DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 2
Appendix 31.2 Greenhouse Gas Assessment Methodology

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Glossary

Term	Definition
Carbon Dioxide Equivalents (CO_2e)	A term for describing different greenhouse gases in a common unit. The unit takes the different global warming potentials of greenhouses gases into account. CO2e signifies the amount of carbon dioxide which would have the equivalent global warming impact.
Climate Change	A long-term change in global or regional climate patterns, such as seasonal averages and extremes.
Design	All of the decisions that shape a development throughout its design and pre-construction, construction / commissioning, operation and, where relevant, decommissioning phases.
Development Consent Order (DCO)	A consent required under Section 37 of the Planning Act 2008 to authorise the development of a Nationally Significant Infrastructure Project, which is granted by the relevant Secretary of State following an application to the Planning Inspectorate.
Effect	An effect is the consequence of an impact when considered in combination with the receptor’s sensitivity / value / importance, defined in terms of significance.
Embodied Carbon	Greenhouse gas emissions from upstream activities associated with materials, including extraction and processing of raw materials, transport to manufacturing site and manufacturing of products.
Energy Storage and Balancing Infrastructure (ESBI)	A range of technologies such as battery banks to be co-located with the Onshore Converter Station, which provide valuable services to the electrical grid such as storing energy to meet periods of peak demand and improving overall reliability.
Environmental Impact Assessment (EIA)	A process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information and includes the publication of an Environmental Statement.
Greenhouse Gas	A gas that traps heat in the atmosphere and causes the greenhouse effect. Greenhouse gas can also be referred to by its shorthand as “carbon”.
Impact	A change resulting from an activity associated with the Project, defined in terms of magnitude.
Inter-Array Cables	Cables which link the wind turbines to the offshore platform(s).

Term	Definition
Jointing Bays	Underground structures constructed at regular intervals along the onshore export cable corridor to facilitate the joining of discrete lengths of the installation of cables.
Landfall	The area on the coastline, south-east of Skipsea, at which the offshore export cables are brought ashore, connecting to the onshore export cables at the transition joint bay above Mean High Water Springs.
Lifecycle Module	A broad category used to identify and report greenhouse gas emission sources across a project's whole lifecycle.
Link Boxes	Structures housing electrical equipment located alongside the jointing bays in the onshore export cable corridor and the transition joint bay at the landfall, which could be located above or below ground.
Net Zero	When total greenhouse gas emissions are equal to or less than the emissions removed from the atmosphere, which can be achieved by a combination of emission reduction and removal.
Offshore Export Cable Corridor (ECC)	The area within which the offshore export cables will be located, extending from the DBD Array Area to Mean High Water Springs at the landfall.
Offshore Export Cables	Cables which bring electricity from the offshore platform(s) to the transition joint bay at landfall.
Offshore Platform(s)	Fixed structures located within the DBD Array Area that contain electrical equipment to aggregate and, where required, convert the power from the wind turbines, into a more suitable voltage for transmission through the export cables to the Onshore Converter Station. Such structures could include (but are not limited to): Offshore Converter Station(s) and an Offshore Switching Station.
Onshore Converter Station (OCS)	A compound containing electrical equipment required to stabilise and convert electricity generated by the wind turbines and transmitted by the export cables into a more suitable voltage for grid connection into Birkhill Wood Substation.
Onshore Export Cable Corridor (ECC)	The area within which the onshore export cables will be located, extending from the landfall to the Onshore Converter Station zone and onwards to Birkhill Wood Substation.
Onshore Export Cables	Cables which bring electricity from the transition joint bay at landfall to the Onshore Converter Station zone (HVDC cables) and from the Onshore Converter Station zone onwards to Birkhill Wood Substation (HVAC cables).

Term	Definition
Operation and Maintenance (O&M) Base Port	The operation and maintenance (O&M) base port will be the home for the Project’s service vessels, crew transfers and the control centre for managing marine logistics and traffic for offshore O&M activities. At this stage, no decision has been made regarding which port(s) would be used for the Project’s offshore O&M activities. A decision upon an O&M base port would not be made until post DCO determination.
Project Design Envelope	A range of design parameters defined where appropriate to enable the identification and assessment of likely significant effects arising from a project’s worst-case scenario. The Project Design Envelope incorporates flexibility and addresses uncertainty in the DCO application and will be further refined during the EIA process.
Scour Protection	Protective materials used to avoid sediment erosion from the base of the wind turbine foundations and offshore platform foundations due to water flow.
Study Areas	A geographical area and / or temporal limit defined for each EIA topic to identify sensitive receptors and assess the relevant likely significant effects.
Temporary Construction Compounds	Areas set aside to facilitate the construction works for the onshore infrastructure, which include the landfall construction compound, main and intermediate construction compounds for onshore export cable works and OCS and ESBI construction compounds.
The Applicant	SSE Renewables and Equinor acting through 'Doggerbank Offshore Wind Farm Project 4 Projco Limited'.
The Project	Dogger Bank D (DBD) Offshore Wind Farm Project, also referred to as DBD in this PEIR.
Transition Joint Bay (TJB)	An underground structure at the landfall that houses the joints between the offshore and onshore export cables.
Wind Turbines	Power generating devices located within the DBD Array Area that convert kinetic energy from wind into electricity.

31.2 Greenhouse Gas Assessment Methodology

31.2.1 Introduction

1. This appendix to the Dogger Bank D Offshore Wind Farm (hereafter "the Project" or "DBD") Preliminary Environmental Information Report (PEIR) supports **Volume 1, Chapter 31 Climate Change**.

2. The purpose of this technical appendix is to present the detailed greenhouse gas (GHG) assessment methodology, associated activity data, emission factors and assumptions used for calculating GHG emissions arising from the Project during the construction, operation and maintenance (O&M) and decommissioning phases. A full description of the Project is provided in **Volume 1, Chapter 4 Project Description.** This appendix informs the realistic worst-case scenarios for the GHG assessment presented in **Table 31-6** of **Volume 1, Chapter 31 Climate Change**.

3. The emissions sources (and their associated lifecycle module(s)) considered in this appendix are detailed in **Table 31.2-1**.

