SHEPHERD+WEDDERBURN

RESPONSE TO QUESTIONS OF THE EXAMINING AUTHORITY

(1) BARROW OFFSHORE WIND LIMITED (REF: 20048546) (2) BURBO EXTENSION LTD (REF: 20048544) (3) WALNEY EXTENSION LIMITED (REF: 20048542) (4) MORECAMBE WIND LIMITED (REF: 20048547) (5) WALNEY (UK) OFFSHORE WINDFARMS LIMITED (REF: 20048545) (6) ØRSTED BURBO (UK) LIMITED (REF: 20048543) (THE "ØRSTED IPs")

IN CONNECTION WITH THE Application by Mona Offshore Wind Limited for an Order Granting Development Consent for the Mona Offshore Wind Farm

Introduction

1.1 This document, containing responses to questions of the examining authority ("**ExQ1**"), is provided in accordance with Deadline 3 of the examination timetable for the application by Mona Offshore Wind Farm Limited (the "**Applicant**") for an Order under the Planning Act 2008 (the "**Act**") granting Development Consent for the Mona Offshore Wind Farm (the **"Project**").

1.2 We represent six owners of operational offshore windfarms in the East Irish Sea (as set out relevant representations RR-004, RR-007, RR-047, RR-087, RR-088 and RR-090), who we refer to together as the "**Ørsted IPs**" for the purposes of this document.

1.3 The Ørsted IPs' responses to ExQ1 are set out in the table overleaf. The Ørsted IPs have responded to the following questions, which have been directed towards them:

1.3.1 Q1.19.3;

1.3.2 Q1.19.4; and

1.3.3 Q1.15.7.

	Examining Authority Question	Answer by the Ørsted IPs
Q1.19.3	**Potential wake effects** • Do you agree that Table 10.10 of [APP-062] accurately reflects the approximate distances between the proposed Mona array area and the operational wind farms that you represent?	The distances recorded in table 10.10 are approximately accurate. For completeness, the Ørsted IPs note that there are some minor differences between the distances recorded by the Applicant and the Ørsted IPs' figures in respect of some developments.
	• Noting that all of the operational wind farms that you represent are at least 30km away from the proposed Mona array area, how do you respond to the Applicant's statement that based on the findings of the 2023 Frazer-Nash study, wake effects become "vanishingly small" when there is a farm-to-farm separation of more than 20km?	The Ørsted IPs consider the Applicant has misrepresented the meaning of this sentence in the Frazer-Nash Consultancy "Offshore Wind Leasing Programme – Array Layout Yield Study" report dated 5th October 2023. The purpose of this study was to *"…maximise the energy production from the portfolio of existing and future wind farms"*. The Crown Estate (**TCE**) is trying to optimise the UK seabed to find some balance between how the size of future offshore wind development zones and how far they should keep them apart (buffers). TCE is seeking to maximise the production from the entire portfolio and not only for new lease areas. The Frazer-Nash study takes some generic, theoretical offshore wind farm pairs and looks at the balance in total production based on different densities and separation buffers – asking whether the "portfolio" production increases when development zones are smaller and further away from each other (reducing the neighbour wake effect) versus larger wind farms which are closer to each other (the larger leases would allow lower turbine density inside the development zones reducing the internal wake effect). The *"vanishing small"* comment in full is as follows: "*For separations much larger than 20km, farm-to-farm wake losses will become vanishingly small…".* It is notable that the study uses the language "much larger" than 20km and not simply "more than". The study should be interpreted as saying that *relative to the internal wake losses* the neighbour wake losses are not as significant for separations much larger than 20km. Hence, in the context of the TCE's goal to maximise the portfolio production of total seabed of the UK, new developments should not be forced into very small array areas with very high turbine density as in this case the internal wakes will dominate relative to neighbour wakes. The study does not comment on whether wake losses extend beyond 20km, but it does advise against using long range wakes as a basis for designing how to allocate

		the seabed. In fact, in section 2.2 of the report it mentions that *"Ørsted … have shown evidence from their own portfolio of offshore wind production data that the method reproduces long range wakes well up to 50km separation"*. Additionally, the Ørsted IPs highlight that the study was based on a theoretical, unrealistic regular grid wind farm pair orientated directly North-South and not aligned with the principal wind direction. Therefore, it should not be relied on to predict the likelihood of actual wake losses in these circumstances. The Ørsted IPs consider it would be quite straightforward for the Applicant to model the real-world situation in the Irish Sea and reiterate their request that the Applicant does so.
	• Do you wish to provide any evidence of material wake effects being discernible at farm-to-farm separation distances of 30km or greater?	The Ørsted IPs maintain (as explained in detail in response to question 1.19.4 below) that it is for the Applicant to undertake an assessment of the wake effects of the Project on other sea users. However, if the Applicant does not undertake this assessment, the Ørsted IPs will undertake this exercise. Notwithstanding the above, the Ørsted IPs record that there is ample evidence of material wake effects occurring at farm-to-farm separation distances greater than 30km, both in their own portfolios and in academic research. This evidence can be categorised as follows: • Satellite observations and aircrafts; • Scanning LiDAR; • Wake and other atmospheric models; and • Observations from existing turbines' SCADA data. These categories are explained further below, along with key excerpts of relevant evidence. The Ørsted IPs are able to provide further analysis, and copies of the papers referred to below, if that would assist the examining authority. **<u>Satellite observations and aircrafts</u>** Synthetic Aperture Radar or SAR installed on satellites can be used to directly observe wakes in the sea. The papers referred to below combine this approach with specially equipped research aircraft and laser measurements or models to

