RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Appendix 30.1 Greenhouse Gas Assessment Methodology

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Glossary

Term	Definition
Array Areas	The DBS East and DBS West offshore array areas, where the wind turbines and array cables will be located. The array areas do not include the offshore export cable corridor.
'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.
Inter-Platform Cables	Cables linking offshore platforms.
Landfall	The point on the coastline at which the offshore export cables are brought onshore, connecting to the onshore export cables at the Transition Joint Bay.
Offshore Converter Platforms (OCPs)	Offshore Converter Platforms (OCPs) will be required for the HVDC option. The OCPs are fixed structures located within the array area that collect the AC power generated by the wind turbines and convert the power to DC, before transmission through the offshore export cables to the Project's onshore grid connection points.
Offshore Substation Platforms (OSPs)	Offshore Substation Platforms (OSPs) will be required for the HVAC option. These are fixed structures located within the array areas that contain electrical equipment to aggregate the power from the wind turbines, followed by conversion into a more suitable voltage for transmission through the offshore export cables to the Project's onshore grid connection points.
Onshore Export Cable Corridor	This is the area which includes cable trenches, haul roads, spoil storage areas, and limits of deviation for micro-siting. For assessment purposes, the cable corridor does not include the onshore substations, Transition Joint Bays or temporary access routes; but includes construction compounds (purely for the cable route).

Term	Definition
Onshore Export Cables	Onshore export cables take the electricity from the Transition Joint Bay to the onshore substations.
Onshore Substations	A compound containing electrical equipment required to transform and stabilise electricity generated by the Projects so that it can be connected to the electricity transmission network. There will be one onshore substation for each Project.
The Applicant	RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited as the owners of DBS West and DBS East respectively are the named undertakers that will have the benefit of the Development Consent Order. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited.
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South offshore wind farms).
Wind turbine	Power generating device that is driven by the kinetic energy of the wind.

Acronyms

Term	Definition
AW	Agusta Westland
CTV	Crew Transfer Vessel
DBS	Dogger Bank South
ES	Environmental Statement
DfT	Department for Transport
GHG	Greenhouse Gas
HGV	Heavy Goods Vehicle
ICE	Inventory of Carbon and Energy
JUV	Jack-Up Vessel
NRMM	Non-road mobile machinery
OCP	Offshore Converter Platforms
OSP	Offshore Substation Platforms
SOV	Service Operations Vessel

30.1 Greenhouse Gas Assessment Methodology

1. This appendix presents the greenhouse gas (GHG) assessment methodology for embodied carbon emissions in construction material and marine vessels, in addition to the emission factors used in the assessment presented in **Chapter 30 Climate Change.** The GHG assessment is performed based on the realistic worst case scenario (i.e. the sequential scenario) detailed in section 30.3.2 of **Chapter 30 Climate Change**.

30.1.1. Embodied emissions in materials

2. Emissions of 'cradle-to-factory gate', a term which includes the extraction, manufacture and production of materials to the point at which they leave the site of the final processing location, are calculated for the Projects. GHG emissions are derived from quantities or volumes of known materials that would be used in construction, including the following infrastructure:

- The key offshore components of the Projects comprise:
    - Wind turbines (i.e. tower, nacelle, rotor, blades) and associated foundations;
    - Offshore substation platforms (OSPs) and / or Offshore converter platforms (OCPs) and associated foundations;
    - Other platforms and their associated foundations;
    - Wind turbine monopile and OSP and / or OCP jacket foundations;
    - Scour protection around foundations and cable protection (i.e. rock); and
    - Offshore export and inter-platform cables (i.e. copper or aluminium);
- The key onshore components comprise:
    - Onshore export cables installed underground from the landfall to the onshore substations;
    - Joint bays and link boxes installed along the onshore export cable corridor;
    - Trenchless crossing points at certain locations such as some roads, railways and sensitive habitats (e.g. rivers of conservation importance);
    - Temporary construction compounds and accesses;
    - Temporary bridges and culverts;

- Onshore substations and onward HVAC connection to the new National Grid substation near Creyke Beck; and
- Permanent operational substation access

3. To provide a precautionary assessment, it is assumed that there will be no reduction in the emission intensity during abstraction and manufacturing of materials up until and during the construction phase of the Projects. This is likely to be a conservative approach, as the earliest that construction of the Projects would commence is anticipated to be 2026, where the emissions intensity of some sectors such as transport and industry is likely to have reduced. The maximum quantities of each type of construction material to be used on site are obtained, and the relevant emission factors sources from the Inventory of Carbon and Energy (ICE) database (Jones & Hammond, 2019) where possible. Alternative sources for emission factors are used for more specific components of offshore wind farms and are detailed in **Table 30-1**.

