NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

Appendix 33.1 Greenhouse Gas Assessment Methodology

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Glossary of Acronyms

AUV	Autonomous Underwater Vehicles
BEIS	Department for Business, Energy & Industrial Strategy (replaced by DESNZ)
CBS	Cement Bound Sand
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CTV	Crew Transfer Vessel
DESNZ	Department for Energy Security and Net Zero
DfT	Department for Transport
ES	Environmental Statement
GHG	Greenhouse Gas
GRP	Glass Reinforced Plastic
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
HLV	Heavy Lift Vessel
ICE	Inventory of Carbon and Energy
JUV	Jack-up vessel
MGO	Marine Gas Oil
NdFeB	Neodymium proxy
NRMM	Non-Road Mobile Machinery
O&M	Operation and Maintenance
PVC	Polyvinyl chloride
ROV	Remotely Operated Vehicles
SOV	Serviced Operation Vessel
TP	Transition Pieces
WTG	Wind Turbine Generator

Glossary of Terminology

Array cables	Cables which link the wind turbine generators with each other and the offshore substation platform(s).
Cable circuit (onshore)	The onshore export cables are comprised of cable ‘circuits’. Each cable circuit is typically comprised of three power cables, as well as fibre cables and earth cables. It is expected that each circuit would compromise up to seven cables in total.
‘Cradle to (factory) gate’	The extraction, manufacture and production of materials to the point at which they leave the factory gate of the final processing location
Haul road	The track along the onshore cable route used by construction traffic to access different sections of the onshore cable route.
Horizontal directional drill (HDD)	Trenchless technique to bring the offshore cables ashore at the landfall. The technique will also be used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Jointing bay	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	The location where the offshore cables come ashore.
Link boxes	Underground chambers or above ground cabinets next to the onshore export cables housing low voltage electrical earthing links.
Offshore cable corridor	The corridor of seabed from array areas to the landfall within which the offshore export cables will be located.
Offshore export cables	The cables which bring electricity from the offshore substation platform(s) to the landfall, as well as auxiliary cables.
Offshore project area	The overall area of the array areas and the offshore cable corridor.
Offshore substation platform(s)	Fixed structure(s) located within the array areas, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable voltage for export to shore via offshore export cables.
Offshore converter platform	Should an offshore connection to a third party HVDC cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via a third party HVDC cable.
Onshore cable corridor(s)	Onshore corridor(s) considered at PEIR within which the onshore cable route, as assessed at ES, is located.
Onshore cable route	Onshore route within which the onshore export cables and associated infrastructure would be located.
Onshore export cables	The cables which take the electricity from landfall to the onshore substation. These comprise High Voltage Alternative Current (HVAC) cables and auxiliary cables, buried underground.
Onshore project area	The boundary in which all onshore infrastructure required for the Project will be located (i.e. landfall; onshore cable route, accesses, construction compounds; onshore substation and national grid substation extension), as considered within the PEIR.
Onshore substation	A compound containing electrical equipment required to transform and stabilise electricity generated by the Project so that it can be connected to the national grid.
Onshore substation works area	Area within which all temporary and permanent works associated within the onshore substation are located, including onshore substation, construction compound, access, landscaping, drainage and earthworks.

Scour protection	Protective materials to avoid sediment being eroded away from the base of the wind turbine generator foundations and offshore substation platform (OSP) or/and offshore converter platform (OCP) foundations as a result of the flow of water.
Temporary construction compound	Area set aside to facilitate construction of the onshore cable route. Will be located adjacent to the onshore cable route, with access to the highway where required.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Transition joint bay	Underground structures that house the joints between the offshore export cables and the onshore export cables
Trenchless crossing compound	Areas within the cable corridor which will house trenchless crossing (e.g. HDD) entry or exit points.
Wind turbine generator (WTG)	Power generating device that is driven by the kinetic energy of the wind

1 Greenhouse Gas Assessment Methodology

1.1 Introduction

1. This appendix of the Environmental Statement presents the greenhouse gas (GHG) assessment methodology, associated assumptions and emissions factors used for calculating GHG emissions arising from the North Falls offshore wind farm (hereafter ‘North Falls’ or ‘the Project’), specifically for:

- Embodied carbon emissions in construction materials and spare parts (Section 1.3);
- Emissions arising from marine vessels in transit and undertaking construction and operation and maintenance (O&M) activities at the wind farm site (Section 1.4);
- Emissions arising from helicopter movements for construction and O&M personnel (Section 1.5);
- Emissions arising from road traffic vehicle movements (Section 1.6);
- Emissions arising from plant and equipment (Section 1.7); and
- Emissions arising from waste disposal (Section 1.8).

2. A number of assumptions are made in the GHG assessment, and these are presented in Table 33.14 of ES Chapter 33 Climate Change (Document Reference: 3.1.35) and outlined in this appendix. Updates to Project parameters and assumptions between the Preliminary Environmental Information Report (PEIR) stage and the ES stage are reflected within this document.

1.2 Context

1.2.1 Climate Change Benefit of Offshore Wind

3. Emissions from electricity generation in the UK have decreased by 68% since 1990, the majority of which occurred within the last decade (CCC, 2020). This decrease reflects a move away from coal to gas and low-carbon generation, of which the renewables and offshore wind sector has been a key player. Further reductions are necessary, however, which will require an increase in the role of renewables, along with other supply and demand-side responses.

4. The UK has increased its offshore wind operational capacity to 14.7 gigawatts (GW) (RenewableUK, 2024). The UK government has a target to achieve 50 GW of offshore wind capacity by 2030 (BEIS, 2022), which will include developments such as this Project.

5. Recent advances in technology and improved construction, and O&M practices have led to an increase in the efficiency of electricity generation. In particular, increases in turbine size yield higher capacity factors. As a result, DESNZ advises that the load factor for new build offshore wind is likely to be 61.5%, which is a significant improvement from 10 years ago (DESNZ, 2023a).

6. Offshore wind is therefore considered to be the backbone of electricity generation in the CCC's scenarios for net zero pathways, contributing 65 – 70% of total generation by 2050 (CCC, 2022).

