Morecambe Offshore Windfarm: Generation Assets

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Glossary of Acronyms

BaU	Business as Usual
DDM	Dynamic Dispatch Model
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
EN-1	National Policy Statement for Energy
ES	Environmental Statement
ExA	Examining Authority
GHG	Greenhouse Gas
IoM	Isle of Man
IPs	Interested Parties
LNG	Liquified Natural Gas
MGO	Marine Gas Oil
NRA	Navigational Risk Assessment
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
TTS	Temporary Threshold Shift
UK	United Kingdom

Glossary of Unit Terms

CO_2e	Carbon Dioxide Equivalent
CO_2e/MWh	Carbon Dioxide Equivalent per Megawatt-hour
kg	Kilogram
kWh	Kilowatt hour
MW	Megawatt
MWh	Megawatt-hour
t	tonnes

Glossary of Terminology

Capacity factor	The ratio of average power generated by the windfarm under real-world conditions to its theoretical maximum output.
Carbon Dioxide Equivalent (CO_2e)	Carbon dioxide equivalent is a term for describing different greenhouse gases in a common unit. The unit takes the different global warming potentials of greenhouses gases into account. CO_2e is signifies the amount of CO_2 which would have the equivalent global warming impact.
Greenhouse effect	The greenhouse effect is the way that some of the heat from the sun is trapped close to the earth's surface by greenhouse gases.
Greenhouse gas (GHG)	A greenhouse gas is a gas that traps heat in the atmosphere and causes the greenhouse effect.
Wakes	Flow regions behind wind turbines and wind farms that are characterised by lower wind speeds and higher turbulence levels, caused by the extraction of momentum by wind turbines.
Wake effect	The impacts of wakes on energy production of downstream wind turbines and wind farms.
Wake loss	The loss in energy production from a wind farm due to wake effects, represented as a percentage of the expected energy production.

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1 Introduction

1. This document provides an overview of potential net effects associated with the Morecambe Offshore Windfarm Generation Assets (the Morecambe Project) on greenhouse gas (GHG) emissions, taking into account wake effects on existing operational offshore wind farms (OWFs), and diverted vessels.

2. This document has been compiled to address Action Point 14 from Issue Specific Hearing 2: Environmental Matters, and presents a summary of indirect GHG emissions arising from wake effects, and the diversion of vessels. In particular, the document responds to the points raised by Ørsted Interested Parties (IPs), who in their Relevant Representation (REP1-112), indicated that an assessment of wake loss effects is required to fully evaluate the GHG outcomes of the Morecambe Project. In addition, the impact of diverted vessels on GHG emissions has been presented in response to questions raised during Issue Specific Hearing 2: Environmental Matters.

2 Background

2.1 GHG Assessment

3. The predicted effect on GHG emissions associated with the Morecambe Project is presented in Chapter 21 of the Environmental Statement [APP-058]. The assessment predicted that there would be a GHG saving of approximately 35.9 million or 900,000 tonnes carbon dioxide equivalent (CO_2e) during the operational and maintenance phase, depending on the scenario adopted to determine the effect of displaced emissions from other forms of generation.

4. The Morecambe Project will produce renewable energy, which is expected to be result in the displacement of other more GHG-intensive forms of generation. In Scenario 1, GHG savings from the displacement of emissions was calculated using an emissions intensity factor provided by The Department for Energy Security and Net Zero (DESNZ) for electricity suppled from ‘all non-renewable forms’, which at the time of assessment was 424 $kgCO_2e$ / MWh (DESNZ, 2023a). This scenario was adopted to highlight the level of emissions savings that would occur if renewable energy from the Morecambe Project replaced fossil fuel-based forms of generation supplying the grid at the time of assessment. This scenario aligns with the United Kingdom (UK) Government policy to support the transition from fossil fuel generation towards renewable energy.

5. This emission factor relates to generator emissions in the ‘operational phase’ only, and does not include emissions related to the fuel supply chain or

maintenance activities. It is noted however that this is a static emission factor, and does not account for future UK electricity grid decarbonisation.