Table 31.2-1 Lifecycle Modules and Emission Sources Considered in the Greenhouse Gas Assessment

Section	Emission Source(s)	Lifecycle Module(s)*
Section 31.2.2.1 Embodied carbon in materials	Embodied carbon in construction materials from upstream supply chain activities.	Modules A1-A3
	Embodied carbon in spare parts used during repair and replacement events from upstream supply chain activities.	Modules B3-B4
Section 31.2.2.2 Marine vessels	Emissions arising from marine vessels travelling to / from the offshore construction site and undertaking pre-construction activities.	Module A0
	Emissions arising from marine vessels travelling to / from the offshore construction site.	Module A4
	Emissions arising from marine vessels undertaking offshore construction activities.	Module A5
	Emissions arising from marine vessels used for offshore O&M activities.	Modules B2-B4

Section	Emission Source(s)	Lifecycle Module(s)*
Section 31.2.2.3 Road vehicles	Emissions arising from road vehicles travelling to / from the onshore construction site.	Module A4
	Emissions arising from road vehicles used for onshore O&M activities.	Modules B2-B4
Section 31.2.2.4 Helicopters	Emissions arising from helicopters travelling to / from the offshore construction site.	Module A4
	Emissions arising from helicopters used for offshore O&M activities.	Modules B2-B4
Section 31.2.2.5 Onshore plant and equipment	Emissions arising from plant and equipment undertaking onshore construction activities.	Module A5
Section 31.2.2.6 Fugitive emissions	Fugitive sulphur hexafluoride (SF_6) emissions from the use of electrical equipment during operation.	Module B1
Section 31.2.2.7 End of life	Emissions arising from decommissioning activities and downstream end-of-life processes.	Modules C1-C4

*See **Table 31-9** of **Chapter 31 Climate Change** for further information on the different lifecycle modules

4. A number of assumptions are made in the GHG assessment, which are presented in **Table 31-11** of **Volume 1, Chapter 31 Climate Change** and expanded further in this appendix.

5. It is not anticipated that significant updates to the GHG assessment will be required at the Environmental Statement (ES) stage. However, additional or more refined project information (i.e. refinement to the Project Design Envelope) may become available and provided for the assessment at ES stage. This will enable a refinement of the GHG emission calculations to be undertaken where required. Any refinement to the GHG assessment between PEIR and ES is unlikely to change the effect significance concluded in the GHG assessment prepared for the PEIR.

31.2.2 Emission Sources and Methodology

6. In order to account for all the relevant emission sources within the Study Area for the GHG assessment (as defined in **Section 31.2.2.1** of **Volume 1, Chapter 31 Climate Change**, emission sources have been categorised into lifecycle modules adapted from the PAS 2080 *'Carbon Management in Buildings and Infrastructure'* guidance (BSI, 2023) and The Carbon Trust's *'Offshore Wind Industry Product Carbon Footprinting Guidance'* (2024), and then further by type of emission source, as detailed in **Table 31-9** of **Volume 1, Chapter 31 Climate Change**.

7. To avoid repetition, the methodology discussed in the following sections focuses on each type of emission source, as the same emission sources may belong to more than one life cycle module, e.g. marine vessels belong to numerous lifecycle modules (i.e. A0, A4, A5 and B2-B4). The relevant lifecycle modules to each type of emission source are identified throughout the following sections.

31.2.2.1 Embodied Carbon in Materials

8. 'Cradle-to-(factory) gate' emissions for the main materials to be used during construction and for spare parts during the O&M phase are calculated for the Project. The term 'cradle-to-factory gate' includes raw material extraction and processing, transport to the manufacturing facility, manufacturing and packaging of the materials to the point at which they leave the site of the final processing location. GHG emissions are derived from quantities or volumes of likely and / or known materials at this stage of the Project that will be used during construction and for spare parts and their likely material composition.

9. These include the following infrastructure components:

- The key offshore components of the Project comprise:
  - Wind turbines, including the tower, nacelle, rotor, blades;
  - Offshore platform topside;
  - Wind turbine and offshore platform foundations (e.g. piled- jacket, suction bucket jacket, gravity-based structure, etc.);
  - Scour and cable protection; and,
  - Offshore export and inter-array cables.
- The key onshore components of the Project comprise:
  - High Voltage Direct Current (HVDC) and High Voltage Alternating Current (HVAC) onshore export cables;
  - Onshore converter station (OCS);
  - Energy storage and balancing infrastructure (ESBI); and

- Other imported materials to support civil works for landfall, the onshore export cables, OCS and ESBI (e.g. engineering fill, asphalt, cement bound sand (CBS), ducting, fencing, etc.).

31.2.2.1.1 Construction (Modules A1 to A3)

10. Quantities for all materials to be used during construction are not available at the time of the assessment, therefore, estimated quantities of high volume and high embodied carbon content materials are included in the GHG assessment. To provide a conservative assessment, it is assumed that there will be no reduction in the GHG intensity of upstream supply chains of materials (e.g. emission reduction in manufacturing methods, low carbon material alternatives) up to and during the construction phase of the Project. This is considered to be a conservative approach as the GHG intensity of activities in sectors such as transport and industry in the UK and internationally is likely to decrease over time. The earliest construction start year of the Project is anticipated to be 2029.

11. It is assumed that all materials used for construction of the Project would require raw material extraction, e.g. virgin steel, to present a conservative assessment. However, it is likely that materials that will be used in construction will have a higher recycled content, and thus a lower embodied carbon content than what has been assumed for the assessment.

12. Worst-case assumptions are also adopted with respect to material quantities required for each infrastructure component of the Project, which account for contingencies to build flexibility into the Project Design Envelope (e.g. the maximum number of wind turbines or offshore platform(s)). The specific nature and composition of some materials, such as the type of steel to be used, is unknown, which may affect the embodied carbon content considered in the GHG assessment. Assumptions with respect to material composition are developed based on industry benchmarks and professional judgment using information provided by the Applicant, as outlined in **Table 31.2-2**.

13. Relevant emission factors sourced from the Inventory of Carbon and Energy (ICE) database v4.0 (Circular Ecology, 2024), where available, are then applied to the material quantities to calculate total tonnes of carbon dioxide equivalent (CO_2e), which is a common unit used to express the magnitude of GHG emissions. Where emission factors for specific components are not available in the ICE database, the relevant emission factors are obtained for other literature sources.

14. There are many possible design options included in the Project Design Envelope (e.g. foundation types for the wind turbines and offshore platform(s), type of electrical cable). The option with the highest GHG emission sources based on the worst-case material quantities required is quantified and included in the GHG assessment.

15. **Table 31.2-2** outlines the materials assumed for each key infrastructure components, their emission factors and data source(s), and any assumptions or caveats used in the GHG assessment.