1.2.2 GHG Emission Sources for Offshore Wind Farms

7. The construction, O&M and decommissioning of offshore wind farm projects entails the generation of GHG emissions, both from the standpoint of:

8. Embedded carbon and GHGs from the Project components. These are the emissions caused by the extraction and refinement of raw materials and their manufacture into the commodities and products that make up the components of the offshore (i.e., WTGs, offshore substation, export and array cables, etc.) and onshore (i.e., cables, material imports, onshore substation, etc.) infrastructure.

9. Carbon and other GHG emissions arising from the combustion of fuels and energy used in constructing, operating and maintaining wind farm components over the Projects' lifetime and in decommissioning. These emissions in this assessment are associated with marine vessel, helicopter, onshore plant and equipment and road transport vehicles.

10. The release of emissions from these sources is small in comparison to emissions from the fossil fuel generation of energy, and the emissions saved during the generation of electricity from wind resources (when compared to fossil fuel sources) outweigh those released from construction, O&M, and decommissioning activities.

11. There are inherent uncertainties associated with carrying out GHG footprint assessments for offshore wind energy projects, although the approach to determine emissions from individual source groups is well-defined. The assumptions and limitations of the GHG footprint assessment are detailed in Section 33.4.6 of ES Chapter 33 Climate Change (Document Reference: 3.1.35)

12. A report published by the University of Edinburgh in 2015 (Thomson & Harrison, 2015) examined the lifecycle costs and GHG emissions associated with offshore wind energy projects, comparing data gleaned from the analysis of some 18 studies carried out over the period between 2009 and 2013 (Thomson & Harrison, 2015). This report supplies useful context for the Project's GHG assessment, and provides benchmark figures which are used to verify the outcomes of the assessment. It is acknowledged that advancements and efficiencies have been gained in the offshore wind sector since this study was undertaken; however, the figures and details within this study are assessed to be applicable and provide useful context for the GHG assessment.

13. Table 1 provides a summary of the percentage of total GHG emissions associated with the different phases of an offshore wind farm development as provided within the report (Thomson & Harrison, 2015).

Table 1 Summary of Offshore Wind Farm GHG Emissions (Thomson & Harrison, 2015)

Phase	% of total GHG emissions
Manufacture and Installation	78.4
Operation and Maintenance	20.4
Decommissioning	1.2

14. The report highlighted that the greatest proportion of emissions are associated with the manufacture and installation of the wind farm components. Decommissioning accounted for the smallest proportion, only 1.2%, of total lifecycle GHG emissions. A more detailed breakdown of emissions is given in Thomson & Harrison (2015) for an offshore windfarm with steel foundations. This is reproduced in Plate 1.

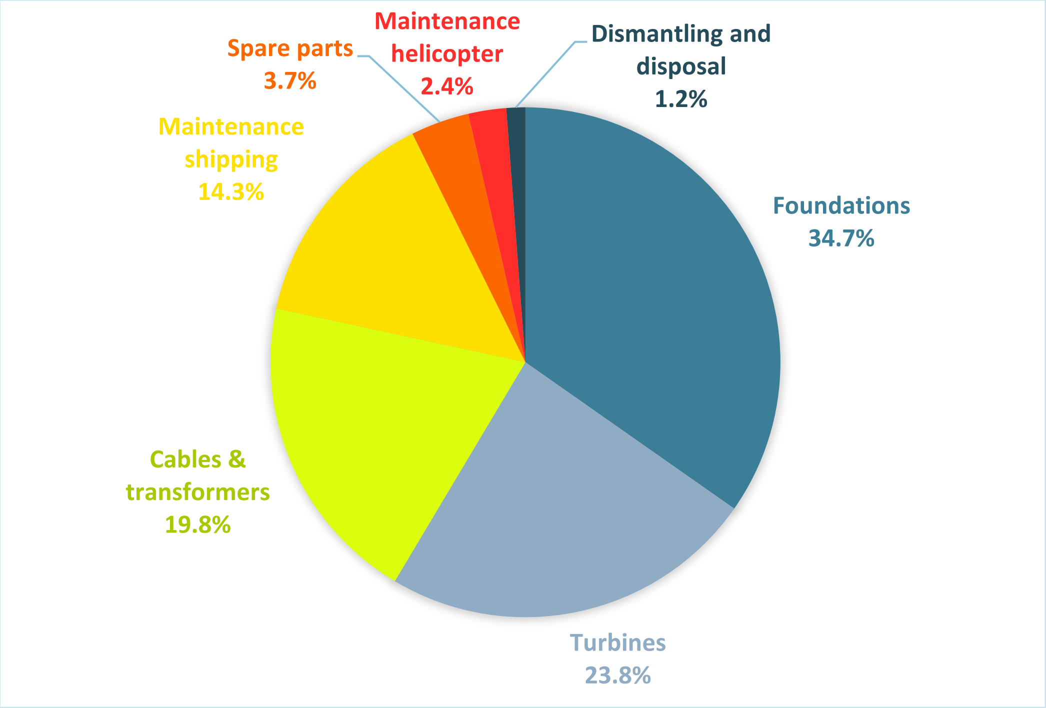

Plate 1 Summary of offshore windfarm GHG emissions (Thomson & Harrison, 2015)

15. Of the components, or phases, shown in Plate 1., GHG emissions associated with foundation fabrication and installation accounted for the largest proportion of emissions (34.7%), followed by manufacture and installation of the turbines (23.8%) and the cables and transformers (19.8%). GHG emissions from shipping movements during maintenance operations over the operational lifetime of the example windfarm contributed 14.3%. This value may appear to be unexpectedly high, but the vessel movements contribution is associated with an assumed 20-year operational lifetime of the wind farms considered in the studies. The operational lifetime of the Project is 30 years; therefore, vessels are likely to be a key source of emissions during O&M. Emissions derived from spare parts (3.7%), helicopter movements (2.4%) and dismantling and disposal (1.2%) are all small in comparison.