		measure the wake impact directly. The relevant findings of this research regarding wake loss beyond 20km is noted below: • Platis, A., Siedersleben, S., Bange, J. et al 'First in situ evidence of wakes in the far field behind offshore wind farms':[1] *"…satellite imagery reveals wind-farm wakes to be several tens of kilometres in length under certain conditions (stable atmospheric stratification), which is also predicted by numerical models. The first direct in situ measurements of the existence and shape of large wind farm wakes by a specially equipped research aircraft in 2016 and 2017 confirm wake lengths of more than tens of kilometres under stable atmospheric conditions, with maximum wind speed deficits of 40%..."* • Platis, A et al 'Long-range modifications of the wind field by offshore wind parks – results of the project WIPAFF':[2] *"The in situ measurements recorded on-board the research aircraft DO-128 and remote sensing by laser scanner and SAR prove that wakes of more than 50 kilometers exist under certain atmospheric conditions."* • Hasager, C.B.; Vincent, P.; Badger, J.; Badger, M.; Di Bella, A.; Peña, A.; Husson, R.; Volker, P.J.H, 'Using Satellite SAR to Characterize the Wind Flow around Offshore Wind Farms':[3] *"The approximate extent of the individual wind farm wakes is outlined in the image. The longest is at Belwind around 55 km long while at Thornton Bank it is 45 km…"*

[1] Platis, A., Siedersleben, S., Bange, J. et al. First in situ evidence of wakes in the far field behind offshore wind farms. Sci Rep 8, 2163 (2018).

[2] Platis, A et al. Long-range modifications of the wind field by offshore windparks – results of the project WIPAFF. Meteorologische Zeitschrift Vol. 29 No. 5 (2020), p. 355 – 376.

[3] Hasager, C.B.; Vincent, P.; Badger, J.; Badger, M.; Di Bella, A.; Peña, A.; Husson, R.; Volker, P.J.H. Using Satellite SAR to Characterize the Wind Flow around Offshore Wind Farms. *Energies* 2015, *8*, 5413-5439.

		Scanning LiDAR Scanning LiDARs are wind measurement devices that use the doppler shift of laser beams to accurately measure wind speed. The majority of modern offshore wind farms have their energy yield analysis based on measurements from LiDAR technology. The papers referred to below contain relevant findings based on this data source: • J. Schneemann et al. 'Cluster wakes impact on a far-distant offshore wind farm's power':[4] *"Our results showed clear wind speed deficits that can be related to the wakes of wind farm clusters up to 55 km upstream in stable and weakly unstable stratified boundary layers resulting in a clear reduction in power production…"* • B. Cañadillas et al. 'Offshore wind farm cluster wakes as observed by long-range-scanning wind lidar measurements and mesoscale modelling':[5] *"Both the observations (Fig. 8a) and model (Fig. 9) show a wake extending at least 40 km downstream of the N-3 wind farm cluster…"* **Wake and other atmospheric models** Mathematical models can also be used to predict the extent of offshore wakes by modelling the behaviour of the atmosphere when interacting with offshore wind farms. In all cases these models have been validated on operational data from offshore wind farms and hence can be relied on as good predictors of the behaviour of offshore wakes. The papers referred to below contain relevant findings based on these models:

[4] J. Schneemann et al. Cluster wakes impact on a far-distant offshore wind farm's power. Wind Energ. Sci., 5, 29–49, 2020

[5] B. Cañadillas et al.: Offshore wind farm cluster wakes as observed by long-range-scanning wind lidar measurements and mesoscale modelling. Wind Energ. Sci., 7, 1241–1262, 2022.