4. Precautionary assumptions are adopted with respect to material quantities to be used for each component of the Projects; these include contingencies allowing for the worst case scenario (e.g. maximum number of wind turbines) of the maximum design envelope to be considered. It has also been assumed that virgin materials will be used for the Projects, whereas it is likely that recycled materials will be utilised for some components.

5. There are many possible foundation types currently available to support offshore wind turbines and/or offshore platforms. The options under consideration include, monopiles, pin pile jackets, suction bucket jackets or gravity based foundations (platforms only). Based on the current foundation options being considered for the Projects, emissions are quantified for monopiles or jackets in the GHG footprint assessment, depending on the worst case for each material type. The worst case maximum scour protection and cable protection volumes for each foundation type are used.

6. The emission factors from the ICE database are 'cradle-to-(factory)' and, therefore do not include the transportation of materials to site. Emissions associated with the movement of materials to the site are quantified from the information available at this stage in the application for the road traffic vehicle and marine vessel source groups, as highlighted in section 30.4.2.3.2 and 30.4.2.3.3 of **Chapter 30 Climate Change** respectively. The road traffic vehicle source group also included emissions associated with the removal of excavated materials from the site.

7. The emissions factors used in the GHG assessment for embodied emissions in construction materials are presented in **Table 30-1**.

Table 30-1 Emission Factors for Embodied GHGs in Materials

Component(s)	Material	Emission factor (kg $CO_2e.kg^{-1}$, unless otherwise stated)	Source	Notes
Wind turbines transformer / switchgear, array cables, offshore export cables, onshore export cables, onshore substation transformers and reactors	Copper	2.71	ICE Database, v3.0 November 2019 (Jones & Hammond, 2019)	Average of embodied CO_2e virgin and recycled values provided in ICE Database
Wind turbine main and blade bearing	Engineering steel (42CrMo4 proxy)	1.27		N/A
Wind turbine blades, nacelle cover	Glass reinforced plastic (GRP) – Fibreglass (fibreglass and carbon fibre proxy)	8.1	ICE Database, v3.0 November 2019 (Jones & Hammond, 2019)	CO2 only. Also used for carbon fibre as a proxy in lieu of other available embodied carbon emission factor
Wind turbine switchgear	General polyethylene (polyester proxy)	2.54		N/A
Wind turbine transformer	Glass (general)	1.44		N/A
Wind turbine hub	Iron (cast iron proxy)	2.03		N/A

Component(s)	Material	Emission factor (kg $CO_2e.kg^{-1}$, unless otherwise stated)	Source	Notes
Wind turbine components, monopile/jacket foundation, offshore substation topside and foundation, onshore substation components	Steel (average) (also used 100 Cr6 proxy)	2.47		Average of embodied CO_2e steel values provided in ICE Database
Wind turbine and offshore substation foundation and cable scour protection, onshore landfall/ onshore export cable route	Rock or gravel	0.079		Stone (general)
Offshore array cables	Aluminium (general, European mix including imports)	6.67		N/A
Onshore landfall/ onshore export cable route (used for temporary accesses)	Asphalt	0.05	ICE Database, v3.0 November 2019 (Jones & Hammond, 2019)	Assumed mid-ranged, 5% binder content
Onshore landfall/ onshore export cable route	Clay (bentonite proxy)	0.39		Assumed clay representative of bentonite as bentonite is “is an absorbent swelling clay consisting mostly of montmorillonite”