16. A recent report by Catapult (Spyroudi, 2021) investigated the carbon and GHG implications of end-of-use management after decommissioning, as well as some context to carbon Life Cycle Analysis (LCA) of offshore wind farms. Within the studies considered, turbines were predicted to contribute to 50% of the total GHG footprint of materials used in wind farm components. The Catapult report references the National Renewable Energy Laboratory (NREL) report (NREL, 2015), which states that wind turbines are predominantly made of steel (71 to 79% of total turbine mass), fiberglass, resin or plastic (11 to 16%), iron or cast iron (5-17%), copper (1%) and aluminium (0 to 2%). The Catapult report

(Spyroudi, 2021) advises that recycling can save, on average, at least 35% of CO_2e per kilowatt-hour (kWh) of generation from assets in an offshore wind farm (operating 6 MW and 10 MW turbines), as opposed to new manufacturing of components.

1.2.3 GHG Intensity of Offshore Wind Energy

17. In the University of Edinburgh report (Thomson & Harrison, 2015), additional analysis of the data extracted from the 18 technical studies expressed the GHG emissions as grammes (g) of CO_2e per kilowatt-hour (kWh) of electricity generated. These were found to vary quite widely, between approximately 5 g and 33 g CO_2e/kWh. There was not clear relationship between the metrics for either turbine rating (in MW) or capacity factor.

18. A further study in 2012 (Dolan & Heath, 2012), amassed the results of over 200 studies of carbon emissions from wind power and attempted to “harmonise” the results to use only the most robust and reliable data and to align methodological inconsistencies. The harmonised results of this study revealed that the range in GHG emissions per kWh of electricity generated varied between approximately 7 g and 23 g CO_2e/kWh, with a mean value of around 12 g CO_2e/kWh.

19. It is noted that these studies were undertaken in 2012 and 2015, and there have been significant advances in the technology, infrastructure and components used for offshore wind farms. Therefore, other available published sources were reviewed to evaluate average GHG intensity of energy produced offshore wind farms, and these are presented in Table 2. As shown, the range of energy intensities for offshore wind farms across the range of studies is 7.8 g to 25.5 g CO_2e/kWh.

Table 2 Review of average carbon emissions per kWh

Windfarm sizes	Energy intensity (gCO_2e/kWh)	Source
15 x 5 MW	32	Chen et al. (2011), referenced in Bhandari et al. (2020)
N/A	6	IEA World Energy Outlook (2012), referenced in Siemens Gamesa (no date) and Orsted (2021)
100 x 2.5 MW	13.7	Arvesen & Hertwich (2012), referenced in Bhandari et al. (2020)
80 x 4 MW	10.9*	Bonou et al. (2016), referenced in Bhandari et al. (2020)
100 x 6 MW	7.8*	Bonou et al. (2016), referenced in Bhandari et al. (2020)
28 x 3.6 MW	25.5*	Yang et al. (2018), referenced in Bhandari et al. (2020)
*offshore wind farm studies published from 2016 onwards		

20. To place these metrics into context, comparable values for electricity generation by gas and coal are approximately 371 g and 945 g $CO_2.kWh^{-1}$ respectively (approximately 31 and 79 times that of offshore wind respectively, using the mean value from Dolan & Heath (2012)) (DESNZ, 2023b). These values are for the generation only and are unlikely to account for the construction of the power station infrastructure (i.e., the construction materials such as concrete or steel), or the extraction and processing of the fossil fuels to generate power.

21. Although robust and fit for the purposes of an EIA, this assessment should not be taken to be a comprehensive, detailed LCA of the Project, the reason being that it is not possible to fully define the supply chain for the Project and

undertake the relevant detailed assessments at this stage in the Project. Therefore, assumptions and simplifications to the methodology are made in certain areas and a precautionary approach has been adopted for the assessment to allow for this. These assumptions and simplifications (outlined in Section 33.4.6 of ES Chapter 33 Climate Change (Document Reference: 3.1.35) and the worst-case scenario is set out in Table 33.3 of ES Chapter 33 Climate Change (Document Reference: 3.1.35)) to the methodology are made in certain areas and a precautionary approach has been adopted for the assessment to allow for this.

1.3 Embodied emissions in materials

22. Emissions of 'cradle-to-(factory) gate' for the main materials to be used in construction are calculated for the Project. The term 'cradle-to-factory gate' includes raw material extraction, transport, manufacturing and packaging of the materials (required for the construction of the Project) to the point at which they leave the site of the final processing location. GHG emissions were derived from quantities or volumes of likely and/or known materials (at this stage of the DCO Application) that will be used in construction, and their likely material composition.

23. These include the following infrastructure:

- The key offshore components (and their main material components) of the Project comprise:
    - Wind turbine generators (WTGs), including the tower, nacelle, rotor, blades (materials: steel, copper, iron, fiberglass, etc.);
    - Offshore substation platform(s) (OSP(s)) / Offshore converter platform (OCP) and structures (material: steel);
    - WTG and offshore substation foundations (e.g. monopiles, jackets, gravity based, etc.) (material: steel);
    - Scour protection (material: rock); and
    - Offshore HVAC export and array cables (main material is likely to be copper).
- The key onshore components (and their main material components) of the Project comprise:
    - Onshore cables (main material is likely to be aluminum) and ducting (main material: HDPE) installed underground from the landfall to the onshore substation and the 400 kV cables connecting the onshore substation to the proposed national grid connection point;
    - Onshore substation (main materials are likely to be steel and copper); and
    - Imported (and subsequently exported) material for construction at landfall, along the onshore cable route and at the onshore substation, including Bentley Road improvement works, such as aggregate, asphalt, concrete, pipe, cement bound sand (CBS), ducting, geogrid/geotextile, bentonite, water and steel reinforcement, fencing.

24. Quantities for all materials to be used during construction are not available at the time of the assessment, therefore estimated quantities of the most common and GHG intensive materials are included in the assessment. To provide a precautionary assessment, it is assumed that there will be no reduction in the emissions intensity of upstream supply chains of wind farm components (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 emissions intensity of activities in sectors such as transport and industry in the UK is likely to decrease over time. The earliest construction start year is anticipated to be 2027.

25. 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.

26. Worst-case assumptions are also adopted with respect to material quantities to be used for each component of the Project, which accounts for contingencies to build flexibility into the design envelope (e.g., the maximum number of WTGs or OSP/OCPs). 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 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 3.