6. Scenario 2 used the long-run marginal electricity generation factor, which is derived from projections of the carbon intensity of the UK electricity grid published by DESNZ (DESNZ, 2023b). The long run marginal factor accounts for the adoption of renewable energy schemes such as the Morecambe Project becoming fully operational and decarbonising the UK Grid. Furthermore, the long run marginal factor is derived from modelling using a Dynamic Dispatch Model (DDM) to analyse the impact of power sector decarbonisation. It is therefore indicative of what the future electricity mix may look like rather than being a prescriptive forecast. These model scenarios are subject to a level of uncertainty, influenced by the pace of innovation in the market, technological feasibility, demand levels and investment decisions (DESNZ, 2023b). Scenario 2 was adopted as highly-conservative approach. In itself it is inconsistent with policy and energy transition (or at least contains an internal circularity), as it presents a situation whereby renewable energy is displacing future generation from other renewable schemes and for that future generation to be from renewable sources then projects like this need to be developed. It is likely that the true value of avoided emissions would be higher.

7. Furthermore, the Overarching National Policy Statement for Energy (EN-1) outlines the need to "*dramatically increase the volume of energy supplied from low carbon sources*", as "*demand for electricity is likely to increase significantly over the coming years and could more than double by 2050*". The alternative to renewable or low GHG schemes such as the Morecambe Project is non-renewable or fossil fuel generation. Therefore, scenario 1 is arguable more reasonable in light of UK energy policy such as EN-1 and the current generation mix than scenario 2. As noted above, the GHG assessment in Chapter 21 is based on a consideration of both scenarios.

2.2 Wake Effects Assessment

8. The Ørsted IPs representation, submitted at Deadline 2 [REP2-040, REP2-041] discusses the potential Wake Effects of the Morecambe Project on eight operational wind farms in the Irish Sea. Preliminary modelling, compiled by Wood Thilsted [REP3-112] shows that the Morecambe Project would have an impact on these existing operational wind farms, with wake effects predicted to be in the range of 0.32%-1.37% (Wood Thilsted Partners Ltd, 2024). Further details regarding the assumptions behind the predicted level of wake effects are presented in the Wake Impact Assessment Report produced by Wood Thilsted Partners Ltd (2024) [REP3-112], submitted at Deadline 3.

9. The Ørsted IPs also state:

"*Wake loss is also relevant to the Applicant's EIA, in relation to the climate change benefits of the Project. Regulation 5(2) of the EIA Regulations sets out the factors for which significant effects should be assessed, including 'climate'. Effects on climate are further elaborated on in under Schedule 4 (Information for inclusion in Environmental Statements), which relevantly provides that "the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions)" should be assessed*."

"It includes a finding that in the operational phase, the Project will have a beneficial effect on GHG emissions which would be significant EIA terms. While the Ørsted IPs do not dispute that the Project will result in avoided emissions, they consider that the assessment contains inaccuracies, in that it does not account for the loss of renewable generation at their developments, arising from the Project."

"*Therefore, its assessment in EIA terms is likely inaccurate. The information presented in the EIA must be accurate in order for the SoS to be able to assess the Project's benefits and adverse effects, when determining the application*."

10. In its written responses to the Examining Authority's (ExA's) Written Questions 1, the Applicant stated:

"*The Applicant acknowledges that reductions in wind speed at other operational projects could occur, however the variability in wake effects calculations compared to the small percentages presented by the Ørsted IPs (REP2-041) is noted. The Applicant has reviewed the numbers provided by the Ørsted Interested Parties (IPs) both annually and over the lifetime of the Project in terms of the loss of generation. Given the low magnitude for any potential wake effects, it is not considered that there would be a material impact on the predicted greenhouse gas savings and the outcomes of the Environmental Statement (ES) would not be altered*."

11. The Applicant does not agree that its assessment in Environmental Impact Assessment (EIA) terms is inaccurate, nor that the consideration of wake effects would have a material impact on the outcomes of the GHG assessment. However additional analysis has been undertaken to incorporate the change in reported GHG savings associated with potential wake effects of the Morecambe Project on the Ørsted IPs existing operational wind farms.

12. It is noted that the published decommissioning dates (and earliest decommissioning date supplied by Ørsted) result in little temporal overlap with the Project. While clarity is being sought and not agreed by the Applicant, the Ørsted IPs note that its operational wind farms can continue to operate beyond their current expected decommissioning dates without requiring further consent (beyond marine licences for maintenance activities). The Applicant

has therefore undertaken its analysis of wake effects based on an potential lifetime of 35 years for each currently operating wind farm to ensure the assessment is undertaken on a precautionary basis. It is however noted that the Environmental Statements for these Projects assessed a 20 to 25 year operational period. Further, there will be GHG emissions released from the current and ongoing activities associated with the operation and maintenance, or any upgrades for life extension, of the Ørsted IPs windfarms, which have not been accounted for in this analysis.