Component(s)	Material	Emission factor (kg $CO_2e.kg^{-1}$, unless otherwise stated)	Source	Notes
Onshore landfall/ onshore export cable route	Mortar (1:6 cement: sand mix) (cement bound sand proxy)	0.12	ICE Database, v3.0 November 2019 (Jones & Hammond, 2019)	N/A
Onshore landfall/ onshore export cable route	Concrete	0.1		N/A
Onshore landfall/ onshore export cable route	Concrete slab	0.13		N/A
Onshore landfall/ onshore export cable route	Lime	0.78		N/A
Onshore landfall/onshore export cable route	Polypropylene (duct proxy)	3.69	Cableizer (n/a)	CO_2 only.
Onshore landfall/onshore export cable route	Polypropylene (geogrid, geotextile and wind turbines converter proxy)	4.98	ICE Database, v3.0 November 2019 (Jones & Hammond, 2019)	CO_2 only
Onshore landfall/onshore export cable route	PVC pipe (perforated pipe proxy)	3.23		N/A
Onshore landfall/onshore export cable route	Sand	0.01		Estimate of market average aggregate

Component(s)	Material	Emission factor (kg $CO_2e.kg^{-1}$, unless otherwise stated)	Source	Notes
Onshore landfall/onshore export cable route	Soil	0.02		N/A
Onshore landfall/onshore export cable route	Water	0.149 (as kg $CO_2e.m$-3)	Department for Business, Energy & Industrial Strategy (BEIS) (2022)	N/A

30.1.2. Marine Vessels

8. Marine vessels will be used to bring materials and components to the wind farm site, install infrastructure (wind turbines, OSPs and / or OCPs, foundations and cables), provide crew accommodation and support during construction, commissioning and for operation and maintenance activities.

9. The current working assumption for offshore vessel logistic during the construction and operation and maintenance phases of the Projects are supplied by the design team for the Projects. These are outlined in **Table 30-2** and **Table 30-3** for construction and operation and maintenance respectively. All construction vessels are assumed to operate from a port that is a maximum of 240 km from the centre of the windfarm array areas. Assumptions for the vessel movements will be further refined before the environmental Statement (ES) and the GHG emissions will be updated where relevant.

Table 30-2 Indicative Number of Vessels Movements During Construction

Activity	Vessel	Maximum number of return trips	Notes
Site Preparation	Site Preparation Vessel	78	Assumes an offshore support vessel.
Foundation Installation	Scour Layers Vessel	1,676	Assumes a fall pipe installation vessel.
	Gravity Base Foundation Ballast Vessel	1,261	Assumes a transport vessel.
	Foundation Installation Spread	267	Assumes a Jack-Up vessel (JUV).
	Transition Piece Installation	24	Assumes the main vessel is a JUV and other vessels include anchor handlers.
Wind Turbine Installation	Wind Turbine Installation Spread	148	Assumes the main vessel is a JUV and other vessels include anchor handlers, barge, and tug vessels.

Activity	Vessel	Maximum number of return trips	Notes
Installation Activities	Commissioning Vessel	78	Assumes a SOV.
	Accommodation Vessel	2	Assumes a Crew Transfer Vessel (CTV).
Inter-array Cable Installation	Inter-array Cable Vessels	36	Assumes the main vessel is a cable lay vessel and other supporting vessels include cable support vessel, seabed prep vessels and tugs.
	Inter-array Rock Berm Vessels	470	Assumes the use of a fall pipe installation vessel.
Offshore Export Cable Installation	Export Cable Vessels	52	Assumes the main vessel is a cable laying vessel and other supporting vessel include cable support vessel, seabed prep vessels and tugs.
Export Cable and Inter Platform Rock Berm Installation	Export cable and Inter Platform Cable Rock Berm Installation Vessels	3,030	Assumes the use of a fall pipe installation vessel.
Landfall Cable Installation	Landfall Cable Installation Vessels	3	Assumes the main vessel is a cable laying vessel and other supporting vessel include cable support vessels.
Offshore substation Installation	Substation Installation Vessel Topside	32	Assume the main vessel is an installation vessel and other supporting vessels include tugs and barges.
	Substation Installation Vessel Foundation	64	
Other Vessels	Other Vessel	4,380	Assume the main vessel is a CTV and other supporting vessels includes guard ships and installation support vessel.

10. As a conservative approach, for construction activities where the maximum number of return trips is provided as a total for all the vessels associated with a particular activity (i.e. JUV, barge, support vessel), the maximum number of return trips is attributed to the main vessel (i.e. JUV) used during the activities and is used to calculate the corresponding vessel emissions for the construction activity.