27. Realistic worst-case scenarios for the GHG assessment are outlined in Table 33.3 of ES Chapter 33 Climate Change (Document Reference: 3.1.35).

28. Relevant emission factors sourced from the Inventory of Carbon and Energy (ICE) database (Jones & Hammond, 2019), 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 wind farm components are not available in the ICE database, the relevant emission factors are obtained for other literature sources.

29. There are many possible foundation types currently available to support offshore WTGs and/or offshore platforms. Based on the current best estimates of foundations to be used for the Project, emissions are quantified for monopiles or jackets in the GHG footprint assessment, depending on the worst case (in terms of material quantities) for each type of material. The worst case maximum scour protection volumes for each foundation type are used, these are gravity based monopile structures for both the WTGs and OSPs/OCPs.

30. Table 3 outlines the materials assumed for each key wind farm component, their emission factors and data source(s), and any assumptions or caveats used in the GHG assessment.

Table 3 Emission factors for embodied GHGs in materials

Component(s)	Name of Construction Material*	Emission factor**	Source	Notes
Onshore material imported for construction	Aggregate	0.007	ICE database, v3.0	Aggregates and sand, general UK, mixture of land won, marine,

Component(s)	Name of Construction Material*	Emission factor**	Source	Notes
			November 2019 (Jones & Hammond, 2019)	secondary and recycled, bulk, loose
Onshore cables and onshore substation	Aluminium	6.67		General, European mix including imports
Onshore material imported for construction	Asphalt	0.054 0.058		Assumed mid- ranged, 5% binder content for general and 7% binder content for Proprietary SMA
Onshore material imported for construction	Bentonite (proxy)	0.39		Used ‘clay’ as representative of bentonite
Onshore material imported for construction	Bitumen	0.19		Straight-run bitumen
Offshore WTG	Cast iron (proxy)	2.03		Used ‘iron’
Onshore material imported for construction	Cement bound sand (CBS) (proxy)	0.12		Used ‘Mortar (1:6 cement: sand mix)’
Onshore material imported for construction	Concrete	0.10		N/A
Onshore material imported for construction	Concrete slab	0.13		N/A
Offshore WTG and array/export cables, and onshore substation	Copper	3.81		Virgin copper
Offshore WTG	42CrMo4 (proxy)	1.27	ICE database, v3.0 November 2019 (Jones & Hammond, 2019)	Used ‘engineering steel’
Offshore WTG	Fibreglass and carbon fibre (proxy)	8.1		Used ‘glass reinforced plastic (GRP) – Fibreglass’. CO_2 only. Also used for carbon fibre as a proxy in lieu of other available embodied carbon emission factor
Onshore material imported for construction	Geogrid and geotextile (proxy)	4.98 kg CO_2 per m^2		Used ‘polypropylene’
Offshore WTG	Glass	1.44		General
Offshore foundation	Grout	0.62		Cement (grout)
Onshore material imported for construction	HDPE ducting	2.52		HDPE Pipe
WTG generator	NdFeB magnets (Neodymium proxy)	27.6	Jin *et al.* (2016)	N/A
Onshore material imported for construction	Perforated pipe (proxy)	3.23	ICE database, v3.0 November 2019 (Jones	Used ‘PVC pipe’
Offshore WTG	Polymer (proxy)	7.92		Used ‘Nylon (polyamide) 6,6 Polymer’

Component(s)	Name of Construction Material*	Emission factor**	Source	Notes
Offshore WTG	Polyester (proxy)	2.54	& Hammond, 2019)	Used ‘general polyethylene’
Onshore material imported for construction	Road surface asphalt	15.2 kg CO_2e per 1 m^2 and 100 m depth		Assumed 5% binder content
Onshore material imported for construction	Sand	0.007		General UK, mixture of land won, marine, secondary and recycled, bulk, loose
Offshore WTG and OSP/OCP (including foundations) and onshore substation	Steel (average) (also used as 100 Cr6 proxy)	2.47		Average of embodied CO_2e steel values provided in ICE database
Onshore substation	Structural steel Steel (assumed for cladding/ roofing)	2.73 3.06		Steel, finished cold-rolled coil Steel, Organic coated sheet
Onshore material imported for construction	Steel (assumed in fencing)	2.76		Steel, hot-dip galvanized steel
WTG and OSP/OCP foundation scour protection	Rock or gravel (scour protection)	0.079		Stone (general)
Onshore material imported for construction	Timber (assumed for fencing)	0.49		Timber (average)
Onshore material imported for construction	Water	0.18 kg CO_2e per m^{-3}	Department for Energy Security and Net Zero (DESNZ) (2023)	Water supply (2023)

*Not all construction materials are provided in the ICE database (or in other 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)

31. The emission factors from the ICE database are ‘cradle-to-factory’ and, therefore do not account for GHG emissions from the transportation of materials to the wind farm site or onshore Project area. Emissions associated with the movement of materials to the site are quantified from the information available at this stage in the Project for the marine vessel and road traffic vehicle source groups, as highlighted in Section 33.1 of ES Chapter 33 Climate Change (Document Reference: 3.1.35) and detailed in Section 1.4 and 1.6 of this appendix, respectively.

32. Material quantities associated with spare parts to be used during repair and replacement events over the Project’s operational lifetime are unknown at this stage. Embodied carbon from spare parts was assumed to be 3.7% of construction and O&M emissions based on benchmarks available in literature sources (Thomson & Harrison, 2015).

1.4 Marine vessels

33. Marine vessels will be used to bring materials and components to the wind farm site, install infrastructure (WTGs, offshore substation platforms/offshore

converter platform, substructure and cables), provide crew accommodation and support during construction, commissioning and O&M activities.

1.4.1 Indicative vessels logistics – current working assumptions

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

- In transit to/from the wind farm site; and
- Situated at the windfarm site during construction/operation activities.

35. The current working assumptions for offshore vessel logistics during construction and O&M have been supplied by the Applicant and are based on current best estimates. The number of vessel movements and approximate duration on site during construction are outlined in Table 4.