2.3 Vessel Diversion

13. Analysis as part of the Project Navigational Risk Assessment (NRA) [APP-073]. identified that one of the ferry route options between Liverpool and Belfast would be diverted by the Project. This route has been shown to be used roughly once every two days. In the Statement for Common Ground with Stena Line [REP1-062], it is acknowledged that the Morecambe Project may result in a 1.6 nautical mile (NM) deviation on the impacted route.

14. Stena Line provided comments on the Preliminary Environmental Information Report (PEIR) on 02 June 2023 as part of the statutory consultation process, including the following statement "*The GHG Emissions for the Transmission Assets for Morecambe and Morgan Windfarms have not been considered in the assessments. There are GHG Emissions associated with the Transmission Assets for Morecambe and Morgan Windfarms which should be considered in determining the overall GHG Emissions footprint and carbon payback periods*".

15. The Applicant responded to this comment in Table 21.1 of Chapter 21 of the Environmental Statement [APP-058]:

16. "*The GHG assessment within this chapter considers emission sources directly associated with the Project, and therefore indirect effects such as the diversion of vessels have not been included. Any changes to vessel travel associated with the provision of the Project-alone is likely to result in a nonsignificant increase in journey times, as detailed in Chapter 14 Shipping and Navigation. Therefore, inclusion of indirect effects such as changes to vessel journey times is not considered to change the outcomes of the assessment. Indirect emissions arising from increased journey times to ferry and commercial vessel routes affected by the Project are estimated at 37.2 tonnes CO_2e/year, which is considered negligible compared to other emission sources. Emission calculation and assumptions behind this figure are provided in Appendix 21.1*."

17. The assessment made by the Applicant is provided in further detail in **Section 3.2**, alongside assessment of other commercial routes with a deviation identified in the NRA.

3 Methodology

3.1 Wake Effects Assessment

18. Two scenarios have been considered to calculate the net effect of wake losses on GHG emissions, accounting for different decommissioning dates for the Ørsted IPs existing offshore wind farms:

- **Business as usual (BaU):** annual energy production from the existing Ørsted IPs offshore wind farms in the Irish Sea, in the absence of the Morecambe Project.
- **Presence and operation of the Morecambe Project:** energy production from the Morecambe Project, accounting for the potential reduction in energy production due to wake effects, measured from the Ørsted IPs operational date until:
  - The expected earliest decommissioning date of the Ørsted IPs offshore wind farms; and
  - The potential decommissioning date being extended to cover a 35-year operational lifetime for each of the Ørsted IPs offshore wind farms.

19. The following methodology was adopted to determine the effects of GHG emissions associated with wake loss:

- The annual energy production by the Ørsted IPs Projects was calculated based on the size of each offshore wind farm (in MW), and the capacity factor in the absence of any wake effects (business as usual scenario).
- Annual energy production of Ørsted IPs Projects was calculated including the influence of the wake effects associated with the Morecambe Project.
- The reduction in energy production at the Ørsted IPs Projects was calculated, considering the earliest decommissioning dates for the Ørsted IPs Projects, and the dates under lifetime extension scenarios.
- The resulting effects on GHG emissions from the reduction in energy production was calculated using the same approach as the two scenarios adopted in the EIA (discussed in **Section 2.1**).

20. Data sources used to conduct the calculations are presented in **Table 3.1.**

Table 3.1 Data sources used in the wake effect calculations

Data source	Data contents
Wake Impact Assessment report Rev 1-2, Irish Sea Cluster – Ørsted IPs Deadline 3 Submission [REP3-112]	Offshore wind farm capacities (MW) of Ørsted IPs Projects Ørsted IPs Projects' commissioning dates for offshore wind farms Estimated wake losses for Ørsted IPs Projects
Responses to ExQ1, Ørsted IPs Deadline 3 Submission [REP3-109], Q ref 1OOI3.	Ørsted IPs Projects' earliest expected decommissioning dates for offshore wind farms Implied capacity factors (%) for Ørsted IPs Projects
Morecambe Offshore Windfarm: Generation Assets Environmental Statement, Volume 5, Chapter 21 Climate Change, [APP-058], Table 21.18 *'Do Nothing' scenarios for the GHG assessment's baseline*	Morecambe Project's anticipated electricity production and avoided emissions

