Partners in UK offshore wind

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Annex 5.4 to the Applicant's response to EXQ2 INF 2.4 Comments on Wood Thilsted Report

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Image of an offshore wind farm

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Glossary

Term	Meaning
Applicant	Morgan Offshore Wind Limited.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP).
Morgan Array Area	The area within which the wind turbines, foundations, inter-array cables, interconnector cables, scour protection, cable protection and offshore substation platforms (OSPs) forming part of the Morgan Offshore Wind Project: Generation Assets will be located.
Morgan Offshore Wind Project: Generation Assets	This is the name given to the Morgan Generation Assets project as a whole (includes all infrastructure and activities associated with the project construction, operations and maintenance, and decommissioning).

Acronyms

Acronym	Description
CFD	computational fluid dynamics
BEET	Blockage Effect Estimator Tool
MDS	Maximum Design Scenario
MSL	Mean Sea Level
LAT	lowest astronomical tide
PEIR	Preliminary Environmental Information Report

Units

Unit	Description
km	kilometers

1 ANNEX 5.4 TO THE APPLICANT'S RESPONSE TO EXQ2 INF 2.4 ORSTED IP'S WAKE LOSS ASSESSMENT REPORT

1.1 Introduction

1.1.1.1 This document sets out the Applicant's response to the Ørsted IPs Wake impact assessment report (REP4-049), referred to below as 'the Report'.

1.1.1.2 This response does not repeat the Report in full, in order to limit the document size (given it extends to 122 pages of text and appendices), but makes some general observations on the Report, as well as specific observations on the model set-up, validation and assumptions, and on its conclusions, to assist in an understanding of the context and limitations of the Report.

1.1.2 General observations of the Report

1.1.2.1 The Applicant has the following general observations on the Report:

- Section 1.1 of the Report Says states it is an '*independent assessment'*. The Applicant does not consider this to be an accurate representation as it is a study commissioned by the Ørsted IPs to underpin their position on wake effects. This is highlighted by the stated starting hypothesis of the Report, that '. . . additional losses will be incurred from the proposed future neighbouring wind farms, including Morgan, Mona and Morecambe (abbreviated as MoMoMo) and Awel y Môr'.
- The Report states in section 5 (and other places) that the assessment is '*industry standard*". As the Applicant has highlighted in its previous representations, there is no industry standard approach to assessing wake effects. Whilst the model used to inform the Report is one known to be used within the offshore wind industry there are also a number of other models that are used. Each of the models uses a different approach to modelling, such as 'engineering models' (of a range of complexity and typically empirically tuned using power data from operational wind farms) and higher-fidelity 'numerical models' (such as those based on the principles of computational fluid dynamics (CFD)). There are also multiple variants on those approaches from different model providers - the model reported as used in the assessment can be considered an engineering model of which there are many alternatives in use across the offshore industry.
- While most models would be considered to provide credible predictions by their developers, a wide range of wake loss estimates may be expected from these different models for any given wind farm scenario. This is particularly the case for scenarios involving the estimation of wake impacts over large distances, given the very limited opportunity to calibrate and validate the models. This is due to the small number of suitable operational wind farms for such studies from which operational data can be readily obtained, not least those relevant to the specific meteorological conditions which may be experienced in the Irish Sea. The Report refers to Wood Thilsted's typical best practice approach being used, but all consultants or competent model users would argue their modelling approach accords with their own best practice, despite the range of different predictions which may be expected for the same scenario assessed. The Report acknowledges this difficulty in section 5, where it states that ' . . *No specific sensitivity assessment of the available range of wake models has been undertaken* . . .'. The Applicant's view is that the results of any alternative

modelling approach may substantially differ from those presented in the Report, so the output values in the Report must be viewed in that context of significant uncertainty.