36. Vessels used during construction and O&M phases are assumed to travel to the wind farm site from a range of locations, including the marshalling, manufacturer and mobilisation ports and a local construction and O&M port.

Table 4 Indicative number of vessels transit movements and approximate duration on site per trip during construction

Activity	Indicative vessel type	Maximum number of return trips	Notes on number of return trips*	Approximate duration each vessel type is present on site per trip
Foundation installation	Scour Layer Vessels	241	Based on fallpipe vessel with capacity of 20,000 t. Assumption is that scour layer vessels originate from Norway (only included one-way transit in calculations as Project has no control over where scour layer vessels go after visiting site)	3 days per trip
	Gravity Base Foundation Vessels	375	Based on vessel with capacity of 1,650 t	10 days per Gravity Base Foundation installation trip
	Jack-up installation vessels (JUVs)	30	Assumes the installation vessel is moving between the wind farm site and marshalling harbour (in either the Netherlands or Germany) with two foundations per trip.	15 days per trip (relocated every 2-4 days to new foundation)
	Support vessels	57	Variety of vessels to facilitate the foundations, such as multicast, serviced operation vessels (SOVs), tugs, etc. operating out of local harbours. 7 other vessels in foundation spread to go to port every 14 days.	5 days per trip
	Transport vessels	40	N/A	2 days per trip
	Crew transfer vessels (CTVs)	240	Assuming four visits per foundation, from local harbour. Used to transport construction workers to/from the offshore site.	Average of daily trips. Assumed 12 hours, as vessels travel to site in the morning and return in the evening.
	Transition Piece Installation Vessels	33	Based on 6 Transition Pieces per loadout, 3 vessels in the spread	15 days per trip
WTG installation	WTG Installation vessels	20	Assuming 3x installation spreads, with main vessels shuttling between the site and pre-assembly harbour with three WTGs sets per trip, where one set includes the tower, nacelle, rotor and blades.	15 days per trip
	Support vessels	35	Guard vessels, anchor handlers, etc, for main installation vessels, operating out of local harbours. 4 other vessels in WTG spread to go to port every 14 days.	5 days per trip

Activity	Indicative vessel type	Maximum number of return trips	Notes on number of return trips*	Approximate duration each vessel type is present on site per trip
	CTVs	600	Assuming 10 visits per turbine, from local harbour. Includes windfarm commissioning movements. Used to transport construction workers to/from the offshore site.	Daily trips to/from windfarm for 12 months. Assumes average of 1.5 boats per day (used for 6 months for OSP commissioning and 6 months for WTG installation/commissioning). Assumed 12 hours per trip.
Offshore substation installation	Installation vessels	12	Assuming topside, jackets and pin piles transported and installed separately from marshalling harbour (in either UK, the Netherlands or Denmark).	20 days per trip
	Support vessels	12	Such as multicast, SOVs, tugs, etc. operating out of local harbours	20 days per trip
	Transport vessels	12	N/A	20 days per trip
	CTVs	60	During commissioning of the substations. Assuming local harbour. Used to transport construction workers to/from the offshore site. Installation only.	Daily trips (every five days). Assumed 12 hours, as vessels travel to site in the morning and return in the evening.
	JUVs	8	Assumed for HVAC installation. For commissioning to allow workers to stay adjacent to the OSP.	2 months each trip (docked to the OSP)
Array cable installation	Main laying vessels	25	Assuming cable manufacturers in north east UK.	2 weeks per trip
	Main burial vessels	25	For remedial burial works, if needed.	2 weeks per trip
	Support vessels	300	Such as multicast, CTVs, dive spreads, etc. operating out of local harbours	Depends on vessel type**
Export cable installation	Main laying vessels	6	Assuming cable manufacturers in Southern Europe	2 weeks per trip
	Main burial vessels	360	Fallpipe vessel with capacity of 4000 t, to and from port of mobilisation in Europe. For remedial burial works, if needed.	Daily trips. Assumed 12 hours, as vessels travel to site in the morning and return in the evening.
	Main jointing vessels	6	Joints are not planned. If required, vessels would operate from local construction port, so these have been included to provide a worst case scenario	7 weeks per trip
	Support vessels	60	Such as multicast, CTVs, dive spreads, etc. operating out of local harbours	Depends on vessel type**
*At this stage, assumptions were made regarding the originating location of vessels, and, where practicable, have been based on the reasonable worst case option for each originating location.				

Activity	Indicative vessel type	Maximum number of return trips	Notes on number of return trips*	Approximate duration each vessel type is present on site per trip
** It is difficult to apply an 'average' approximate duration that the array and export cable installation support vessels would be present on site during construction, given that these vessels vary in type and purpose, and there would be peaks and troughs in the number/duration these support vessels would be present on site during cable installation activities. For the purposes of the GHG assessment, these support vessels have been assumed to be present on site for an average, approximate duration of 5 days per support vessel trip (regardless of support vessel type), as per the assumption used for WTG and foundation installation support vessels.				

37. The number of vessel movements during the O&M phase is outlined in Table 5. As mentioned previously, vessels used during construction and O&M phases are assumed to travel to the wind farm site from a range of locations, including the marshalling, manufacturer and mobilisation ports and a local construction and O&M port.

Table 5 Indicative number of vessels transit movements during O&M

Vessel type	Visits per year	Notes
JUV (to turbines and platforms)	7	Vessel(s) will be on site for multiple days and move between WTGs
SOV	52	N/A
Small O&M vessel (CTV)	1,095	N/A
Lift vessels	7	N/A
Cable maintenance vessels	1	N/A
Auxiliary vessels	60	Auxiliary vessels include: survey vessels, remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), diver platforms, tug operations, cargo vessels, scour replacement vessels.

38. As a conservative scenario, it is assumed that each visit in Table 5 will require a separate vessel movement to/from the O&M base. The duration that each vessel listed in Table 5 will spend on site is not known at this stage, and therefore further assumptions adopted from other projects of a similar nature are also used for the assessment. These assumptions include:

- Each JUV and CTV will be on site for four days per visit; and
- O&M, lift, cable maintenance and auxiliary vessels will be on site for two weeks per visit.