3.1.1 Business-as-Usual scenario

21. The annual electricity production for the Ørsted IPs offshore wind farm projects was calculated based on the information provided in **Table 3.2**. The earliest decommissioning dates, installed capacities, and capacity factor for each of the Ørsted IPs offshore wind farm projects was obtained from the responses to the first written questions of the ExA by the Ørsted IPs, submitted at Deadline 3 [REP3-109].

Table 3.2 Ørsted IPs Offshore Wind Farm Details

Existing Project	Commissioning Date	Earliest Expected Decommissioning Date	Decommissioning Date with 35-year lifetime	Installed Capacity (MW)	Capacity Factor (%)
Barrow	2006	2030	2041	90	34%
Walney 1	2011	2035	2046	183.6	39%
Walney 2	2012	2036	2047	183.6	44%
Walney Extension 3	2018	2042	2053	330	45%
Walney Extension 4	2018	2042	2053	329	45%
West of Duddon Sands	2014	2038	2049	388.8	43%
Burbo Bank	2007	2031	2042	90	32%
Burbo Bank Extension	2017	2041	2052	256	40%

22. Annual energy production for the BaU scenario was calculated using the following equation:

$$\begin{aligned} &BaU\ annual\ energy\ production\ (MWh\ per\ year) \\ &\qquad = Installed\ Capacity\ (MW) * Capacity\ Factor(\%) \\ &\qquad * 8766\ hours\ per\ year \end{aligned}$$

23. Energy production over the remaining lifetime of the for the Ørsted IPs offshore wind farms was calculated for the two decommissioning scenarios presented in **Table 3.2.** These included:

- Earliest expected decommissioning of Ørsted IPs offshore wind farms; and
- Decommissioning with a 35-year lifetime for Ørsted IPs offshore wind farm.

24. The earliest expected commissioning date for the Morecambe Project (2029) was used to determine the energy production over the remaining lifetime of the Ørsted IPs offshore wind farms.

3.1.2 Wake Effects

25. Wake loss effects associated with the Morecambe Project were obtained from analysis completed by Wood Thilsted Partners Ltd (2024) (REP3-112), and provided in **Table 3.3**.

Table 3.3 Wake Effects of the Morecambe Project on Ørsted IPs Offshore Wind Farms

Barrow	Walney 1	Walney 2	Walney Extension 3	Walney Extension 4	West of Duddon Sands	Burbo Bank	Burbo Bank Extension
1.37%	0.53%	0.32%	0.40%	0.56%	1.01%	0.46%	0.45%

26. The reduction in annual energy production at the Ørsted IPs offshore wind farms, as a result of wake effects was calculated using the following equation:

$$\begin{aligned}&Annual\ energy\ loss\ (MWh\ per\ year)\\&\quad = BaU\ energy\ production\ (MWh\ per\ year)\\&\quad * Wake\ loss\ percentage\ (\%)\end{aligned}$$

27. The reduction in total energy production for the Ørsted IPs offshore wind farms as a result of wake effects was calculated using the following equation:

$$\begin{aligned}&Total\ energy\ reduction\ (MWh)\\&\quad = Annual\ energy\ loss\ (MWh\ per\ year) * Remaining\ lifetime\ (years)\end{aligned}$$

28. To evaluate the impacts on GHG emissions, the loss of avoided emissions at the Ørsted IPs offshore wind farms resulting from the reduction in remaining lifetime energy production was assessed using the two emission factor scenarios discussed in **Section 2.1**, which is consistent with Chapter 21: Climate Change of the Environmental Statement [APP-058]. These emission factors included:

- 'Non-renewable fuel' sources (DESNZ, 2023a); and
- Long-run marginal emission factor (DESNZ, 2023b).

29. The change in avoided emissions for all Ørsted IPs offshore wind farms (tonnes CO_2e) was compared to the avoided emissions as a result of the Morecambe Project, as reported in Chapter 21 of the Environmental Statement [APP-058].