Table 31.2-2 Emission Factors for Embodied Carbon in Construction Materials

Infrastructure Component(s)	Construction Material*	Emission Factor**	Notes	Data Source
Other onshore civils works	Aggregate	0.007	Aggregates and sand, general UK, mixture of land won, marine, secondary and recycled, bulk, loose. Assumed for scour protection and engineering fill.	ICE DB v4.0
Wind turbines, inter-array cables, offshore export cables, onshore export cables, OCS and ESBI	Aluminium	6.67	General, European mix including imports	ICE DB v4.0
Other onshore civils works	Asphalt	0.058	Assumed 7% binder content	ICE DB v4.0
Wind turbines	Wood	0.31	Assumed balsa / hardwood (as proxy), excluding carbon storage	ICE DB v4.0
Onshore export cables	Bentonite (proxy)	0.34	Used 'clay' as representative of bentonite	ICE DB v4.0
Onshore export cables and other onshore civils works	Cement Bound Sand (CBS) (proxy)	0.06	Used 'cement stabilised soil 5%' as proxy	ICE DB v4.0
OCS and ESBI	Ceramic	0.93	General	ICE DB v4.0
Offshore platform foundations, inter-array cables, offshore export cables, onshore export cables, OCS and ESBI	Concrete (average)	0.1	General	ICE DB v4.0

Infrastructure Component(s)	Construction Material*	Emission Factor**	Notes	Data Source
Wind turbines, offshore platform topside, inter-array cables, offshore export cables, onshore export cables, OCS and ESBI	Copper	3.81	Assumed virgin copper	ICE DB v4.0
Other onshore civils works	Ducting	2.52	High Density Polyethylene (HDPE) pipe	ICE DB v4.0
Wind turbines, OCS and ESBI	Epoxy resin (average)	5.44	Assumed average of epoxy resin product types	The Carbon Trust (2024)
Inter-array cables, offshore export cables and onshore export cables	Polymer (proxy)	2.97	Assumed ethylene vinyl acetate (EVA) as polymer	Almqvist and Larsson (2021)
Wind turbines, offshore platform topside, inter-array cables, offshore export cables and onshore export cables	Fibreglass (proxy)	4.18	Assumed average of polyamide profiles reinforced with 25% fibreglass and fibreglass mesh	The Carbon Trust (2024)
Inter-array cables, offshore export cables and onshore export cables	Galvanised Steel	2.62	Steel, hot-dip galvanized steel	ICE DB v4.0
Other onshore civils works	Geotextile membrane / geogrid	4.98	Assumed polypropylene	ICE DB v4.0
OCS and ESBI	Glass	1.44	General	ICE DB v4.0
Offshore platform topside	HPDE	1.93	HDPE resin	ICE DB v4.0
OCS	Insulation (average)	1.39	Assumed average of glass and mineral wool insulation	ICE DB v4.0
Inter-array cables and offshore export cables	Iron	2.03	General	ICE DB v4.0

Infrastructure Component(s)	Construction Material*	Emission Factor**	Notes	Data Source
Inter-array cables, offshore export cables and onshore export cables	Lead	3.37	Assumed virgin lead	ICE DB v4.0
OCS and ESBI	Lubricants	1.12	Assumed Q8 Henry 68	Q8 Oils (no date)
Wind turbines	NdFeB magnets (neodymium proxy)	27.6	N/A	Jin *et al*. (2016)
Offshore platform foundations	Olivine	0.07	N/A	GreenSand (2023)
OCS and ESBI	Paint	2.15	General	ICE DB v4.0
OCS and ESBI	Paper	1.29	Assumed paperboard (general)	ICE DB v4.0
OCS and ESBI	Plasterboard	0.24	N/A	ICE DB v4.0
Wind turbines, OCS and ESBI	Plastic	3.31	General	ICE DB v4.0
Inter-array cables and offshore export cables	Polyethylene ducting	2.54	General	ICE DB v4.0
Inter-array cables, offshore export cables and onshore export cables	Polypropylene Yarn	3.69	N/A	Cableizer (no date)
OCS and ESBI	Reinforced Concrete	0.24	Precast concrete beams and columns -steel reinforced with world average steel. Assumed for kerbs.	ICE DB v4.0
Wind turbines	Rubber	2.55	General	ICE DB v4.0

Infrastructure Component(s)	Construction Material*	Emission Factor**	Notes	Data Source
Other onshore civils works	Sand	0.01	Aggregates and sand, general UK, mixture of land won, marine, secondary and recycled, bulk, loose	ICE DB v4.0
Offshore platform topside, OCS and ESBI	SF_6	9.00	N/A	Campbell and McCulloch (1998)
Wind turbines, wind turbine foundation, offshore platform topside, offshore platform foundation, OCS, ESBI and other onshore civils works	Steel (Average)	2.34	Average of embodied CO_2e steel values provided in ICE database	ICE DB v4.0
Wind turbine foundation, offshore platform foundation, inter-array cables, offshore export cables, and other onshore civils works	Stone	0.079	General Assumed for cable protection and crushed run stone.	ICE DB v4.0
Other onshore civils works	Timber	0.49	Average, excluding carbon storage	ICE DB v4.0
Wind turbines, offshore platform topside, OCS and ESBI	Transformer Natural Ester Oil	1.40	N/A	Yu (2022)
Inter-array cables, offshore export cables and onshore export cables	Crosslinked polyethylene (XLPE)	1.93	N/A	Cableizer (no date)

* Not all construction materials are provided in the ICE database (or in other literature sources), therefore, some materials used a ‘proxy’ material that best represented the actual construction material. This is detailed further in the ‘Notes’ column, where relevant.

**In kg CO_2e per kg material, unless otherwise stated.

16. Limited information is currently available on the battery units and power conversion system (PCS) units associated with the ESBI. Therefore, estimates of the embodied carbon associated with the manufacturing of battery units and PCS units have been taken from literature. As advised by the Applicant, an embodied carbon value of 175kg CO_2e/kWh (Romare and Dahllöf, 2017) has been applied to an indicative installed storage capacity of 900 MWh (based on a 2-hour system) for the battery units, and an embodied carbon value of 83 kg CO_2e/kWp (EPD, 2023) has been used for the PCS units (where it has been assumed that kWp is equal to the kWh of the installed storage capacity). Where possible, these assumptions will be further refined at ES stage.

17. The emission factors in **Table 31.2-2** and discussed above are 'cradle-to-factory' and therefore do not account for GHG emissions from the transportation of materials to the construction site.