11. It should be noted that only indicative vessel transit details are provided by the vessel team for construction as outline in **Table 30-2**. An indicative construction programme has been provided, the durations are based on the assumptions that the Projects are built sequentially, and those indicative durations (detailed below) are used in the calculation of GHG emission from vessel activity during construction. These assumptions will be further refined for the ES:

- Wind turbine installation vessels – approximately 54 months;
- Foundation installation vessels – approximately 36 months;
- Offshore substation installation vessels – approximately 48 months; and
- Array and export cable installation vessels – 54 months.

Table 30-3 Indicative Number of Vessels Movements During Operation and Maintenance

Vessel Type	Visits per year	Notes
JUV (to turbines and platforms)	16	Vessel(s) will be on site for multiple days and move between wind turbines
SOV	104	N/A
Small accommodation vessel	104	N/A
Small operation and maintenance vessel (CTV)	104	N/A
Cable maintenance vessels	1	N/A
Auxiliary vessels	128	Auxiliary vessels include: survey vessels, remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), diver platforms, tug operations, cargo vessels, scour replacement vessels.

12. As a conservative scenario, it has been assumed that each visit in **Table 30-3** will require a separate vessel movement to/from the operation and maintenance base. The duration that each vessel (listed in **Table 30-3**) will spend on site is not known at this stage, and therefore further assumptions adopted from other projects of similar nature have also been used for this assessment. These assumptions include:

- Each JUV will be on site for two weeks per visit; and
- Cable maintenance and auxiliary vessel will be on site for four weeks per visit.

13. For the vessels used during the construction phase, it anticipated that the construction port is a maximum of 240 km from the centre of the array areas and it's the distance used for the worst case scenario in this assessment. as detailed in **Table 30-2**. For the operation and maintenance phases, vessels are assumed to travel to the wind farm site from Port of Grimsby**.** This may not be wholly representative of actual locations where the vessel will travel from but is deemed suitable for this assessment. Indicative sailing distances from the anticipated construction port (240 km from the centre of the array areas) and from the Port of Grimsby to the windfarm site are input into the assessment. If more detailed information is available in future, the assumption and assessment will be refined for the ES.

14. Emissions from dredging activities during the construction of the Projects have not been included in the assessment, as a breakdown of information regarding dredging activities is not known at this stage.

15. Marine vessel activities associated with the Projects are estimated to derive estimated fuel consumption during construction and operation and maintenance. Emission factors for marine gas oil (MGO), in kg CO_2e per kWh are obtained from BEIS (BEIS, 2022). The shipping sector is expected to decarbonise over the lifespan of the Projects, although projections for the speed and the extent that this will take place are difficult to predict. It is therefore assumed that marine vessels continued to use MGO during the construction and operation and maintenance phases of the Projects. This approach is considered to be precautionary and likely to result in an overestimation of emissions, particularly with respect to the operation and maintenance phases.

16. Indicative vessel types and representative vessel specifications for these vessel types are taken from projects of a similar nature. Fuel consumption figures are calculated by multiplying the engine size of the vessels by activity hours in transit (accounting for average engine load factors).

17. Emissions are quantified from the operation and maintenance phases over the anticipated life span of the Projects (currently anticipated to be 32 years). This included the use of JUVs, CTVs, large and small operation and maintenance vessels, lift vessels, cable maintenance vessels and auxiliary vessels (e.g. survey, ROVs, tugs, etc.), as detailed in **Table 30-3**.

18. 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.

30.1.3. Helicopters

19. Helicopter movements associated with the construction and operation and maintenance phases of the Projects 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 Projects, and unplanned maintenance tasks will be undertaken via helicopters during the operation and maintenance phase, when CTV access is not possible or deemed not to be suitable. The amount of GHG emissions from helicopters is calculated by determining the expected fuel consumption using maximum trip data.. The volume of GHG emissions from helicopters use during the construction, operation and maintenance phases are calculated by determining the expected fuel consumption using trip data.

20. The anticipated number of helicopter journeys during construction/commissioning and operation and maintenance for the Projects are outlined in **Table 30-4**.