3.2 Vessel Diversion

30. The methodology for calculating emissions from ferry and cargo routes affected by the Morecambe Project were presented in Appendix 21.1 of the Environmental Statement [APP-087].

31. The total annual vessel movements (2022 data) and additional route distances that vessels would have to travel following the implementation of the Morecambe Project were obtained from **Chapter 14 Shipping and Navigation** [APP-051], and **Appendix 14.1 Navigation Risk Assessment** [APP-073]. The data used in the assessment are provided in **Table 3.4.**

Table 3.4 Ferry and commercial vessel route diversions

Vessel Route	Total annual vessel count (2022)	Additional route distance (nm)	Total annual deviation distance (nm)
Ferry route			
Stena Line LIV-BEL (East of Isle of Man (IOM) – East of Calder)	196	1.6	314
Commercial vessel routes			
Liverpool East of IoM (East of Calder)	14	2.4	34
Liverpool East of IoM (West of Calder)	13	0.1	1
Heysham Off Skerries Temporary Threshold Shift (TSS) (Eastwards)	10	2.4	21
Heysham Off Skerries TSS (Westwards)	7	1.4	10
Barrow Off Skerries TSS (Eastwards)	13	1.7	22
Barrow Off Skerries TSS (Westwards)	4	-0.4	-2

32. Indicative vessel types for the ferry and commercial vessels were assumed from the unique vessels intersecting the windfarm site, as reported in **Appendix 14.1** of the Environmental Statement [APP-073].

33. For the methodology adopted for the GHG assessment in Chapter 21 of the Environmental Statement (detailed in Appendix 21.1, [APP-087]), it was assumed that affected ferries would be powered by Liquefied Natural Gas (LNG), as the Stena Edda is a new build vessel which is LNG-ready. There is considerable uncertainty regarding the uptake of alternative fuels in the shipping sector, therefore to present a conservative assessment in GHG terms, it was assumed that all vessels would be powered by Marine Gas Oil (MGO). This is likely to result in an overestimation of GHG emissions, as the uptake of zero- or low-carbon fuel alternatives and other decarbonisation

initiatives in the maritime sector is likely to occur over the operational lifespan of the Morecambe Project.

34. Parameters used to calculate emissions from deviated vessels are presented in **Table 3.5**.

Table 3.5 Parameters used to Calculate Emissions from Diverted Vessels

Vessel	Vessel Speed (kn)	Total annual deviation distance (nm)	Additional Transit Time (hours per year)	Propulsion Engine (kW)	Auxiliary Engine	Additional Power (kW)
Ferry route						
Stena Edda	22	314	14.3	25,207	4,080	197,439
Commercial vessel routes						
Celtic Fortune	10	34	8.7	1,800	336	6,453

4 Results

35. Predicted GHG savings during the operational and maintenance phase of the Morecambe Project were presented in **Table 21.25** of Chapter 21 of the Environmental Statement [APP-058], which are reproduced in **Table 4.1**.

Table 4.1 Predicted GHG Savings Associated with the Morecambe Project as Presented in the ES

Baseline scenario	Project's total operation and maintenance GHG emissions (tonnes CO_2e)	GHG emissions from 'Do Nothing' scenarios (tonnes CO_2 / CO_2e)	GHG emissions saved by operation of the Project (tonnes CO_2e)
Do Nothing Scenario 1 GHG emissions from electricity generated using 'non-renewable fuels'	517,145*	36,441,151	**-35,924,007**
Do Nothing Scenario 2 GHG emissions from the long run marginal emission factor		1,418,906	**-901,761**
* There was a typographical error in Chapter 21 where the Projects total operational and maintenance emissions was listed to be 516,854 tonnes CO_2e, rather than 517,145 tonnes, as reported in Table 21.24 of the Chapter. This typographical error did not affect the GHG emissions saved values presented in Table 21.25.			

36. The figures presented in **Table 4.1** only account for the emissions released during the operation and maintenance of the Morecambe Project. To provide a complete lifetime assessment, emissions from the construction and decommissioning phases of the Morecambe Project were also included as part of this indirect effects assessment. As detailed in **Section 4.3**, across its full lifecycle, the Morecambe Project was predicted to release 1,413,858 tonnes CO_2e, as stated in **Table 21.26** of Chapter 21 of the Environmental Statement [APP-058]. It is noted however that a number of conservative assumptions were adopted in line with the Rochdale Envelope approach to calculate emissions arising from project related activities.

