direct, indirect, secondary or cumulative. The degree of reversibility refers to the capacity to return an impacted resource / receptor to its pre-impact state. Ideally, all impacts associated with the project are reversible. Probability, nature, type and reversibility are elaborated upon in Table 2-2.

Table 2-2 Probability, nature, type and reversibility of impacts.

Probability of impact	
High	>75% -
Medium	25-75%
Low	<25%
Nature of impact	
Negative	An impact that is considered to represent an adverse change from the baseline or to introduce a new, undesirable factor.

Positive	an impact that is considered to represent an improvement to the baseline or to introduce a new, desirable factor.
Type of impact	
Direct	Impacts that result from a direct interaction between a planned project activity and the receiving environment (e.g., the loss of a habitat during wind park construction/installation).
Indirect	Impacts that result from other activities that are encouraged to happen as a consequence of the project (e.g., an increase in fishery activity I the wind park area due to the creation of an artificial habitat favourable to certain target species).
Secondary	Impacts that arise following direct or indirect impacts as a result of subsequent interactions within the environment (e.g., secondary direct: an impact upon marine fauna due to a loss of a habitat; secondary indirect: by-catch of non-target species).
Degree of reversibility	
Reversible	Impacts on resources / receptors that cease to be evident, either immediately or following an acceptable period of time, after termination of a project activity (e.g., turbidity levels in the water column will return to normal levels shortly after the construction works in an area are finalised).
Irreversible	Impacts on resources / receptors that are evident following termination of a project activity and that remain for an extended period of time. Impacts that cannot be reversed by implementation of mitigation measures (e.g., the occupation of seabed by the windpark).

2.3.3 Impact variables and overall significance

Impact variables

Predicted impacts are defined and assessed in terms of a number of variables. This would comprise an assessment of the intensity, scale and duration of an impact. Awarding values are, for the most part, objective due to the limits in place. However, awarding a value to variables, such as intensity, may be subjective in that the extent of change is difficult to define. Experts carrying out the assessments draw on their professional judgement and prior experience from similar projects and environments to ensure a reasonable degree of consensus on the value placed on an impact variable.

Various methods are employed in determining the value of the variables. These include:

- The use of modelling techniques to determine the extent of interaction between a project activity and the receiving environment
- The use of Geographical Information Systems (GIS) to plot resources / receptors in relation to the wind park area and the sphere of influence of an impact (determined by modelling, previous studies and available literature)
- Statistical evaluation
- The use of results of desk studies and field surveys into resource / receptor presence and sensitivity

- Prior experience of the EIA team

An explanation of the variables and values employed in the EIA are presented in Table 2-3.

Table 2-3 Criteria for intensity, scale and duration of effects

Intensity of effects	
No effect:	There will be no effects on structure or function of the resource/receptor within the affected area.
Minor effect:	There will be minor effects on structure or function of the resource/receptor inside the affected area, but its basic structure/function is retained.
Medium effect:	There will be partial effects on structure or function inside the affected area. Structure/function of the resource/receptor will be partially lost.
Large effect:	The structures and functions of the resource/receptor are affected completely. Structure/function loss is apparent inside the affected area.
Geographical extent of effects	
Local effects:	There will be changes in the immediate vicinity of the construction site for the wind park. Effects are restricted to the project area (approximately 144 km^2).
Regional effects:	There will be effects outside the immediate vicinity of the construction area (local effects), and up to around 20 km outside the project area – corresponding the distance from the wind park to Anholt/Djursland.
National effects:	Effects will be restricted to Danish territorial waters and to the Danish EEZ.
Transboundary effects:	Effects will be experienced outside the Danish EEZ.
Duration of effects	
Short-term:	Effects during and immediately after the construction phase of the wind park; however the effects stops immediately when the activity is stopped.
Medium-term:	Effects throughout the period of construction of the wind park and until three years after.
Long-term:	Effects that continue over an extended period, more than three years after the construction of the wind park.

Overall significance of impacts

The overall significance of the impacts is evaluated on basis of the evaluation of the single impact variables, as described above, and on the sensitivity of the resource/receptors affected.