18. Emissions associated with the movement of materials to the site are quantified from the information available at this stage of the Project for marine vessels and road vehicles, as highlighted in **Volume 1, Chapter 31 Climate Change**, and detailed in **Sections 31.2.2.2** and **31.2.2.3** of this appendix respectively.

31.2.2.1.2 Operation (Modules B3 and B4)

19. Material quantities associated with spare parts to be used during repair and replacement events over the Project's O&M phase (anticipated to be approximately 35 years) are unknown at this stage and have been estimated by the Applicant based on previous experience and industry benchmarks. The following assumptions have been used in the GHG assessment for spare parts:

- Offshore infrastructure:
  - 11 km and 24 km of inter-array cables and offshore export cable replacement, respectively, over the O&M phase;
  - 10% replacement of converter valves associated with the offshore platform topside every third year;
  - 11% replacement of wind turbines and other electrical equipment associated with the offshore platform topside over the O&M phase; and
  - No routine replacement anticipated for other offshore infrastructure components.
- Onshore infrastructure:
  - 4 km and 2 km of HVDC and HVAC onshore export cable replacement, respectively, over the O&M phase;
  - Battery units will be replaced three times over the O&M phase, as the units have an expected lifetime of 10 to 15 years;
  - PCS units will be replaced once over the O&M phase;

  - 10% replacement of the OCS converter valves every third year; and
  - No routine replacement anticipated for other onshore infrastructure components.

20. Where possible, these assumptions will be further refined at ES stage.

31.2.2.2 Marine Vessels

21. Marine vessels will be used to bring materials, components and personnel to site, install offshore infrastructure (i.e. wind turbines, offshore platform topside, offshore foundations and cables) and provide crew accommodation and support during construction, commissioning and O&M activities.

22. In both the construction and O&M phases of the Project, two vessel operating modes are considered in the GHG assessment:

- In transit to / from site; and
- Undertaking activities on-site.

23. Emissions from these two modes are split by lifecycle module during construction (A4 – Transport to construction site and A5 – Construction respectively) but have been reported together for operation (as lifecycle modules B2-B4 – Maintenance, Repair and Replacement).

24. The number of vessel movements during construction and operation has yet to be defined in detail. Vessel logistics used in the GHG assessment were provided by the Applicant based on assumptions about the current best estimates of vessel movements required and may be further refined for ES. A detailed breakdown of duration that construction and O&M vessels would be on-site by vessel type is not known at this stage, therefore, realistic worst-case duration assumptions have been made using information available in the indicative offshore construction programme and offshore O&M strategy, and where possible, estimated from other comparable offshore wind projects (i.e. proportionate to the size of the Project). These will be further refined where information is available for the ES.

25. Marine vessel activities estimated for the Project are based on best practice guidance documents, including the United States Environmental Protection Agency's (US EPA) 'Port Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions' (2022) and the Global Maritime Energy Efficiency Partnerships Project's (GloMEEP) 'Port Emissions Toolkit' (2018).

26. Indicative vessel types, as shown in **Table 31.2-4** and **Table 31.2-5**, that will be used during construction and O&M activities were provided by the Applicant, and representative vessel specifications for these vessel types have been assumed from information provided by the Applicant and experience on comparable offshore wind projects. Based on the estimated vessel specifications, vessel parameters relevant to GHG emission calculations are obtained such as transit speed and engine sizes.

27. Vessel emissions during transit are calculated by dividing the total distance covered with the average transit speed to derive total transit time, which was multiplied by the propulsion and auxiliary engine power, their respective load factors and the emission factor. This calculation can be summarised as the following formula:

$$E_{transit} = \left(\left(A_{transit} \ x \ PE \ x \ LF_{prop} \right) + \left(A_{transit} \ x \ AE \ x \ LF_{aux} \right) \right) x \ EF$$

Where:

$\boldsymbol{E_{transit}}$ = *GHG emissions during transit (CO_2e)*

$\boldsymbol{A_{transit}}$ = *Activity (hours), defined as the product of the number of return trips and distance per return trip, divided by the vessel's average transit speed*

PE = Propulsion engine size (kW)

AE = Auxiliary engine size (kW)

LF = Load factors for the propulsion (prop) and auxiliary (aux) engines

EF = Emission factor (tonnes CO_2e/kWh)

28. Vessel emissions for offshore construction and O&M activities are calculated by multiplying the total on-site time provided by the propulsion and auxiliary engine power, their respective load factors and the emission factor. This calculation can be summarised as the following formula:

$$E_{site} = \left(\left(A_{site} \ x \ PE \ x \ LF_{prop} \right) + \left(A_{site} \ x \ AE \ x \ LF_{aux} \right) \right) x \ EF$$

Where:

$\boldsymbol{E_{site}}$ = *GHG emissions during offshore activities (CO_2e)*

$\boldsymbol{A_{site}}$ = *Activity (hours), defined as the total time on-site as provided by the Applicant*

PE = Propulsion engine size (kW)

AE = Auxiliary engine size (kW)

LF = Load factors for the propulsion (prop) and auxiliary (aux) engines

EF = Emission factor (tonnes CO_2e/kWh)

29. The emission factor for marine gas oil (MGO) used in the vessel emission calculations is 0.337 $kgCO_2e/kWh$, which has been obtained from the Department for Energy Security and Net Zero's (DESNZ) 'Greenhouse Gas Reporting: Conversion Factors' (2024). This emission factor is well-to-wake (WTW) and account for emissions released during the entire process of fuel production and delivery up to the point of consumption. It should be noted, however, that the maritime sector is expected to decarbonise over the Project's O&M phase, although projections regarding the rate and extent that such emission reduction will take place still hold considerable uncertainties. As a conservative estimate, it is therefore assumed that construction and O&M vessels will continue to use MGO. However, this is likely to result in an overestimation of GHG emissions, especially with respect to vessels used towards the latter end of the O&M phase.

30. The Applicant has provided example names of the different vessel types that would be used during construction and O&M activities, and vessel specifications (i.e. engine sizes, speeds) have been obtained from public vessel specification sheets where available. Propulsion engine sizes are assumed to include the main propulsion engines where provided. Auxiliary engine sizes tend to be undisclosed, therefore, they are estimated based on the total installed power calculated using a ratio provided in US EPA's report on vessel emissions (2009) where auxiliary engine sizes are not specified. The majority of vessels included in the GHG assessment could be broadly categorised as bulk carriers whose auxiliary to propulsion ratio is estimated at 0.222. For vessels without total installed power specified and whose type falls outside of the US EPA's ratio table, an indicative estimate of 10% of the propulsion engine size is assumed for the auxiliary engine (US EPA, 2009).