4.1 Wake Effects Assessment

4.1.1 Business-as-Usual scenario

37. The annual energy production under the BaU scenario, and under the remaining lifetime off the Ørsted IPs offshore wind farms for both of the decommissioning scenarios are presented in **Table 4.2**. These values were calculated using 8,766 hours in a year to account for leap years. The emission savings associated with the operation of the Morecambe Project, as reported in Chapter 21 of the Environmental Statement [APP-058] and reproduced in **Section 4** were calculated using 8,760 hours in a year.

38. Therefore, the calculation of avoided emissions from wake loss Ørsted IPs offshore wind farms includes an additional six hours per year when compared to those calculated for the operation of the Morecambe Project.

Table 4.2 Business-as Usual Ørsted IPs Offshore Wind Farm Energy Production

Existing Project	Annual Energy Production (MWh)	Remaining Lifetime Energy Production to Earliest Expected Decommissioning Date (MWh)	Remaining Lifetime Energy Production to Decommissioning Date with 35-year lifetime (MWh)
Barrow	268,240	536,479	3,487,115
Walney 1	627,681	4,393,765	11,298,252
Walney 2	708,153	5,665,220	13,454,898
Walney Extension 3	1,301,751	18,224,514	32,543,775
Walney Extension 4	1,297,806	18,169,288	32,445,158
West of Duddon Sands	1,465,535	14,655,349	30,776,234
Burbo Bank	252,461	757,382	3,534,451
Burbo Bank Extension	897,638	11,669,299	21,543,322
Total	**6,819,265**	**74,071,296**	**149,083,205**

4.1.2 Wake Effects

39. The energy loss for each of the Ørsted IPs offshore wind farm under both of the two decommissioning scenarios are presented in **Table 4.3**.

Table 4.3 Wake Effects on Ørsted IPs Offshore Wind Farm Energy Production

Existing Project	Wake Loss (%)	Annual Energy Loss (MWh)	Total Energy Reduction to Earliest Expected Decommissioning Date (MWh)	Total Energy Reduction to Decommissioning Date with 35-year lifetime (MWh)
Barrow	-1.37%	3,675	7,350	47,773
Walney 1	-0.53%	3,327	23,287	59,881
Walney 2	-0.32%	2,266	18,129	43,056
Walney Extension 3	-0.40%	5,207	72,898	130,175
Walney Extension 4	-0.56%	7,268	101,748	181,693
West of Duddon Sands	-1.01%	14,802	148,019	310,840
Burbo Bank	-0.46%	1,161	3,484	16,258
Burbo Bank Extension	-0.45%	4,039	52,512	96,945
Total	**-**	**41,745**	**427,427**	**886,621**

40. The annual energy loss from the predicted wake effects were calculated to be 41,745 MWh. It should be noted that the Morecambe Project alone is expected to generate 2,456,000 MWh (2,456 GWh) per year, providing a much higher quantity of renewable energy than any potential wake loss that would occur. The predicted wake loss from the Ørsted IPs offshore wind farms is 1.7% of the total electricity generation by the Morecambe Project in a year (in the event that all operational projects extend beyond 2030). This figure will also reduce year on year as the Ørsted IPs offshore wind farms are decommissioned, therefore the figure of 41,745 MWh is highly precautionary and would only be realised for a period of between one and eleven years depending on which decommissioning dates are used from **Table 3.2**.

41. Based on the results in **Table 4.3**, the effects of wake loss associated with the Morecambe Project on GHG savings from the Ørsted IPs offshore wind farms for each of the electricity displacement scenarios are summarised in **Table 4.4**.

Table 4.4 Impact of Wake Effects on Avoided Emissions

	Scenario 1 - Non-renewable fuels emissions factor (tonnes CO_2e)	**Scenario 2 - Long-run marginal emissions factor (tonnes CO_2e)**
Loss in Avoided Emissions from Ørsted IPs projects		
Earliest expected decommissioning date	181,229	22,181
Decommissioning Date with 35-year lifetime	375,927	27,316

42. The wake effects from the Morecambe Project would result in a loss of avoided emissions between 22,181 tonnes CO_2e (long-run marginal emission factor) and 181,229 tonnes CO_2e (non-renewable fuels emission factor) if the Ørsted IPs offshore wind farm projects were to be decommissioned by the earliest expected date; and between 27,316 tonnes CO_2e (long-run marginal emission factor) and 375,927 tonnes CO_2e (non-renewable fuels emission factor) if the lifetime of the Ørsted IPs offshore wind farm projects were to be extended to 35 years.