Table 30-4 Operation and Maintenance Phase Helicopter Movements

Phase	Activity	Annual maximum number of return trips
Construction	Logistics	730 per project
Operation and Maintenance	Routine operations	20
Operation and Maintenance	Emergency situations	12

21. The total distance travelled by helicopters is determined by multiplying the number of trips by the maximum trip distance. The possible airbases for the construction phase of the Projects are Humberside airport and Teesside International Airport / Durham Tees Valley Airport. The approximate distance from Teesside International Airport / Durham Tees Valley (MME) to the centre of the project array area is a straight line distance of approximately 203 km (one-way). The approximate distance from the Humberside airport to the centre of the project array area is a straight line distance of 175 km (one-way). As a worst case, it is assumed that helicopter trips originate at Teesside International Airport / Durham Tees Valley Airport during the construction phase. As the operation and maintenance base for the Projects is still not defined, it is also assumed that operation and maintenance phase helicopter trips originated at Teesside International Airport.

22. The likely types of helicopters for these activities include the Agusta Westland 139 (AW139), Agusta Westland 189 (AW189) and Airbus H175. Based on previous project experience, the AW189 helicopter type is selected to determine fuel consumption. The average cruise speed and fuel consumption data for an AW139 is obtained from manufacturers specifications to estimate fuel consumption. Emission factors for aviation turbine fuel (or jet fuel), in $CO_2e.t^{-1}$ fuel, are obtained from the BEIS (2022).

30.1.4. Road Traffic Vehicles

23. Road traffic vehicle movements associated with the construction, operation and maintenance phases of the Projects will result in the release of GHG emissions. GHG emissions are calculated from the total miles travelled by heavy goods vehicles (HGVs) and staff transport to and from the onshore construction sites, and also during the operation and maintenance phase.

24. The total distance of vehicles travelled during the whole construction phase is obtained from **Chapter 24 Traffic and Transport**. To provide a conservative assessment, the fleet make up (in terms of fuel and Euro standards) for the earliest year of construction (2026) is used in the assessment for employee travel.

25. Emission factors for each vehicle type considered in the assessment are obtained from BEIS (2022), in kg CO_2e per km travelled. To provide a conservative assessment, it is assumed that there are no fuel efficiency improvements or reduction in emissions over the temporal extent for each mode of transport in the assessment.

26. Distance travelled during the construction phase are calculated for HGVs and employee movements according to the following methodology:

- General:
  - Vehicles movements are collated by the Transport Consultants for the Projects from **Chapter 24 Traffic and Transport**.
  - The approach adopted is considered to represent a worst case, noting that no reduction in traffic movements has been applied to account for reassignment of traffic. For example, many HGVs would already be on the local network serving existing supply chains and would potentially reassign to serve the Projects without creating additional demand within the local area.
- HGV movements:
  - Bulk materials such as concrete and stone aggregate is assumed to make up the majority of the total HGV trips for the Projects and that these deliveries would be expected from the Port of Hull.
  - The distances from the Hull Port are calculated to each of the Projects infrastructure destination site for each stage of the construction (this is approach is considered to represent a worst-case scenario noting that deliveries from local supplies would reduce the distance travelled).
  - To calculate the total distance travelled in km, the total HGV movement per Projects infrastructure destination are multiplied by the distance from the Hull Port to the infrastructure destination.
- Light vehicle movements:
  - **Chapter 24 Traffic and Transport** adopted a conservative approach that assumes all construction employees travel by single occupancy vehicles, i.e. no reduction to light vehicle movements has been applied to account for employees using public transport, car-sharing etc.
  - The distribution of light vehicles presented in **Chapter 24 Traffic and Transport** is informed by a review of the distribution of local and in-migrant labour.
  - **Chapter 24 Traffic and Transport** outlines that origin of in-migrant labour is based upon the number of bed spaces within local hotels, whilst the distribution of local labour is informed by census data.
  - The total distance covered by light vehicles for each construction section is obtained based on the two-way movement per

construction section, the distribution of light vehicles per entry link and the distance from the entry link to the construction section.

- The total light vehicle movements are multiplied by calculated distances. This provides the total light vehicle distance travelled in miles.