- The Report states that the WindFarmer: Analyst Eddy Viscosity with large wind farm correction model has been used to estimate the wake effects in the modelled scenarios. It is known that the model outputs are entirely sensitive to the settings used for this modelling. These settings are neither provided nor referenced in the Report, so it is not possible to scrutinise or reproduce the modelling that has been performed. Even when differences in settings could be considered as similar or close, the influence on model outputs can be significant. Therefore, the precision of the specified settings is important.
- There is a more general lack of information on some of the assumptions and inputs that mean another party (Morgan, or any other) is not able to repeat the assessment in order to check, verify, or refute the findings. The Applicant would draw specific attention to the statement made in section 2.2.1 that ' . . *the characteristics and performance data of the turbines are presented in Appendix B. It should be noted that the characteristics and performance data of the neighbouring operational wind farms [the Ørsted IPs projects] are redacted for confidentiality reasons'*. This information, in particular the Ørsted IPs turbine power curves for each of its operational projects, are fundamental to any attempt to model or understand potential impacts on those projects.
- The Report attempts to present ' . . .*the comparative loss in energy for Ørsted assets due to wakes caused by the addition of new wind farms, and not estimating the absolute values for energy production and wakes'*. This therefore means there is no inclusion of impacts or losses from other sources on the Ørsted IPs, including downtime from their operations and maintenance activities and grid curtailments. This presents a significant limitation in understanding the results of the Report in a real-world setting, where numerous factors other than wind climate will affect the energy output of a project.
- The Applicant would query why Awel y Mor has not been included in the Baseline scenario, or as a first additional scenario, as it is an already consented project, in comparison to Morgan Generation Assets, Mona and Morecambe Generation Assets. The Applicant considers that any "addition" of the MoMoMo projects can only properly be considered as an addition to all projects that have already been consented. The Applicant would also note that there is an inconsistent approach taken to inclusion of other projects in the Report. In section 1.1 it is noted that '. . . *the Mooir Vannin wind farm is excluded from the assessment since it hasn't obtained consent at the time of writing*.' The Applicant would note that Mooir Vannin is being developed by Ørsted, and that the '. . .*likely . . . additional impact* . . . ' it would have on the results of the assessment are not quantified or presented.

1.1.3 Model set-up, validation and assumptions in the Report

1.1.3.1 The Applicant has the following observations regarding the model set-up and assumptions used:

- In section 1.2 of the Report there is reference to the Eddy Viscosity model used in the assessment being validated by its developers, DNV, in 2019. This validation exercise only assessed cases of wind farms in isolation and so is not relevant for cases of wind farms interacting with one another over large

distances, as for the scenarios modelled in the Report. The Applicant is also aware that the settings recommended for use of the model by DNV are known to have changed in 2022, with significant consequence on the predictions made by this model, making this 2019 validation study irrelevant. The Applicant does not recognise that the Eddy Viscosity approach used in the study can be considered to be 'validated' as stated in the Report, particularly for the case of modelling wake impacts over large distances.

- In section 2.2.2 of the Report it is noted that project details for the future wind farms (Mona, Morgan and Morecambe) have been taken from project submissions on the respective Planning Inspectorate portal pages. The project boundary used in the Report for Morgan Offshore Wind Project: Generation Assets is not the Morgan Generation Assets DCO application order limits, but the boundary Morgan Offshore Wind Limited consulted on in its section 42 consultation (using their Preliminary Environmental Information Report (PEIR)). That PEIR array area is approximately 13% larger, and is 0.6 km closer to the 'Walney cluster' of Ørsted IP projects, than the array area presented in the Morgan Generation Assets DCO application. This will result in the assessment overestimating the outcomes for both the Morgan alone and the cumulative scenarios. The Applicant is unable to say what the level of effect of that error would be, other than to highlight it is likely to have increased the level of effects presented.
- The Report has made assumptions on the turbine parameters for Morgan (as well as the other planned projects modelled). The Report states that a nominal 22.6 MW turbine with a 276 m rotor diameter and a 170 m (above Mean Sea Level (MSL)) hub height has been used for Morgan, which the Applicant notes is within the design envelope presented in Volume 1, Chapter 3: Project description (APP-010). However, the Applicant also highlights that the maximum design parameters in the Morgan design envelope as presented in Volume 1, Chapter 3: Project description (APP-010) is a turbine with a 320 m rotor diameter, with a maximum tip height of 364 m (above lowest astronomical tide (LAT)), which would result in a hub height of 204 m above LAT (or c. 200 m above MSL). Noting that in section 6 (6) the Report concludes that based on the sensitivity tests undertaken in the Report ' . . *additional wakes losses are reduced when using the larger turbine*', the Applicant would highlight that if a larger turbine was modelled, the predicted effects on the Ørsted IPs projects would likely be less.
- Section 3.1 of the Report sets out assumptions on the wind climate used for the assessment. The Applicant notes that Wood Thilsted did not have access to information that would allow them to validate the long-term corrected time series of wind data that was provided by the Ørsted IPs. Whilst they did undertake some cross comparison of the data set with the Shell Flats met-mast, the Applicant would note that there is a degree of uncertainty in the validity of the inputted wind climate information. This has the potential to affect not just the overall value of effects predicted by the model, but the distribution of effects, where assumptions on the distribution of wind direction will influence the modelled effects on individual Ørsted IPs projects, as they lie in a range of directions from Morgan.
- Model set-up parameters are presented in the Report, but some key parameters are not stated. For instance, in section 5 of the Report it is noted that a large wind farm correction model has been applied in the Windfarmer: Analyst software, the predictions from which are known to be entirely dependent on a number of key settings which are not provided. In addition, the Blockage Effect Estimator Tool (BEET) has been used to calculate blockage effects. The Applicant is aware that

there are different settings for this tool, but it is not disclosed which has been used.