43. The resulting effect on emission savings associated with the Morecambe Project are discussed in **Section 4.3**.

4.2 Vessel Diversion

44. Predicted GHG emissions from the diversion of vessels, using the parameters in **Table 3.5** were calculated to be 51.3 and 1.7 tonnes CO_2e per year from ferries and commercial vessels respectively. Over the 35-year operational lifespan of the Morecambe Project, this equates to 1,855 tonnes CO_2e.

45. These figures were derived from the assumption that all diverted vessels would operate using MGO, rather than alternative fuels such as LNG and methanol. If these alternative fuels were adopted, it would be expected than annual emissions from diverted marine vessels would be less.

4.3 Net Effects

46. The effects of indirect GHG emissions associated with wake loss at the Ørsted IPs offshore wind farms and vessel diversions are presented in **Table 4.5**. Wake loss effects associated with the 35-year lifetime decommissioning dates were used in **Table 4.5** to present a conservative scenario.

47. To present a comprehensive assessment, GHG emissions generated across the lifecycle of the Morecambe Project, as well as a proportion of the Transmission Assets which are shared with the Morgan Offshore Wind Project

and subject to a separate DCO application, are considered. A reasonable proportion was derived by apportioning the proposed generation capacities of both projects to determine the GHG contribution from the Morecambe Project, which was calculated to be around 24% based on the capacity of the projects and the specifications and size of the transmission infrastructure required (480 MW for Morecambe and 1,500 MW for Morgan).

Table 4.5 GHG emission savings associated with the Morecambe Project, accounting for indirect emission sources

Parameter	Scenario 1 - Non-renewable fuels emissions factor (tonnes CO_2e)	Scenario 2 - Long-run marginal emissions factor (tonnes CO_2e)
Avoided emissions	-36,441,151	-1,418,906
Lifecycle emissions for the Morecambe Project	1,413,858	1,413,858
Transmission Assets (proportion of the Morecambe Project).	341,116	341,116
Net Effects Without Indirect Emission Sources	**-34,686,177**	**336,068**
Wake Loss Effects, assuming 35-year decommissioning dates	375,927	27,316
Vessel Diversion	1,855	1,855
Net Effects Accounting for Indirect Emission Sources	**-34,308,394**	**365,240**

48. The results presented in **Table 4.5** reflect two indicative scenarios which are subject to limitations, which are described in **Section 2.1**.

49. The Ørsted IPs note that they do not expect to require additional consent (beyond marine licences for maintenance activities) to continue the operation of its developments beyond their earliest decommissioning dates, which are listed in **Table 3.2**. The Wake Effects assessment has been undertaken on the basis of each of the Ørsted IPs offshore wind farm reaching a 35-year operational life. It is noted however, that the ongoing operation and maintenance of each of these wind farms will require activities resulting in the release of GHG emissions, such as the provision of spare parts, and marine vessel and helicopter movements. The level of current operational and maintenance activities associated with Ørsted IPs windfarms is not known, and therefore has not been accounted for in this assessment, however across the eight projects, with some nearing the end of their design life, operational

and maintenance emissions would reasonable be expected that emissions would be higher than that of the Project maintenance.

50. Emissions during the operational and maintenance phase of the Morecambe Project were estimated to be approximately 14,776 tonnes CO_2e per year, as reported in Table 21.24 of Chapter 21 of the Environmental Statement [APP-058]. Given the size of the Ørsted IPs offshore wind farms, it is considered to be likely that operational and maintenance emissions would be at least equivalent to those predicted for the Morecambe Project.

51. Furthermore, as discussed in paragraph 37, the calculation of avoided emissions from wake loss at the Ørsted IPs offshore wind farm projects is derived from a period of six hours greater than those reported in Chapter 21 of the Environmental Statement [APP-058]. The figures in **Table 4.5** also assume that each of the Ørsted IPs offshore wind farm projects reach a lifespan of 35 years, therefore presenting a conservative scenario.