27. The construction phase movements used to calculate GHG emissions are provided **Table 30-5**.

Table 30-5 Construction Phase Traffic Movements

Vehicle	Total distance travelled (miles)
Cars or light vehicles	22,590,000
HGVs	23,253,291

28. The forecasted fleet composition for 2026 (first year of construction) (i.e. proportion of diesel, petrol and electric cars) is obtained from the Department for Transport (DfT) WebTAG data v1.17 (DfT, 2022). The proportion of diesel, petrol and electric cars in the UK fleet for 2026 is obtained from the DfT (2022) 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 30-6.** Emission factors for each vehicle type were obtained from BEIS (2022).

Table 30-6 Calculation of Emission Factor Used for Light Vehicle in Assessment

Earliest year of construction	Fleet composition (DfT, 2022)			Vehicle emission factor (kg $CO_2e.km^{-1}$) (BEIS, 2022)			Emission Factor Used in the Assessment (kg $CO_2e.km^{-1}$)
	Diesel	Petrol	Electric	Diesel	Petrol	Electric *	
2026	39.0 %	53.0 %	7.0%	0.0171	0.17	0.0684	0.162
* Assumed to be plug-in hybrid electric vehicle, as battery electric vehicle has 0 CO_2e emissions in the 2022 BEIS dataset.							

29. It is assumed that all HGVs used for the Projects would be diesel powered. The emission factor for HGV movements (50% laden) is obtained from BEIS (2022) and is 0.850 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.

30. During the operation and maintenance phase of the Projects, traffic movements would be limited to those generated by the routine operation and periodic maintenance at the onshore substation and at link boxes along the onshore cable corridor. It is assumed that there would be eight traffic movements (i.e. one visit) per week for the onshore substation operation and maintenance activities during the 32-year lifespan of the operational phase of DBS. Therefore, a total of 416 annual traffic movements is anticipated for the onshore substation operations during the lifespan of the Projects. It is estimated that one visit per year is required for operation and maintenance activities at each cable joint pit / link boxes and it is assumed that each visit requires two movements with a worst case total of 343 cable joint pit /link boxes for the Projects sequentially. The total annual traffic movement for the onshore cable route operation and maintenance activities is 686 movements during the lifespan of the Projects. Each traffic movement is assumed to be 20 km, therefore, the annual distance from the operation and maintenance activities is 22,040 km and the total distance for the lifespan of the Projects is 705,280 km

30.1.5. Plant and Equipment

31. The Onshore Development Area is split into sections for the construction phase. Plant and equipment use for the different sections vary over the duration of the construction phase.

32. Fuel consumption associated with the operation of non-road mobile machinery (NRMM) for the onshore components of the Projects were calculated based on the estimated use of each item of plant and equipment. Indicative construction plant and equipment for construction activities at landfall and along the onshore cable route and onshore are provided and are specific to the Projects. These will be further refined for the ES.

33. The anticipated fuel demand over the duration of construction is calculated and the emission factor for gas oil consumption is obtained from BEIS (2022) to derive GHG emissions.

34. The following assumptions were adopted in the assessment:

- Plant and equipment are assumed to operate throughout the consented working hours for the Projects (65 hours). On-time factors were applied for each plant and equipment, and are consistent with those used in **Appendix 25.2 Construction Noise Assessment**;
- Construction plant and equipment were all assumed to use diesel to provide a conservative assessment; and
- Engine sizes for plant and equipment were either provided by the design team for the Projects, or obtained for NRMM typically required during construction activities, and from manufacturer specifications. It is assumed that engines operated at a load factor of 75%.

35. Indicative durations for plant and equipment at landfall, along the onshore cable export route and at the onshore substations were obtained. The durations will be further refined before the ES.

36. Plant and equipment used during the construction of the Projects is provided **in Table 30-7.** Details of the number of plant required for the fifteen sections of the Onshore Development Area, which includes the possible landfall locations, onshore export cable route and onshore substations.

37. The information provided in **Table 30-7** represents the average monthly number of plant and equipment that could be present at each section. Plant and equipment numbers were provided for each section per month. There will be some variation in the use of plant and equipment over the construction period at the landfall, onshore export cable route and onshore substations, therefore average numbers of each plant and equipment per month calculated (note: due to this approach, these average values may not be a whole number). The duration these plant and equipment were used is dependent on the construction programme. The total number of operational plant hours during construction is calculated by multiplying the total number of plant/equipment required per month by the construction hours (65 hours per week).