31. The vessel's operating mode, such as cruising, manoeuvring and hotelling, affects how much work is being undertaken by the propulsion and auxiliary engines. For the emission calculations, this is captured by the load factor, which represents the percentage of a vessel's maximum engine load while undertaking a specific activity. A vessel's engines are rarely operated at 100% of its maximum load due to fuel consumption costs, efficiency and engine maintenance requirements, therefore most vessel operators limit their engine load to around 83% or less (GloMEEP, 2018). During transit, load factors will be higher for propulsion than auxiliary engines, and vice versa for offshore construction and O&M activities. Load factors used in the vessel emission calculations are detailed in

Table 31.2-3.

Table 31.2-3 Vessel Engine Load Factors Assumed for the Project

Engine Type	Activity	Load Factor	Data Source	Assumptions
Propulsion engine	In transit	0.75	Assumption based on previous project experience	• Vessel assumed to be in cruising mode.
	On-site	0.31 (tugs) 0.38 (workboat and miscellaneous)	GloMEEP (2018)	• Vessel assumed to be in manoeuvring mode as a worst-case; and • All vessels assumed to be work boats with the exception of tugs.
Auxiliary engine	In transit	0.17	US EPA (2009)	• Vessel assumed to be in cruising mode; and • All vessels assumed to be bulk carrier, ocean-going tugs or miscellaneous (with the same cruising load factor).
	On-site	0.45		• Vessel assumed to be in manoeuvring mode as a worst-case; and • All vessels assumed to be bulk carrier, ocean-going tugs or miscellaneous (with the same maneuvering load factor).

32. Some elements of the data used to calculate GHG emissions from marine vessels are confidential at this stage due to commercial sensitivities, therefore, a detailed breakdown of information used to derive GHG emissions from this source is unavailable.

33. Due to the lack of information, emissions associated with the mobilisation of vessels to offshore construction and O&M base port(s) from their point of origin and the import of materials from their manufacturing point of origin have been excluded from the GHG assessment. Should further sourcing and logistics information become available, these emissions will be estimated in the ES.

34. Emissions from dredging activities during the construction of the Project are not included in the assessment, as a breakdown of information regarding dredging activities is not known by the Applicant at this stage.

31.2.2.2.1 Construction (Modules A4 and A5)

35. Vessel emissions during construction are derived from the sum of all in transit and offshore construction emissions, for all vessel types specified across the entire construction period. The indicative number of maximum marine vessel movements during construction is outlined in **Table 31.2-4**.

Table 31.2-4 Indicative Number of Maximum Marine Vessel Movements during Construction

Activity	Maximum Number of Vessel Round Trips	Indicative Vessel Type
Site preparation	243	Boulder clearance vessels, offshore construction support vessels (CSV), survey vessels (including unmanned survey vessels (USV) and geo-tech survey vessels), jack-up vessels (JUV))
Wind turbine foundation installation	1,808	Tugs, guard vessels, anchor handling tugs (AHT), general purpose cargo vessels, CSV, floating heavy lift vessels (HLV), JUV
Transition piece installation	113	JUV, HLV
Wind turbine installation	1,695	Tugs, guards, heavy transport vessels (HTV), floating HLV, semi-sub barges, JUV, barges, general purpose cargo vessels
Wind turbine commissioning	452	Service operation vessels (SOV), associated daughter craft (DC)
Offshore platform foundation installation	60	Floating HLV, guard vessels, CSV
Offshore platform topside installation	48	Floating HLV, semi-sub barges, AHT, guard vessels, tugs, barges, HTV
Offshore platform commissioning	38	JUV, support vessels
Scour, cable protection and ground installation	678	Rock dump vessels, multi-purpose support vessels, CSV
Inter-array cable installation and commissioning	1,884	Cable lay vessels, SOV, dive vessels, pre-lay grapel run (PLGR) vessels, dredging vessel, installation support vessels (ISV)

Activity	Maximum Number of Vessel Round Trips	Indicative Vessel Type
Offshore export cable and landfall installation and commissioning	376	Cable lay vessels, JUV, tenders, multi-cats and moored barges, SOV, dive vessels, PLGR vessels, dredging vessels
Miscellaneous vessels	132	Offshore supply vessels (OSV)

36. Vessels used during construction are assumed to travel to the offshore construction site from a range of locations. As realistically a range of marshalling and / or fabrication / assembly ports may be used during construction, a standard one-way distance of 1,000km has been assumed for the GHG assessment, which is the upper limit of reasonable distance based on previous project experience by the Applicant. Therefore, for PEIR, a distance of return distance of 2,000km has been applied to the maximum number of vessel round trips detailed in **Table 31.2-4**.

37. At this stage of the Project, it is difficult to approximate the duration vessels would be present and active on-site undertaking the construction activities listed in **Table 31.2-4,** given vessels vary in type, size and purpose, and there would be peaks and troughs in the number of and / or duration vessels that would be present on-site. It has therefore been assumed for PEIR that all vessels would be present on-site for an average of three weeks, as the Applicant has advised that vessels could operate between two to four weeks per trip, with the exception of site preparation vessels which are anticipated to be on site for two weeks.

31.2.2.2.2 Operation (Modules B2 to B4)

38. O&M vessel emissions are calculated as the sum of all in transit and offshore O&M emissions for all vessel types specified during a standard O&M year across the Project's O&M phase of approximately 35 years. O&M activities are categorised into preventative and corrective maintenance.

39. A variety of vessels will be required to transport personnel and spare parts and undertake O&M activities on-site, and these operations can be broadly divided between routine and ad-hoc. The indicative number of vessel movements and approximate duration on-site during the O&M phase is outlined in **Table 31.2-5**.