52. While the loss in avoided emissions in Wood Thilsted Partners (2024) Wake Impact Assessment Report also included the cumulative wake effects of Morecambe, Mona and Morgan Wind Farm Projects on the Ørsted IPs offshore wind farms, this has not been calculated in this technical note. It is expected that a calculation of wake effect impacts in a cumulative scenario would have similar results, in that the total avoided GHG emissions resulting from the operation of these projects would outweigh the loss in avoided emissions for the Ørsted IPs offshore wind farm projects.

4.4 Discussion

53. When considering scenario 1, the change in emissions from wake effects from the addition of indirect effects is significantly outweighed by the avoided emissions the Morecambe Project would enable if generation from fossil fuel sources is replaced. It should be noted that the emission factor only encompasses the operational use of the fossil fuel to generate emissions, and not the supply chain nor any maintenance activities. This scenario however aligns with the Overarching National Policy Statement for Energy (EN-1) and the Net Zero Strategy to transition from fossil fuel generation to renewables (a transition which is ongoing but has not yet fully happened).

54. Under scenario 2, when considering the data in **Table 4.5** and whole life cycle emissions, there would not be avoided emissions associated with the Morecambe Project. As discussed in paragraph 6, there are limitations in using the long-run marginal emission factor to estimate levels of avoided emissions, as the adoption of new renewable energy schemes such as the Morecambe Project are factored into the modelling (i.e. it assumes that the low carbon transition has happened). In particular, it is expected that new energy infrastructure would replace older generation projects to maintain and

continue the UK's trajectory towards net zero. This aligns with paragraph 3.3.3 of the Overarching National Policy Statement for Energy (EN-1) which states "*To ensure that there is sufficient electricity to meet demand, new electricity infrastructure will have to be built to replace output from retiring plants and to ensure we can meet increased demand*."

55. As also noted in **Section 2.1**, there are limitations when using either scenario, and a balanced approach where both scenarios are considered remains an appropriate approach, as has been taken in the GHG assessment in Chapter 21.

56. In addition, the contribution from the ongoing operation and maintenance of the Ørsted IPs offshore wind farm projects have been omitted from this assessment, as outlined in paragraph 50, meaning a direct comparison is not possible.

57. The analysis presented in this note highlights that the outcome of the GHG assessment in Chapter 21 of the Environmental Statement which highlighted that there would be a net benefit in emissions associated with the Morecambe Project would remain (on the continuing assumption that Scenario 2 in isolation is not conservative and not an appropriate basis to draw conclusions on emissions as a whole).

58. The implementation of the Morecambe Project will have the largest benefit to the UK's GHG emissions, and rollout of renewable energy production, despite any indirect emissions such as potential wake effects causing losses to the Ørsted IPs offshore wind farm projects and diverted vessels.

5 Summary

59. The analysis of indirect effects and the results presented in **Section 4**, demonstrate that the wake effects and vessel diversions would not have a material impact on the outcomes of the GHG assessment. The change in reported GHG savings associated with potential wake effects of the Morecambe Project on the Ørsted IPs operational wind farm projects is proportionately very small compared to the renewable energy generated by the Project (both scenarios), and outweighed by the avoided emissions from the Morecambe Project replacing fossil fuel sources (scenario 1).

60. There are limitations associated with the comparison of avoided emissions under scenario 2, which uses the long run marginal factor to predict the quantity of avoided emissions. The modelling undertaken to generate the long run marginal factor assumes the replacement of older generation schemes with new infrastructure such as the Morecambe Project. In addition, the net effects reported in Section 4.3 do not account for any emissions associated with the operation and maintenance of the Ørsted IPs operational wind farm projects.

As noted in paragraph 40, any loss of generation at the Ørsted IPs operational wind farm projects is far outweighed by the annual quantity of generation by the Morecambe Project. This considers the annual energy loss from the predicted annual worst case wake effects calculated to be 41,745 MWh and the 2,456,000 MWh (2,456 GWh) produced by the Project per year, providing a much higher quantity of renewable energy than any potential wake loss that would occur. The predicted wake loss from the Ørsted IPs offshore wind farms is 1.7% of the total electricity generation by the Morecambe Project in a year, and 1.0% over its lifetime, noting this does not factor in emissions associated with the operation and maintenance of the Ørsted IPs offshore wind farms.

6 References

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