39. 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 to the Applicant at this stage.

1.4.2 Emission calculations

40. Marine vessel activities are 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).

41. Indicative vessel types, as shown in Table 4 and Table 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.

42. 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:

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

Where:
$E_{transit}$ = *GHG emissions during transit* (CO_2e)
$A_{transit}$ = *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 propulsion and auxiliary engines
EF = Emission factor (tonnes CO_2e/kWh*)*

43. 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:

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

Where:
E_{site} = *GHG emissions from offshore construction activities* (CO_2e)
$A_{transit}$ = *Activity (hours), defined by the total time on-site as provided by the Project*
PE = Propulsion engine size (kW)
AE = Auxiliary engine size (kW)
LF = Load factors, for propulsion and auxiliary engines
EF = Emission factor (tonnes CO_2e/kWh*)*

44. Vessel emissions during construction are derived from the sum of all in transit, and offshore construction activity emissions, for all vessel types specified across the entire construction period. O&M vessel emissions are calculated as the product sum of all in transit and offshore O&M activity emissions, for all vessel types specified during a standard O&M year across the Project's operational lifetime of 30 years.

45. The emission factors for marine gas oil (MGO) used in the vessel emission calculations is 0.27 kg $CO_2e.kWh^{-1}$, which has been obtained from the Department for Energy Security and Net Zero (DESNZ) (previously BEIS) (DESNZ, 2023c). It should be noted, however, that the maritime sector is expected to decarbonise over the Project's operational lifetime, 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.

46. Vessel engine sizes 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, less the propulsion engine size, or 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).

47. Vessels have various operating modes such as cruising, manoeuvring and hotelling, which affect 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 6.

Table 6 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.
	Offshore construction and/or O&M activities at the windfarm site	0.31 (tugs) 0.38 (work boat and miscellaneous)	GloMEEP (2018)	• Vessels assumed to be in manoeuvring mode as a worst case scenario. • All vessels assumed to be work boats (including miscellaneous) with the exception of tugs.
Auxiliary engine	In transit	0.17	US EPA (2009)	• Vessel assumed to be in cruising mode. • All vessels assumed to be bulk carriers, Ocean-Going tugs or miscellaneous (with the same cruising load factor).
	Offshore construction and/or O&M activities at the windfarm site	0.45		• Vessels assumed to be in manoeuvring mode as a worst case scenario. • All vessels assumed to be bulk carriers, Ocean-Going tugs or miscellaneous (with the same manoeuvring load factor).

48. 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.

1.5 Helicopters

49. Helicopter movements associated with the commissioning and O&M phases of the Project will result in the release of GHG emissions. It is feasible that technicians will be transported to turbines using helicopters during the commissioning of the Project and unplanned maintenance tasks will be undertaken via helicopters during the O&M phase, when CTV access is not possible. 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 an indicative number of helicopter journeys during construction/commissioning and O&M and these are outlined in Table 7.

Table 7 Helicopter movements

Phase	Maximum number of return trips
Construction or commissioning	100
O&M	100

51. The total distance travelled by helicopters is determined by multiplying the number of trips by the average trip distance. As advised by the Applicant, it is assumed as a worst case that helicopter trips originated at an example airport such as Norwich, during the construction phase. The distance from the airport to the centre of the offshore project area is assumed to be a straight line distance of approximately 116 km (one-way). As the O&M base for the Project is still not defined, it is also assumed that helicopter trips during the O&M phase originated at this example airport.

52. The likely type of helicopters used for these activities is unknown at this stage of the Project, so an indicative helicopter model (AW139) from previous project experience is used to determine fuel consumption. The average cruise speed and fuel consumption data for an AW139 has been obtained from manufacturers specifications to estimate fuel consumption. The emission factors for aviation turbine fuel (or jet fuel) has been obtained from the DESNZ (2023c), which was 3,178 kg CO_2e tonne^{-1} fuel. GHG emissions from helicopters are calculated using the following equation:

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

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 per tonne)

1.6 Road traffic vehicles

53. Road traffic 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 (HGVs) and staff transport to and from the onshore construction sites, and also during the O&M phase.

54. The total distance of vehicles travelled during the whole construction phase has been provided by the Transport Consultants for the Project. Distances travelled during the construction phase are calculated for HGVs and employee movements according to the following methodology:

- General:
    - Vehicle movements were collated by the Transport Consultants for the Project from ES Chapter 27 Traffic and Transport (Document Reference: 3.1.29); and
    - The approach adopted is considered to represent a worst case, noting that no reduction in traffic movements has been applied to account for the reassignment of traffic. For example, many HGVs would already be on the local network serving existing supply chains and would potentially reassign to serve North Falls without creating additional demand within the local area.
- HGV movements:
    - ES Chapter 27 Traffic and Transport (Document Reference: 3.1.29) identifies that bulk materials such as concrete and stone aggregate would make up the majority of the total HGV trips for the Project, and that these deliveries would be expected to travel via the A120, either east from the A12 direction or west from Harwich International Port/Bathside Bay;
    - The distances from the A12 or Port of Harwich (via the A120) have been calculated to each of the project infrastructure destination sites for each stage of construction (this approach is considered to represent a worst-case scenario noting that deliveries from local suppliers would reduce the distance travelled); and
    - To calculate the total distance travelled, the total number of HGVs per project infrastructure destination (from ES Chapter 27 Traffic and Transport, (Document Reference: 3.1.29) have been multiplied by the distance to the furthest point of origin, i.e. either the A12 or Port of Harwich depending upon which is furthest.
- Light vehicle movements:
    - ES Chapter 27 Traffic and Transport (Document Reference: 3.1.29) adopted the approach that the origin of labour has been distributed using census data for all Project labour and that employee mode share of 1.5 people per vehicle, so this assumption has also been used in the GHG assessment;

- The distribution of light vehicles presented in E Chapter 27 Traffic and Transport (Document Reference: 3.1.29) has been informed by a review of the distribution of local and in-migrant labour;
- Distances between the employee origins and the project infrastructure destination sites for each stage of construction have been calculated; and
- The total light vehicle movements (per project infrastructure destination sites) were multiplied by calculated distances. This provides the total light vehicle distance travelled in miles.