It is imperative to place some form of value (low, medium and high) on a resource/receptor that could potentially be affected by project activities. Such a value may be regarded as subjective to some extent.

However, expert judgement and stakeholder consultation ensure a reasonable degree of consensus on the intrinsic value of a resource/receptor. The allocation of a value to a resource/receptor allows for the assessment of a resource's/receptor's sensitivity to change (impact). Various criteria are used to determine value / sensitivity, including, amongst others, resistance to change, adaptability, rarity, diversity,

value to other resources/receptors, naturalness, fragility and whether a resource/receptor is actually present during a project activity. These determining criteria are elaborated upon in Table 2-4.

Table 2-4 Criteria used to evaluate sensitivity of resource/receptor.

Sensitivity / value	
Low:	A resource / receptor that is not important to the functions/services of the wider ecosystem or that is important but resistant to change (in the context of project activities) and will naturally and rapidly revert to pre-impact status once activities cease.
Medium:	A resource / receptor that is important to the functions/services of the wider ecosystem. It may not be resistant to change, but it can be actively restored to pre-impact status or will revert naturally over time.
High:	A resource / receptor that is critical to ecosystem functions/services, not resistant to change and cannot be restored to pre-impact status.

For this assessment, the overall significance of impacts has been defined as no impact, minor impact, moderate impact or significant impact, as shown below. The evaluation, including the different variables of intensity, scale and duration, and sensitivity of resource/receptor, is partly subjective, as mentioned, and is included to give the reader a brief overview of the evaluation of the impacts, see Table 2-5**Error! Reference source not found.**.

Table 2-5 Criteria for evaluation of overall significance of impacts.

Overall significance of impacts	
No impact:	There will be no impacts on the environment;
Minor impact:	The structure or functions in the area will be affected partially, but there will be no impacts outside the affected area, and impacts will be short-long term, without significant impacts on the environment;
Moderate impact:	The structure or function in the area will be changed, but the impact will have no significant effects outside the affected area. Impacts will be medium-long term, without significant impacts on the environment;
Significant impact:	The structure or function in the area will be changed, and the impact will also have effect outside the project area.

In the impact assessment, every resource/receptor assessed will be accompanied by a schedule at the end of the section that includes an assessment of the different variables and an evaluation of the overall significance of the impacts, see Table 2-6. This matrix serves as a guideline for the impact assessments in all phases of the suggested project.

Table 2-6 Criteria used in the environmental impact assessment for the off-shore wind park.

Intensity of effect	Scale of effect	Duration of effect	Overall significance of impact[1]
No	Local	Short-term	No impact
Minor	Regional	Medium-term	Minor impact
Medium	National	Long-term	Moderate impact
Large	Transboundary		Significant impact
[1]: Evaluation of overall significance of impact includes an evaluation of the variables shown and an evaluation of the sensitivity of the resource/receptor that is assessed.			

Example of the summary table for the impact assessment:

Summary of impact on fish

Impact	Intensity of effect	Scale / geographical extent of effect	Duration of effect	Overall significance of impact[1]
Sediment spreading and sedimentation	Minor	Local	Short-term	No
Physical disturbance and noise during construction	Minor	Local	Short-term	No/Minor
Occupation of seabed and changes of bathymetry	Minor	Local	Lon-term	Minor

The definition of the terms may vary according to the specific topic (especially in terms of duration and extent) and should be defined within the separate technical subject fields. As an example: when considering birds and marine mammals the extent of impact may very well be more at regional/national level and of medium – long term duration and most likely linked to the operation phase. Contrary to this, the impact from turbidity is supposed only to be linked to the construction phase and of only local extent of impact and of short term duration.

Finally, the potential impact must be assessed in terms of how seriously any parts of the environment might be affected. For the off shore wind park it has been agreed, that the “significance” of the potential impact is assessed ***before*** mitigation measures have been taken into account.