Table 31.2-5 Indicative Number of Maximum Marine Vessel Movements during Operation

Activity	Maximum number of Vessel Round Trips, per Year	Indicative Vessel Type	Duration On-Site, per Trip
Routine Operations			
Preventative and corrective maintenance on wind turbines, offshore platform(s) and foundations	39	SOV	Two weeks
	Based on board SOV	DC	Two weeks
Preventative and corrective maintenance on offshore platform(s)	12	Platform supply vessels (PSV), OSV	Two weeks
Various surveys of seabed and sub-sea assets as required by both DCO / Deemed Marine Licence (dML) requirements and asset integrity purposes	12	Survey vessels, research vessels, OSV, OCV, USV	Three months
Ad-Hoc Operations			
Corrective maintenance – major component repair / replacement activities	23	Wind turbine installation vessels, JUV, HLV, OCV	Two weeks
Corrective maintenance – cable repair / replacement activities	2	Cable layer with OSV, OCV	Three months
Corrective maintenance of foundations – anode replacement, j-tube repair / replacement	4	OSV, OCV	Four weeks
Corrective maintenance – cable remedial burial, cable protection replacement, scour rectification	4	Fall pipe vessels, OSV, OCV	Four weeks

40. Routine SOV (and associated DC) used during the O&M phase are provisionally assumed to operate from the Port of Tyne where the existing Dogger Bank O&M Facility is located[1], approximately 240km (one-way) from the Offshore Development Area. All other O&M vessels are unlikely to operate from the Port of Tyne and could realistically operate from any port in the North Sea basin. A one-way distance of 550km has been assumed for these vessel movements in the GHG assessment.

31.2.2.3 Road Vehicles

41. Road vehicle movements associated with the construction and O&M phases of the Project will result in the release of GHG emissions. GHG emissions were calculated from the total kilometres (km) travelled by heavy goods vehicles (HGV) and light vehicles (LV) (i.e. for staff transport) to / from site.

42. The total distance travelled by road vehicles during the whole construction phase has been provided by the traffic EIA specialists for the Project. Distances travelled during the construction phase are calculated for HGV and LV according to the assumptions used in **Volume 1, Chapter 26 Traffic and Transport**.

31.2.2.3.1 Construction (Module A4)

43. The indicative number of maximum construction road vehicle movements used to calculate GHG emissions are provided in **Table 31.2-6**.

Table 31.2-6 Indicative Number of Maximum Road Vehicle Movements during Construction

Vehicle Type	Total Distance Travelled (km) during Construction*
LV (e.g. passenger cars)	14,670,154
HGV	5,879,723
*Calculated using peak daily trips per week multiplied by the number of working days per week and assuming as a worst-case road vehicle originating from a Humber port.	

44. To provide a conservative assessment, the fleet make up (in terms of fuel and European vehicle emission standards) for the earliest year of construction (2029) is used in the assessment for LV. In addition, it is assumed that there would be no fuel efficiency improvements or reduction in emissions over the Project's O&M phase for each mode of transport in the GHG assessment.

[1] This is subject to detailed review post-consent and if not feasible, a suitable alternative in the north-east of England will be selected.

45. The forecasted 2029 fleet composition (i.e. proportion of diesel, petrol and electric cars) has been obtained from the Department for Transport (DfT) WebTAG data v1.23 (DfT, 2024). The proportion of diesel, petrol and electric cars in the UK fleet is used to determine a representative emission factor associated with the LV. The fleet composition used in the GHG assessment, and emission factors associated with each vehicle type, are provided in **Table 31.2-7**. WTW emission factors for each vehicle type have been obtained from DESNZ (2024).

Table 31.2-7 Calculation of Emission Factor Used for Light Vehicles

Vehicle Type	Forecasted Fleet Composition in 2029 (DfT, 2024)	Vehicle Emission Factor (kg CO_2e/km) (DESNZ, 2024)	Emission Factor used in GHG Assessment (kg CO_2e/km)
Petrol	44%	0.2105	0.185
Diesel	25%	0.2113	
Electric*	32%	0.1229	

*Assumed to be plug-in hybrid electric vehicle to provide a conservative assessment.

46. It is assumed that all HGV used on the Project would be diesel-powered. The WTW emission factor for HGV movements (50% laden, to account for one trip fully loaded and return trip empty) has been obtained from DESNZ (2024) and was 1.0125 kg CO_2e/km. In the absence of suitable empirical data, it is assumed that the fleet composition of HGV will not change over the temporal scope of the GHG assessment to provide a conservative approach.

31.2.2.3.2 Operation (Modules B2 to B4)

47. During the O&M phase of the Project, road vehicle movements would be limited to those generated by routine and unplanned inspection and maintenance activities and periodic replacement and repair of onshore infrastructure. It is therefore assumed that there would be one LV round trip movement per week during the 35-year O&M phase of the Project. This visit is assumed to be a 40km round-trip, i.e. 20km each way, and amounts to approximately 2,080km per year.

48. In addition, the ESBI components would need replacing during the O&M phase. In the worst-case scenario, it has been assumed that each battery unit would be replaced three times (since each has a lifespan of 10 to 15 years) and the PCS unit will be replaced once over the O&M phase. This would result in up to two HGV round trip movements per day in a year when replacements are made. It is assumed that a Humber port would be the origin of these ESBI component replacements (i.e. approximately 15km each way).

31.2.2.4 Helicopters

49. Helicopter movements associated with the construction and O&M phases of the Project will result in the release of GHG emissions. The quantity of GHG emissions from helicopters is calculated by determining the expected fuel consumption using trip data provided by the Applicant.

50. The Applicant provided the indicative number of helicopter trips, and the average distance travelled during construction and operation. These are outlined in **Sections 31.2.2.4.1** and **31.2.2.4.2** respectively. The total distance travelled by helicopters is determined by multiplying the number of trips by the average trip distance.

51. The Applicant has advised that a medium-sized offshore transport helicopter (e.g. Augusta Westland AW139, Airbus H179, etc.) is likely to be used for these activities. An AW139 has been used in the GHG assessment, as it is a larger helicopter with a higher fuel consumption, based on manufacturers' specifications, and therefore provides a conservative assessment. The average cruise speed and fuel consumption data for an AW139 has been obtained from manufacturers' specifications to estimate fuel consumption. The WTW emission factor for aviation turbine fuel (or jet fuel) has been obtained from the DESNZ (2024), which was 3,840 kg CO_2e/tonne fuel.

52. GHG emissions from helicopters are calculated using the following equation:

$$E=\left(\frac{\frac{D}{S} \times F}{1,000}\right) \times EF$$

Where:

E = GHG emissions (tonnes CO_2e)

D = Average trip distance (km)

S = Cruise speed (km/hr)

F = Fuel burn (kg/hr)

EF = Emission factor (kg CO_2e/tonne)

31.2.2.4.1 Construction (Module A4)

53. The construction heliport(s) under consideration for offshore construction personnel transport include any heliport on the east coast of England or Scotland, or the north coast of mainland Europe. The Applicant advised that the upper limit of reasonable marshalling distance based on previous project experience was 1,000km, therefore a worst-case one-way distance of 1,000km was used for the GHG assessment.