		• D. Rosencrans et al 'Seasonal variability of wake impacts on offshore wind plant power production':[6] "*The strongest wakes, propagating 55 km, occur in summertime stable stratification…"* • Akhtar, N., Geyer, B., Rockel, B. et al. 'Accelerating deployment of offshore wind energy alter wind climate and reduce future power generation potentials':[7] *"The mean deficit, which decreases with distance, can extend 35–40 km downwind during prevailing southwesterly winds."* • R. Borgers et al 'Mesoscale modelling of North Sea wind resources with COSMO-CLM':[8] *"In weakly stable conditions, absolute capacity factor reductions are much higher, as these exceed 13 % over large zones within and outside the wind farm clusters and 5 % more than 20 km from wind farm clusters and larger wind farms"* • Sara C. Pryor, Rebecca J. Barthelmie, Tristan J. Shepherd 'Wind power production from very large offshore wind farms':[9] *"Under some flow conditions whole wind-farm wakes can extend up to 90 km downwind of the largest lease areas…"*

[6] D. Rosencrans et al.: Seasonal variability of wake impacts on offshore wind plant power production. Wind Energ. Sci., 9, 555–583, 2024.

[7] Akhtar, N., Geyer, B., Rockel, B. et al. Accelerating deployment of offshore wind energy alter wind climate and reduce future power generation potentials. Sci Rep 11, 11826 (2021).

[8] R. Borgers et al.: Mesoscale modelling of North Sea wind resources with COSMO-CLM. Wind Energ. Sci., 9, 697–719, 2024.

[9] Sara C. Pryor, Rebecca J. Barthelmie, Tristan J. Shepherd. Wind power production from very large offshore wind farms. Joule 5, 2663–2686, October 20, 2021.

		• P. Baas et al 'Energy production of multi-gigawatt offshore wind farms':[10] *"In this case, a clear wake is visible, which is still present as the flow reaches the southern edge of the domain. Clearly, for studying wake lengths behind windfarms of this size, much larger domains are required than the present 80 km."* • Sanchez Gomez M. et al 'Can mesoscale models capture the effect from cluster wakes offshore?':[11] *"Long wakes from offshore wind turbine clusters can extend tens of kilometers downstream, affecting the wind resource of a large area"* • Stoelinga M. et al 'Estimating Long-Range External Wake Losses in Energy Yield and Operational Performance Assessments Using the WRF Wind Farm Parameterization':[12] *"The simulations produced dramatic hub-height project-scale wake swaths that extended over 50 km downwind, with a specific example showing a waked wind speed deficit of 7% extending 100 km downwind from the array of turbines that produced it."* **<u>Observations from existing turbines SCADA data</u>** Another way to evidence the impact of wake effects at distances of greater than 30km is to use observations of the power produced by existing wind turbines both before and after a neighbour wind farm has been installed. These "natural experiments" occur with increasing frequency as the number of offshore wind

[10] P. Baas et al. Energy production of multi-gigawatt offshore wind farms. Wind Energ. Sci., 8, 787–805, 2023.

[11] Sanchez Gomez M. et al. Can mesoscale models capture the effect from cluster wakes offshore? Journal of Physics: Conference Series 2767 (2024) 062013.

[12] Stoelinga M. et al, Estimating Long-Range External Wake Losses in Energy Yield and Operational Performance Assessments Using the WRF Wind Farm Parameterization. This paper is a white paper produced by Arcvera Renewables, a renewable consultancy specialising in atmospheric modelling.

		farms that are installed globally increases. As the owner of the world's largest offshore wind portfolio, Ørsted A/S (the parent company of the Ørsted IPs) is uniquely placed to use its own operational data to observe the wake impacts of neighbouring wind farms. In a presentation[13] delivered at the Wind Europe Technology Workshop 2023, Ørsted's Nicolai Nygaard shared some of this evidence. The presentation is referenced in the Fraser-Nash Consulting Study referred to by the Applicant. The paper uses operational data from 37 offshore wind farm pairs located in Northern Europe to demonstrate the neighbouring wake effect through the reduction of power generated by front row turbines. The paper demonstrates that when a wind farm is in the wake of a neighbour at a distance of 30 km you can expect a power reduction of just under 10%, whereas at 50km the reduction is still about 5% of the available power. It should be noted that the paper provides these impacts for a wind speed of 8m/s. The power also shows how the wake impact varies depending on the wind speed, the stability of the atmosphere at the time of the observation and also the size, distance, shape and density of the neighbour wind farm. As the Mona development is anticipated to be 1.5 GW, and is in the predominant wind direction of many of the Ørsted IPs' developments, the Ørsted IPs expect the wake impact to be material on the wind available to the Ørsted IPs developments.
	• Based on the internal modelling referred to in para 1.18 of [REP1-072], do the Ørsted IPs have concerns about all of the operational projects that they represent, or do they contend that the effects would be more pronounced for particular operational projects?	As mentioned above, the wake impact between neighbours depends on the distance between the wind farms, the size and number of turbines, and the frequency with which the wind direction will place one wind farm down stream of another. As all of these considerations vary for the Ørsted IPs assets in the Irish Sea it can be expected that the operational projects will see varying impacts as a result of the Mona development. the Ørsted IPs' internal modelling shows that each asset will be impacted.