Significance rating of data and knowledge for assessment

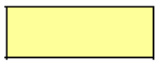
In order to evaluate the quality and significance of data and documentation for the impact assessment a significance rating of data and documentation should be evaluated within the specific technical subject topics using the following categories:

- 1 – Limited (scattered data, some knowledge)
- 2 – Sufficient (scattered data, field studies, documented)
- 3 – Good (time series, field studies, well documented)

The EIA – document

For the EIA-document an impact arising from a planned activity will, depending on its magnitude and the environmental sensitivity, be given a significance rating as follows:

No impact: There will be no impact on structure or function in the affected area;



Minor impact: The structure or functions in the area will be partially affected, but there will be no impacts outside the affected area;

Moderate Impact: The structure or function in the area will change, but there will be no significant impacts outside the affected area;

Significant impact: The structure or function in the area will change, and the impact will have effects outside the area as well;

Generally, projects can also result in positive impacts. Positive impacts are suggested to be shown with a "+" in the comprehensive tables for the predicted impacts.

In Table 2-7 an example of the EIA evaluation of potential impact, significance rating of the assessed impact and the quality of data/documentation is given.

Table 2-7 Example of the EIA evaluation: potential impact, significance rating of the assessed impact and the quality of data/documentation.

Tabel: Samlet betydning af indvirkninger på det biologiske miljø

SANDSYNLIGE KONSEKVENS	SAMLET BETYDNING AF INDVIRKNINGEN	Grundlag for vurdering
INDVIRKNINGER PÅ DET BIOLOGISKE MILJØ		
Indvirkninger på det pelagiske miljø		
Spredning af sediment	Lille	1
Spredning af næringsstoffer, uorganisk og organisk forurenende stoffer	Lille	3
Indvirkninger på bentisk flora og fauna		
Spredning af sediment	Lille	
Spredning af næringsstoffer, uorganisk og organisk forurenende stoffer	Lille	
Møllefundamenternes tilstedeværelse på havbunden	Moderat	2
Indvirkninger på fisk		
Sedimentspredning og sedimentering	Ingen	
Fysisk forstyrrelse og støj under anlægsarbejdet	Ingen/lille	

These evaluations are worked out for impact assessment for physical environment, biological environment and social/socioeconomic environment.

2.4 Cumulative impact from third part activities

Cumulative effects are here defined as combined effects of Anholt offshore Wind Farm and other man-made third part structures/projects, of which the Universal Wind Park at Store Middelgrund is the most important..

2.5 Mitigation measures

When potential impacts in worst case scenario have been identified, each sub-project defines and describes what are believed to be relevant mitigation measures and these may comprise:

- Construction methods (use of mono piles;
- Time limits in construction periods with respect to sea mammals, bird etc.;
- Methods to reduce spillage of sediment;
- Environmental supervision during construction, coordination of environmental issues, and environment management in the operational phase;

- Measures concerning the lay out of the wind park, light, height and size of the mills, colour;
- Measures during construction: recommendations; Ramp-up procedures when ramming etc.;
- Measures to be implemented during operation - such as environmental lead, environmental monitoring;
- Etc. etc.

2.6 Unplanned impacts

In addition to the predicted impacts, those impacts that could result in the event of an accident or unplanned event within the project (e.g. fuel/oil spill or operation failures), or in the external environment affecting the project, are taken into account. These impacts are termed unplanned impacts and are defined as being a combination of event or incident frequency (probability) and the environmental consequences of the event or incident. Unplanned impacts are considered in much the same way as predicted impacts.

2.7 Dealing with uncertainty

As the wind park project is dealing with a “undefined” project design e.g. layout, choice of foundation, number of mills etc., impacts are difficult to predict with certainty and some level of uncertainty in assessing the resultant impacts is inevitable.

Predictions is made by evaluating “worst case” and can be made using varying means ranging from qualitative assessment and expert judgement through to quantitative techniques. Use of these latter techniques allows a reasonable degree of accuracy in predicting changes to the existing environmental conditions and making comparisons with relevant environmental quality standards. Where assumptions have been made, the nature of any uncertainties that stem from the ‘prediction’ process are presented.

Where this uncertainty is material to the findings of the EIA, it should be clearly stated. The general approach then is to take a conservative view of the likely impacts and propose various mitigation measures accordingly.