54. The Applicant advised that the maximum number of helicopter round trips throughout the construction phase would be 2,730.

31.2.2.4.2 Operation (Modules B2 to B4)

55. The likely O&M heliport(s) under consideration for offshore O&M personnel transport would include Humberside or Norwich airports based on previous project experience. The one-way distances from Humberside and Norwich to the Offshore Development Area are 270km and 290km, respectively, therefore, to provide a conservative assessment, it was assumed that Norwich airport would be used.

56. The Applicant advised that the maximum number of helicopter round trips per year during the O&M phase would be 24.

31.2.2.5 Onshore Plant and Equipment

31.2.2.5.1 Construction (Module A5)

57. Fuel consumption associated with the operation of plant and equipment for onshore construction activities are calculated based on the estimated use of each item of plant and equipment. The anticipated fuel demand over the duration of the construction phase is calculated, and the WTW emission factor for diesel (100% mineral diesel) consumption has been obtained from DESNZ (2024) to derive GHG emissions.

58. The following assumptions are adopted in the GHG assessment:

- Plant and equipment are assumed to primarily operate throughout the core working hours for the Project. An engine load factor of 75% is assumed and applied for each plant and equipment;
- On-time factors provided by the Applicant have been applied in the calculation of GHG emissions;
- It is assumed that plant and equipment is operated using diesel (100% mineral diesel) as fuel, which has a WTW emission factor of 0.331 kg CO_2e/kWh (DESNZ, 2024), to provide a conservative assessment; and
- Representative plant and equipment types have been provided by the Applicant, and these have been used to derived engine specifications from manufacturers' specifications or other publicly available information.

59. Indicative durations[2] for plant and equipment at the landfall, along the onshore ECC (corridor sections 1 to 14), and at the OCS zone are provided by the Applicant and are summarised in **Table 31.2-8**. Indicative plant and equipment details, including plant type, size, number and on-time factor, are provided in **Table 31.2-9**.

Table 31.2-8 Indicative Plant and Equipment Requirements and Duration for Onshore Construction Activities

Activity	Total Duration (weeks)[2]	Plant and Equipment References Required for Activity (see Table 31.2-9 for Details)
General Activities	259	1, 2, 3, 4, 7, 16, 17
Onshore ECC Section 1	5	6, 7, 9, 11, 12
Onshore ECC Section 2	41	6, 7, 9, 11, 12
Onshore ECC Section 3	34	6, 7, 9, 11, 12
Onshore ECC Section 4	19	6, 7, 9, 11, 12
Onshore ECC Section 5	31	6, 7, 9, 11, 12
Onshore ECC Section 6	18	6, 7, 9, 11
Onshore ECC Section 7	37	6, 7, 9, 11, 12
Onshore ECC Section 8	43	6, 7, 9, 11, 12
Onshore ECC Section 9	23	6, 7, 9, 11, 12
Onshore ECC Section 10	44	6, 7, 9, 11, 12
Onshore ECC Section 11	50	6, 7, 9, 11, 12
Onshore ECC Section 12	43	6, 7, 9, 11, 12
Onshore ECC Section 13	51	6, 7, 9, 11, 12
Onshore ECC Section 14	68	6, 7, 9, 11

[2] This is the consecutive duration for different sub-activities within each 'Activity' for the purpose of GHG emission calculations. It is realised that the total duration of each 'Activity' is likely to be shorter as some sub-activities would occur at the same time or over a similar timeframe, i.e. site-wide onshore ECC works include jointing bay construction, cable pulling, cable jointing and jointing bay backfilling, each with an expected duration of 38 weeks and therefore 152 weeks consecutively for this 'Activity' group. However, it is likely this duration would be less than 152 weeks as some overlap may occur.

Activity	Total Duration (weeks)[2]	Plant and Equipment References Required for Activity (see Table 31.2-9 for Details)
Site-Wide Onshore ECC	152	10, 13, 14
Landfall	39	2, 3, 4, 6, 8, 10, 13, 14, 16, 17, 19
OCS	149	15
ESBI	372	1, 2, 3, 4, 5, 6, 7, 18, 19

Table 31.2-9 Indicative Breakdown of Plant and Equipment Requirements for Onshore Construction Activities

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
1	Vegetation and Site Clearance	Telehandler with Flail Attachment	Large	1	80
		Excavator	Medium	1	40
		Dump Truck	Medium	2	40
		Strimmer	Standard	2	80
		Lawn Mower	Large	1	80
2	Junction and Other Traffic Modification Works	Excavator	Medium	1	50
		Dump Truck	Medium	2	50
		Vibratory Roller	Medium	1	50
		Whacker Plate	Small	1	20
		Tipper Lorry	Standard	1	50
		Asphalt Paver with Tipper Lorry	Medium	1	25
		Cement Truck	Standard	1	10

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
3	Temporary Fencing Works	Small 4x4 and Trailer	Standard	1	25
		Excavator	Small	1	80
		Tracked Vehicle with Fence Post installer	Medium	1	80
4	Temporary Construction Compound Establishment	Excavator	Large	2	80
		Dump Truck	Large	2	80
		Bulldozer	Large	1	80
		Vibratory Roller	Large	1	40
		Whacker Plate	Large	1	20
		Asphalt Paver with Tipper Lorry	Medium	1	20
		Hi-Ab Crane	Standard	1	10
		Mobile Crane	Medium	1	10
		Tipper Lorry	Standard	3	50
		Generator	40kVa	1	100

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
5	Temporary Construction Compound Ongoing Activities	Telehandler	Large	1	50
		Generator	40kVA	3	80
		Concrete Mixer	Standard	1	20
6	Topsoil Removal and Haul Road Construction	Excavator	Large	2	80
		Dump Truck	Large	2	60
		Bulldozer	Large	2	80
		Vibratory Roller	Large	1	50
		Tipper Lorry	Standard	2	50
7	Land Drainage Works	Excavator	Medium	1	50
		Tipper Lorry	Standard	2	40
		Dump Truck	Medium	1	50
		Drainage Plough	Standard	1	80
8	Landfall Trenchless Installation Works	Excavator	Medium	1	20
		Dump Truck	Medium	1	20
		Drilling Rig	Large	2	100