55. The construction phase movements used to calculate GHG emissions are provided in Table 8.

Table 8 Construction phase traffic movements

Vehicle	Total distance travelled (km)
Cars or light vehicles	4,372,757
HGVs	4,304,778

56. To provide a conservative assessment, the fleet make up (in terms of fuel and Euro standards) for the earliest year of construction (2027) is used in the assessment for employee travel. In addition, it is assumed that there were no fuel efficiency improvements or reduction in emissions over the Project's lifetime for each mode of transport in the assessment.

57. The forecasted 2027 fleet composition (i.e. proportion of diesel, petrol and electric cars) has been obtained from the Department for Transport (DfT) WebTAG data v1.22 (DfT, 2023). The proportion of diesel, petrol and electric cars in the UK fleet for 2027 has been obtained from the DfT (2023) to determine a representative emission factor associated with employee travel. The fleet composition used in the assessment, and emission factors associated with each vehicle type, are provided in Table 9. Emission factors for each vehicle type have been obtained from DESNZ (2023c).

Table 9 Calculation of emission factor used for light vehicle in assessment

Earliest year of construction	Fleet composition (DfT, 2023)			Vehicle emission factor (kg $CO_2e.km^{-1}$) (DESNZ, 2023)			Emission Factor Used in the Assessment (kg $CO_2e.km^{-1}$)
	Diesel	Petrol	Electric	Diesel	Petrol	Electric*	
2027	30.0%	47.0%	23.0%	0.170	0.164	0.066	0.143

*Assumed to be plug-in hybrid electric vehicle to provide a conservative assessment, as battery electric vehicles have an emission factor of 0.000 kg $CO_2e.km^{-1}$ in the 2023 DESNZ dataset.

58. It is assumed that all HGVs used on North Falls would be diesel powered. The emission factor for HGV movements (50% laden, to account for one trip fully loaded and return trip empty) has been obtained from DESNZ (2023) and was 0.814 kg $CO_2e.km^{-1}$. In the absence of suitable empirical data, it is assumed

that the fleet composition of HGVs did not change over the temporal scope of the assessment to provide a precautionary approach.

59. During the O&M phase of the Project, traffic movements would be limited to those generated by the daily operation and periodic maintenance at the onshore substation and at link boxes along the onshore cable route. It is therefore assumed that there would be two traffic movements (i.e. one visit) per week during the 30-year lifespan of the operational phase of North Falls. This visit is assumed to be a 40 km round-trip, i.e. 20 km each way, and amounts to approximately 2,080 km per annum.

1.7 Plant and equipment

60. Fuel consumption associated with the operation of Non-Road Mobile Machinery (NRMM) for the onshore components of the Project 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 emission factor for gas oil consumption has been obtained from DESNZ (2023) to derive GHG emissions.

61. The following assumptions are adopted in the assessment:

- Plant and equipment are assumed to operate throughout the consented working hours for the Project (66 hours per week). An on-time factor of 75% is assumed and applied for each plant and equipment, unless specified by the Applicant;
- Construction plant and equipment are all assumed to use diesel to provide a conservative assessment; and
- Engine sizes for plant and equipment are either provided by the Applicant or obtained for NRMM typically required during construction activities, and from manufacturer specifications. No loading factor was applied to the NRMM engines, as bulking factors were already considered when determining the number of NRMM.

62. Indicative durations for plant and equipment at landfall, along the onshore cable route and at the onshore substation are provided by the Applicant. Plant and equipment required for the Bentley Road improvement works are also provided.

63. Plant and equipment used during the construction of the Project is provided in Table 10 to Table 12. Table 10 details the number of plant required for different sections, which includes landfall, the onshore cable route and 400 kV cable route (between the onshore substation and national grid connection point). The information is provided by the Applicant and has been calculated specifically for North Falls.

64. The information provided in Table 10 represents the average monthly number of plant and equipment that could be present at each section. There will be some variation in the use of plant and equipment over the construction period, therefore average numbers of each plant and equipment per month are calculated (note: due to this approach, these average values may not be a whole number). The duration these plant and equipment are used is dependent on the construction programme. The total number of hours plant is operational during

construction is calculated by multiplying the total number of plant/equipment required per month by the construction hours per month (66 hours per week).

65. Table 11 and Table 12 details the plant and equipment required for the onshore substation and Bentley Road improvement works, respectively, which has been estimated by the Applicant.

66. For the purposes of the assessment, it is assumed that plant and equipment is operated using gas oil as fuel, which has an emission factor of 0.27 kg $CO_2e.kWh^{-1}$ (DESNZ, 2023).

Table 10 Plant and equipment requirements (total construction) for different construction sections (include landfall, the onshore cable route and 400 kV cable route)

Plant	kW	No. of plant (on average) operational per month during 18-months of construction*								Total plant operational duration (hrs)**
		Section 1	Section 2	Section 3	Section 4A	Section 4B	Section 5	Section 6&7	400kV	
D6 Dozer	161	46	28	46	21	42	46	41	0	77,432
30T Excavator	204	56	42	53	36	54	53	52	9	101,809
20T Dumper	231	97	53	87	42	81	87	79	15	155,151
Smooth Drum vibrio road roller	142	27	17	23	10	18	24	17	18	44,165
21T excavator	128	49	30	43	23	37	44	37	4	76,572
5T Forward Tipping Dumper	62.5	49	30	38	23	41	38	38	10	76,572
Loading shovel	170	50	36	48	25	45	50	44	10	88,330
Trench Roller	142	22	9	22	9	16	22	15	11	36,135
Tractor & fencing kit	211	14	12	16	10	15	17	15	3	29,252
Tractor & trailer	211	44	24	42	15	26	43	26	4	64,240
Tractor & Fuel bowser (or self-propelled)	211	18	15	18	15	18	18	18	7	36,422
Tractor & Water bowser (for dust suppression)	211	18	15	18	15	18	18	18	6	36,135
Tractor & cable drum trailer	211	9	3	10	2	4	10	4	6	13,766
Tractor & soil tiller, roller, seeder	211	6	5	6	4	6	6	5	1	11,185
Cement mixer	216	3	0	0	0	0	0	0	1	1,147
Mobile crane	132	6	0	0	0	0	0	0	0	1,721
Grader	205	15	10	15	5	10	14	10	0	22,656
Cable laying tracked crane	107	3	0	0	0	0	0	0	3	1,721
Cable winch	19.1	9	3	10	2	4	10	4	0	12,045