38. For the purposes of the assessment, it is assumed that plant and equipment operated using gas oil as fuel, which has an emission factor of 0.257 kg CO_2e per kWh (BEIS, 2022).

Table 30-7 Plant and Equipment Requirements (Total Construction) for Each Construction Section (Landfall, Onshore Export Cable Route and Onshore Substations)

Plant	kW	On-time	No. of plant (on average) operational per month															Total plant operational
			Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 16A	Section 16B	Section 14	Section 17	Section 15	
D6 Dozer	161	1	36	26	22	19	29	32	19	20	17	29	15	19	21	45	24	373
30T Excavator	204	1	52	48	43	32	45	50	37	36	30	44	26	34	37	n/a	38	552
20T Dumper	231	1	91	73	60	42	66	73	47	46	35	60	33	41	51	128	48	894
Smooth Drum vibrio road roller	142	1	21	11	12	10	15	16	10	11	10	15	8	10	12	50	14	225
21T excavator	128.4	1	45	38	33	23	35	39	27	25	20	32	17	24	27	93	27	505
5T Forward Tipping Dumper	62.5	1	41	34	31	23	32	35	27	25	20	29	17	24	27	81	27	473
Loading shovel	170	1	48	40	36	23	39	43	27	25	21	36	18	23	27	43	28	477
Trench Roller	142	1	22	18	14	9	14	16	11	9	6	12	6	9	11	2	9	168
Tractor & fencing kit	211	0.5	14	8	9	7	10	11	7	8	7	12	7	7	9	8	10	134
Tractor & trailer	211	0.7	42	33	28	19	31	35	21	20	16	29	14	18	22	82	21	431
Tractor & Fuel bowser (or self-propelled)	211	0.1	18	18	16	12	16	18	14	14	12	17	11	13	14	36	14	243
Tractor & Water bowser (for dust suppression)	211	0.25	18	18	16	12	16	18	14	14	12	17	11	13	14	27	14	234
Tractor & cable drum trailer	211	0.5	7	6	4	3	5	6	3	3	2	5	2	3	3	0	3	55
Tractor & soil tiller, roller, seeder	211	0.25	3	3	3	2	4	3	2	2	2	3	2	2	2	4	2	39
Cement mixer	216	0.25	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Mobile crane	132	0.25	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4

Plant	kW	On-time	No. of plant (on average) operational per month															Total plant operational
			Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 16A	Section 16B	Section 14	Section 17	Section 15	
Grader	205	1	10	6	6	6	y9	10	6	7	6	9	5	6	8	21	9	124
Cable laying tracked crane	107	0.25	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Cable winch	19.1	0.5	7	6	4	3	5	6	3	3	2	5	2	3	3	0	3	55
Pre-cast concrete truck	216	0.05	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Mobile concrete pump	216	0.5	10	6	4	3	5	6	3	3	2	5	2	3	3	0	3	58
Telehandler	107	0.7	37	28	22	15	26	29	17	16	12	24	11	15	19	68	18	357
Mobile self-contained welfare unit	8	0.25	18	18	16	12	16	18	14	14	12	17	11	13	14	45	14	252
Crawler Crane	107	0.25	11	8	6	3	6	7	4	3	2	5	2	3	4	1	3	68
Road surface paver & roller	142	0	2	2	2	2	2	2	2	2	2	2	2	2	2	20	2	48
Concrete batching plant	100	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	19	n/a	19
Dry-mix silos	150	0.25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	39	n/a	39
Mobile crane (light for general use)	132	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	42	n/a	42
Mobile crane (heavy)	205	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10	n/a	10
Specialist heavy-lifting gantry & associated equipment	355	0.25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	10	n/a	10
Static crane	132	0.4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	18	n/a	18

Plant	kW	On-time	No. of plant (on average) operational per month															Total plant operational
			Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 16A	Section 16B	Section 14	Section 17	Section 15	
3T Forward Tipping Dumper	32.4	0.25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	30	n/a	30
Scissor lift	18.5	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	82	n/a	82
Mobile powered aerial platform (boom lift / 'cherry picker')	31	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	82	n/a	82
Scaffolding	0	0.25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	144	n/a	144
Formwork	0	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	152	n/a	152
JCB Wheeled excavator	81	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	34	n/a	34
Forklift	28	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	47	n/a	47

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