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
		Concrete Mixer	Standard	1	10
		Generator	Medium	3	100
		Concrete Pump	Medium	1	20
		Water Pump	Large	2	80
9	Trenchless Cable Installation Works along Onshore ECC	Excavator	Medium	1	20
		Dump Truck	Medium	1	20
		Drilling Rig	Large	1	100
		Generator	Medium	3	100
		Water Pump	Large	2	80
10	Jointing Bay, TJB and Link Box Construction	Excavator	Large	2	50
		Dump Truck	Medium	2	40
		Cement Truck	Standard	1	15
		Hi-Ab Lorry	Large	1	10
		Water Pump	Medium	1	100
		Concrete Pump	Medium	1	30

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
11	Open Cut Trenching along Onshore ECC	Excavator	Large	2	75
		Bulldozer	Large	1	50
		Wheeled Loader	Large	1	50
		Generator	Medium	1	100
		Dump Truck	Medium	2	50
12	Duct Installation and Trench Backfilling along Onshore ECC	Excavator	Medium	2	50
		Dump Truck	Medium	2	50
		Vibratory Roller	Small	1	50
		Whacker Plate	Medium	1	50
13	Cable Pulling and Jointing	Excavator	Medium	1	20
		Dump Truck	Medium	1	20
		Cable Drum Tractor	Large	1	40
		Conveyer Roller with Drive Unit	Standard	1	40
		Water Pump	Standard	1	100
		Generator	Medium	1	100

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
		Cable Winch	Large	1	40
14	Jointing Bay and TJB Backfilling	Excavator	Large	1	60
		Dump Truck	Large	1	60
		Cement Truck	Standard	1	20
		Vibratory Roller	Medium	1	60
15	OCS Construction	Excavator	Large	6	75
		Wheeled Loader	Large	4	75
		Bulldozer	Large	4	75
		Dump Truck	Large	8	75
		Vibratory Roller	Large	2	75
		Mobile Crane	Medium	4	60
		Cement Truck	Large	2	50
		Cement Truck Pump with Boom Arm	Large	2	50
		Generator	Large	3	100
		Hydraulic Hammer Piling Rig	Medium	1	15

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
		Asphalt Paver with Tipper Lorry	Medium	1	10
16	Removal of Haul Road	Excavator	Large	2	80
		Bulldozer	Large	1	80
		Dump Truck	Large	2	80
		Tipper Lorry	Standard	2	60
17	Topsoil Reinstatement	Excavator	Large	2	80
		Bulldozer	Large	2	80
		Dump Truck	Large	2	60
		Tractor with Stone Picking Attachment	Large	1	40
18	ESBI Construction	Excavator	Large	4	75
		Wheeled Loader	Large	2	75
		Bulldozer	Large	3	75
		Dump Truck	Large	6	75
		Vibratory Roller	Large	2	50
		Mobile Crane	Medium	2	50

Plant and Equipment Reference	Activity Description	Plant and Equipment Description	Plant and Equipment Size	Number of Plant and Equipment Required	On-Time Factor (%)
		Cement Truck	Large	3	50
		Cement Truck Pump with Boom Arm	Large	2	50
		Generator	Large	3	100
		Hydraulic Hammer Piling Rig	Medium	1	15
		Asphalt Paver with Tipper Lorry	Medium	1	10
		Tipper Lorry	Standard	4	60
		Hand-Held Power Tools (e.g. angle grinder)	Small	2	10
19	Electrical Work and Commissioning	Telehandler	Medium	4	60
		Generator	Large	2	100

31.2.2.6 Fugitive Emissions

31.2.2.6.1 Operation (Module B1)

60. SF_6 is commonly used as an insulating and circuit-breaking gas in the operation of high-voltage switchgears and other electrical equipment, which are required as part of both the Project's offshore and onshore infrastructure. SF_6 is an extremely potent GHG, with a global warming potential of 24,300, as determined by the Intergovernmental Panel on Climate Change (IPCC) in the Sixth Assessment Report (AR6). This means that every kg of SF_6 leaked to atmosphere has the equivalent effect on global warming as the emission of 24.3 tonnes of CO_2e.

61. The Applicant has advised that the Project may use SF_6-reliant equipment only in cases where no other alternatives are available, or when SF_6-free alternatives are considered unsuitable for use on the Project due to technical or commercial feasibility considerations. This applies to the electrical equipment at the wind turbines, offshore platform(s) and at the OCS and ESBI. The Applicant has advised to conservatively assume a maximum total gas leakage rate of 0.5% of stored gas volume per year as per IEC 62271.203 for gas insulated metal-enclosed switchgear.

62. GHG emissions from the leakage of SF_6 gas are quantified by applying the global warming potential of SF_6 (24,300) to the annual leakage volume in kg.

31.2.2.7 End-of-Life

31.2.2.7.1 Decommissioning (Modules C1 to C4)

63. Details surrounding decommissioning activities and downstream end-of-life processes are not yet known at this stage of the Project. Therefore, an assumption of 1.2% of total whole lifecycle GHG emissions has been applied, as obtained from literature (Thompson and Harrison, 2015). Where possible, this assumption will be further refined at ES stage.

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List of Tables

List of Acronyms

Acronym	Definition
AE	Auxiliary engine
AHT	Anchor Handling Tugs
AR6	Sixth Assessment Report
CBS	Cement Bound Sand
CO_2e	Carbon Dioxide Equivalent
CSV	Construction Support Vessels
DBD	Dogger Bank D
DC	Daughter Craft
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
dML	Deemed Marine Licence
ECC	Export Cable Corridor

Acronym	Definition
EF	Emission factor
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESBI	Energy Storage and Balancing Infrastructure
EVA	Ethylene Vinyl Acetate
GHG	Greenhouse Gas
HDPE	High Density Polyethylene
HGV	Heavy Goods Vehicles
HLV	Heavy Lift Vessels
HTV	Heavy Transport Vessels
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICE	Inventory of Carbon and Energy
IPCC	Intergovernmental Panel on Climate Change
ISV	Installation Support Vessels
JUV	Jack-Up Vessels
LF	Load Factors
LV	Light Vehicles
MGO	Marine Gas Oil
OCS	Onshore Converter Station
O&M	Operation and Maintenance
OSV	Offshore Supply Vessels
PCS	Power Conversion System
PE	Propulsion Engine
PEIR	Preliminary Environmental Information Report

Acronym	Definition
PLGR	Pre-Lay Grapel Run
PSV	Platform Supply Vessels
SOV	Service Operation Vessels
TJB	Transition Joint Bay
US EPA	United States Environmental Protection Agency
USV	Unmanned Survey Vessels
WTW	Well-to-Wake
XLPE	Crosslinked Polyethylene