1.1.4 Conclusions and outcomes in the Report

1.1.4.1 The Applicant has the following observations to make regarding the conclusions and outcomes of the Report:

- Section 1.2 notes that '. . . *The full recovery behind a single turbine usually requires distances such as 10-12 turbine rotor diameters. However, wake effects from entire wind farms have been shown to persist for much greater distances > 30km and potentially up to 100km downstream, potentially affecting wind farms located further away*.' The Applicant would reiterate that it does not dispute that the fact that wake effects models and some studies using measured data show that there may be a measurable impact on a wind farm > 30 km away. However, the Applicant would also reiterate that those theoretical effects are only one of a number of influences on an existing project's energy yield, and those effects are likely to be insignificant in comparison to some of those other influences, such as annual variability in wind direction and strength and wake effects within and between adjoining wind farms.
- Section 6 of the Report states that along with impacts on the operational project's' generation '. . . *increased turbulence levels due to the added wake may increase the fatigue / structural loading and also may cause additional downtime for the turbines, where electricity production is halted*.' The Report references IEC 61400-1 Wind turbines – Part 1: Design requirements, Edition 4, 2019, which sets out that beyond a distance of 10 rotor diameters (which for Morgan's MDS would be 3.2 km) fatigue effects are not considered relevant. The Applicant is not aware of any published studies that demonstrate any relevant increase in fatigue effects on turbines at distances greater than 3.2 km.
- There is no consideration made to the high levels of uncertainty in the wake loss estimates provided by the study. In independent energy yield assessments, it is standard practice for an uncertainty analysis to be considered to provide context as to the accuracy of the assessment's outcomes. When no uncertainty analysis is performed, this is often taken as a reflection of the uncertainties being high. For the estimation of wake impacts over large distances, these uncertainties may even be regarded as unquantifiable given the very limited data available to calibrate and validate the modelling approach utilised, none of which are representative of the scale of projects and turbines that are being proposed for the Morgan Generation Assets. In providing estimates without uncertainty bounds, the Report implies a level of accuracy which is not warranted given the limited basis of evidence available to support the modelling. This is reflected in the Applicant's view expressed above that the results from an alternative modelling approach may deviate substantially from those presented in the Report and consequently, an accurate and robust assessment of the wake impacts on the Ørsted IPs projects is not possible.
- The Report relates outcomes of the assessment to a recent study by DNV and RWE which assesses the prediction of wake losses at two operational projects – Amrumbank West and Triton Knoll – from neighbouring wind farms at various separation distances, using various engineering and numerical wake models. However, there are issues of relevance and accuracy in this comparison. To add context to the prediction of wake losses on the Ørsted IPs projects, the Report draws out values of -3.0% and -3.6% from the DNV/RWE study, predictions made

by the Windfarmer: Analyst models used in the Ørsted IPs projects assessment. This is an incorrect comparison as the DNV/RWE study intentionally uses synthetic wind conditions, an assumption that they purposefully state '. . . *will exaggerate the magnitude of the cluster effect. Resulting losses are not the true losses [at the two projects*]'. The DNV/RWE study therefore provides no assurance that the impacts on the Ørsted IPs projects in the assessment is in any way appropriate. Furthermore, the Report does not disclose that these predicted values are part of a wide range of predicted losses from the various models in the DNV/RWE study. For instance, the value of -3.0% for Triton Knoll is in a range of -1.8% to -3.7% from the models applied, with a sophisticated numerical model from RWE providing the lower estimate in this range, suggesting that wake effects could feasibly be overpredicted by 40% in a relative sense by the Windfarmer: Analyst approach used for the Ørsted IPs projects assessment. The range of estimates from the models reinforces the significant level of uncertainty in the outcomes from the assessment, further supporting the Applicant's position that an accurate, robust assessment of the wake impacts on the Ørsted IPs projects cannot be undertaken.