- [13] Presentation by Nygaard, Nicolai at wind Europe Technology Workshop (June 2023): "*Wind farms interacting with the boundary layer: Impact of long-distance wakes between offshore wind farms assessed using operational data".*

Q1.19.4	In the event that no wake assessment was undertaken during the Examination, the Ørsted IPs refer to Requirement 25 of The Awel y Mor Offshore Wind Farm Order 2023 which is focussed on the interaction with Rhyl Flats Wind Farm in light of its geographical proximity. The ExA is clear that any such Requirement would need to meet the relevant legal and policy tests and would introduce an additional pre-construction approval responsibility upon the Secretary of State. As such it should only be considered as a last resort and if supported by substantive evidence. On what basis do you consider that such a Requirement would be justified in this case?	The NPS EN-3 requires that, where a potential offshore wind farm is proposed close to existing operational offshore infrastructure or has the potential to affect activities for which a licence has been issued by government, the applicant should undertake an assessment of the potential effects of the proposed development on such existing or permitted infrastructure or activities. The Applicant has, in the Ørsted IPs' view, erroneously scoped out wake loss effects on the Ørsted IPs' developments from assessment. It is not appropriate to 'scope out' wake loss, as it is a direct effect on another sea user not simply an effect to be considered through the EIA process. Independent literature (see references in response to Q1.19.3) as well as internal modelling undertaken by the Ørsted IPs indicate that the Project will have an impact on energy yield at their developments. This is a matter which must be properly assessed by the Applicant. As noted above, it is required to be assessed under the NPS EN3 as an effect on other sea users. Additionally, it is relevant to any evaluation of the environmental benefits and disbenefits of the Project. Finally, it is a matter of good design. There may be alternative layouts/design solutions which result in a less significant effect on the energy yield at the Ørsted IPs' developments, which should be considered. Finally, we note that the necessary data and modelling tools are available to allow the Applicant to undertake this assessment. Therefore, there are no practical reasons that would prevent the Applicant from fulfilling a condition that requires such an assessment. In summary, we consider that, in order to comply with the relevant legislative and policy requirements outlined above, the Applicant must undertake an assessment of the impacts of the Project on energy yield at the Ørsted IPs developments. At the current stage of the development of the Project, the Applicant is best placed to understand the realistic scenarios for the Project, which can then be tested against the known positions of the existing assets.

Q1.15.7	Further to your submissions that additional engagement beyond the MNEF is required going forward [REP2-104], what do seek in terms of commitment from the Applicant on stakeholder engagement and coordination to address your concerns in respect of vessel traffic at construction and operational stages?	As noted below, and in the Ørsted IPs' written representation (REP1-072), the Ørsted IPs seek engagement in relation to impacts (positive or negative) on their developments from future case agreements and ask that any consultation feedback from vessel operators is shared directly, including highlighting any changes in risk to their developments. Additionally, in order to be able to properly assess and understand the risks at their developments, the Ørsted IPs seek that the Applicant share details of their emergency response plans and consider it would be appropriate to be engaged with and provided copies of in respect to Marine Pollution Contingency Plan and ERCoP. The Ørsted IPs also consider that a post-consent Navigational Safety Plan should be developed, detailing routeing to/from the site for Project vessels.
	Do you wish to comment on the Applicant's response to your Written Representation [REP2-078], ref REP1-072.7-8?	The Ørsted IPs respond to the Applicant's response to their written representation on shipping and navigation matters below. The Ørsted IPs recognise that the Project is over 10nm from their developments. However, the Ørsted IPs wish to comment on the cumulative effects of the Project from a shipping and navigation perspective. It is noted that the Navigational Risk Assessment (APP-098) included a Cumulative Navigation Risk Assessment. The Project cumulatively influences the routeing in the wider Irish Sea area and traffic movements around the Ørsted IPs existing developments. The effects of the Project must be considered both individually and in-combination with other existing and proposed developments. As such, acceptance that the Project alone provides acceptable levels of risk for shipping and navigation does not demonstrate acceptance that the cumulative risks presented as part of the application are acceptable. The Ørsted IPs therefore take this opportunity to note that whilst they do not have comments on the Project-alone assessment for shipping and navigation effects, they do maintain their concerns in relation to cumulative vessel increases in the area including those associated with the Project. The Ørsted IPs maintain there is a need for some form of coordination between projects in the wider Irish Sea area including existing operational projects. Notwithstanding the existence of the Marine Navigation Engagement Forum, the Ørsted IPs maintain that:

		- specific engagement is required in relation to impacts (positive or negative) on their developments as a result of future case agreements; and - consultation feedback from operators should be shared directly with the Ørsted IPs, in particular highlighting any changes in risk to their developments.

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30.09.2024