Plant	kW	No. of plant (on average) operational per month during 18-months of construction*								Total plant operational duration (hrs)**
		Section 1	Section 2	Section 3	Section 4A	Section 4B	Section 5	Section 6&7	400kV	
Pre-cast concrete truck	216	3	0	0	0	0	0	0	1	1,147
Mobile concrete pump	216	13	3	10	3	7	10	6	0	14,913
Telehandler	107	39	19	37	12	24	37	22	1	54,776
Mobile self- contained welfare unit	8	18	15	18	15	18	18	18	5	35,848
Crawler Crane	107	11	3	10	3	5	10	5	6	15,200
Road surface paver & roller	142	2	2	2	2	4	2	3	12	8,317

*Number of plant provided by Applicant as whole numbers per month per section, however these are not the same across the construction period so dividing the total number of each plant needed for a month's duration by 18 (for presentation in the chapter) results in fractions of numbers

**assuming 66 hour work week and 75% on time

Table 11 Indicative plant and equipment to be used during the construction phase at the onshore substation

Plant	kW	On- time (%)	No. of plant	Total plant operational duration (hrs)**
Ground works/ formation of platform				
Excavator (earthworks)	204	100	6	1,226
Excavator (hydraulic breaker)	204	100	4	
Dozer	161	75	4	
Air compressor	272	100	4	
Dump truck	231	70	8	
Generator	1,000	100	2	
Crusher	379	80	2	
Large rotary bored piling rig	113	100	1	
Building foundation works				
Tracked drilling rig with hydraulic drifter	444	100	1	2,074
Crane mounted auger	73.5	100	1	
Mini piling rig	115	100	2	
Compressor for mini piling	104	100	1	
Dump truck	231	50	4	
Truck mixer with pump	92	10	2	
Excavator (earthworks)	204	80	3	
Grinder	2.8	50	5	
Compressor	272	100	2	
Access road and car parking works road works				
Excavator	204	100	2	330
Dump truck	231	70	4	
Asphalt spreader with support lorry	129	100	1	
Vibratory roller	24.3	70	2	
Grader	169	100	1	
Building fabrication and HV Plant Installation				
Mobile crane	270	50	1	2,263
Lorry	216	25	3	
Mobile elevating work platform (MEWP)	18.5	75	2	
Dump truck	231	10	4	
Compressor	272	100	1	
Forklift truck	42	50	2	
Grinder	2.8	50	5	
Pneumatic chipper/drill	2	50	3	

*Assuming 66 hour work week

Table 12 Indicative plant and equipment to be used during the construction phase at Bentley Road Improvement works

Plant	kW	On- time (%)	No. of plant	Total plant operational duration (hrs)*
Excavator	204	100	2	3,728
Dump truck	231	70	4	
Asphalt spreader with support lorry	129	100	1	
Vibratory roller	28.5	70	2	
Grader	169	100	1	
Lorry	216	25	3	
MEWP	18.5	75	2	
Generator	1,000	100	2	
Crusher	379	80	2	
*Assuming 66 hour work week				

1.8 Waste disposal

67. Emissions from the disposal of waste generated during the construction of the Project are calculated. GHG emissions are derived from the quantities or volumes of likely materials that will be used in construction, and their likely material composition.

68. Quantities for all wastes to be generated during construction are not available at the time of the assessment, due to the design maturity that will take place post consent, therefore estimated quantities of the main known waste types generated were included in the assessment. These include wastes generated during onshore construction works, i.e. during the construction at landfall, along the onshore cable route, onshore substation and Bentley Road improvement works. The waste forecasts however do not include waste generated during construction of offshore infrastructure as this level of detail is not known at this stage of the Project.

69. These include the following types of waste:

- Aggregate and stone;
- Asphalt and road surfaces;
- Concrete, hardstanding and kerbs;
- Pipe, geotextile and geogrid;
- Fencing;
- Soil (including topsoil and subsoil) and vegetation;
- Drill fluid, waste oil; and
- Waste wood, metal, packing, office waste, etc.

70. To provide a precautionary assessment, it is assumed that there will be no reduction in the emissions intensity of downstream waste disposal operations up to and during the construction phase of the Project. This is likely to be a conservative approach as the emissions intensity of some sectors such as transport and industry is likely to decrease over time. The earliest construction start year is anticipated to be 2027.

71. The specific waste disposal route for construction waste has not been decided, therefore, worst-case assumptions (i.e. most carbon intensive per tonne of waste) are also adopted with respect to the disposal method, e.g., open- or closed-loop recycling, combustion, composting, landfill, anaerobic digestion, of each waste type.

72. Relevant emission factors are sourced from DESNZ (2023) 'GHG Conversion Factor' database, where practicable. If a waste type is not specified in the database, then the 'commercial and industrial waste' option is used. Emission factors used in the assessment are provided in Table 13.

Table 13: Emission factors used for waste disposal GHG calculations

Project waste type	DESNZ waste type classification	Emission factor (kg CO_2e per tonne)	Notes
Hardstanding, road surfaces, existing road waste, hard core	Aggregate / asphalt / bricks / concrete	0.0012	Landfill disposal route as worst case scenario
Metal	Metal	0.0013	
Vegetation, topsoil, subsoil, cut unacceptable for fill, excess fill, native soil	Soils	0.0195	
Mixed packaging	Plastic / paper	0.0213	Loop / combustion disposal route as a worst case scenario
Mixed construction waste, drill fluid removal, waste hydraulic oil	Average construction / mineral oil	0.0213	Combustion disposal route as a worst case scenario
Contaminated packaging, office general waste / paper, canteen waste, wiping clothes	Commercial and industrial waste	0.5203	Landfill disposal route as worst case scenario
Wood	Wood	0.9252	

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