Bowdun Offshore Wind Farm, Onshore EIA Report

Volume 2, Appendix 15.1: Greenhouse Gas Assessment

TWP-BOW-JCB-ONE-RPT-00025 I November 2025

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Glossary

Defined term	Definition
Blue Carbon	Carbon captured by the world's ocean and coastal ecosystems. Typically includes carbon stored within ocean sediments and ocean vegetation such as seagrasses or kelp.
Embodied Carbon	Embodied carbon refers to the total greenhouse gas emissions associated with the extraction/production, transportation, installation, maintenance, and end-of-life profile of materials used for the Project.
Environmental Impact Assessment (EIA)	Assessment of the potential likely significant effects of the Project on the physical, biological, and human environment during construction, operations and maintenance and decommissioning.
Impact	A change caused by an action that occurs during a Project's lifetime.
Inter-Array Cables (IAC)	Cables which link the wind turbines to each other and with the Offshore Substation Platforms (OSPs).
Interconnector Cables	Cables which will connect individual OSPs to each other to provide redundancy against cable failure elsewhere.
Landfall	The area in which the Offshore Export Cables make landfall and is also the transitional area between the Offshore Transmission Assets and the Onshore Transmission Assets. Located in the intertidal area (see definition above) at Benholm.
Marine Application Boundary	The boundary within which all offshore elements of the Project will be located. The Marine Application Boundary comprises the Offshore Generation Assets and Offshore Transmission Assets which end at mean high water springs.
Maximum Design Scenario (MDS)	The scenario within the design envelope likely to result in the greatest impact on a particular topic receptor, and therefore the one that should be assessed for that topic receptor.
National Grid	The national electricity transmission network.
Offshore Environmental Impact Assessment (EIA) Report	Document prepared to report the findings of the EIA for the offshore elements of the Project.
Onshore Environmental Impact Assessment (EIA) Report	Document prepared to report the findings of the EIA for the Proposed Development and produced in accordance with the EIA Regulations. An Onshore EIA will be submitted to support the Onshore Application for the Project.
Offshore Export Cable	Subsea cables used to transmit electricity generated offshore by the Wind Turbines from the OSPs to shore. The Transition Joint Bay (TJB) is the location where the Offshore Export Cable terminates, and the onshore cabling begins.
Offshore Generation Assets	The infrastructure of the Project required to generate electricity comprising of the Wind Turbines, Wind Turbine foundations and associated infrastructure (e.g. IACs).
Offshore Infrastructure	All of the Offshore Infrastructure associated with the Project that is located seaward of MHWS, comprising the Offshore Generation Assets and the Offshore Transmission Assets.
Offshore Substation Platform(s) (OSPs)	OSPs comprise the support structure, topside and electrical components used for collecting and/or converting electricity generated by the wind turbines for transmission by the Offshore Export Cables.
Offshore Transmission Assets	The infrastructure of the Project required to transmit the generated electricity comprising of the OSPs, Offshore Export Cables and associated infrastructure up to MHWS.
Onshore Export Cable	The cables (220/275 kV) that transfer electricity from Landfall to the Substation.

Onshore Transmission Assets	The transmission infrastructure associated with the Project above MLWS which is covered in the Onshore EIA Report.
Operation and Maintenance	The phase of the Proposed Development following completion of construction. This phase of development includes routine inspections, repairs and replacement of infrastructure and equipment and general upkeep of the Proposed Development through its operational lifespan.
Planning Permission in Principle (PPP) Application Boundary	The red line boundary representing the extent of the planning permission in principle application.
Project (the)	An overarching term for the Bowdun Offshore Wind Farm (Bowdun OWF) comprising the offshore and onshore infrastructure required to generate and transmit electricity from the Array Area to the onshore Grid Connection Point (GCP). The Project includes the Offshore Generation Assets, the Offshore Transmission Assets and the Onshore Transmission Assets.
Project Design Envelope	A description of the range of possible elements that make up the design options for the Proposed Development under consideration when the exact engineering parameters are not yet known.
Scour Protection	Protective materials to avoid sediment being eroded away from the base of the foundations due to the flow of water.
Study Area	For each environmental topic, the baseline environment will be characterised, and the potential environmental impacts will be described within a topic-specific study area. Specific study areas are defined for each topic and are based on the maximum spatial extent across which potential impacts of the Project may be experienced by the relevant receptors.
Substation Search Area	The area identified at scoping that the Proposed Development Substation would be located within in proximity to the grid connection point.
Transition Joint Bay (TJB)	Used to connect the Onshore Export Cables with the Offshore Export Cables. These are typically concrete lined and will be located above MHWS.
Wind Turbines	Structures comprising of a tubular tower, rotor blades, and a nacelle which houses the Wind Turbine generator.

Acronyms

Acronym	Definition
$CaCO_3$	Calcium carbonate
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DESNZ	Department for Energy Security and Net Zero
DUKES	Digest of UK Energy Statistics
EIA	Environmental Impact Assessment
EPD	Environmental Product Declaration
FES	Future Energy Scenario
GHG	Greenhouse Gas
GWP	Global Warming Potential
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HFC	Hydrofluorocarbon
HGV	Heavy Goods Vehicle
HM	His Majesty's
IAC	Inter-Array Cable
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management and Assessment
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Analysis
MDS	Maximum Design Scenario
MLWS	Mean Low Water Spring
MSC	Matters Specified in Conditions
NESO	National Electricity System Operator
NF_3	Nitrogen Trifluoride
N_2O	Nitrous Oxide
O&M	Operation and Maintenance
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PDE	Project Design Envelope
PFC	Perfluorocarbon
PPP	Planning Permission in Principle
RICS	Royal Institute of Chartered Surveyors
SF_6	Sulphur hexafluoride
TJB	Transition Joint Bay
UK	United Kingdom
UPVC	Unplasticized Polyvinyl Chloride
WBCSD	World Business Council for Sustainable Development
WLCA	Whole Life Carbon Assessment
WRI	World Resources Institute

Table of Units

Units	Definition
kg	Kilograms per Cubic Metre
$kgCO_2e$	Kilograms of Carbon Dioxide Equivalent
$kgCO_2e/kg$	Kilograms of Carbon Dioxide Equivalent per Kilogram
$kgCO_2e/km$	Kilograms of Carbon Dioxide Equivalent per Kilometre
$kgCO_2e/kWh$	Kilograms of Carbon Dioxide Equivalent per Kilowatt-hour
$kgCO_2e/MWh$	Kilograms of Carbon Dioxide Equivalent per Megawatt-hour
Kg/hr	Kilograms per hour
kWh	Kilowatt-Hour
km	Kilometre
kV	Kilovolt
kVA	Kilovolt-Ampere
ha	Hectare
hr	Hour
l	Litre
m	Metres
mm	Millimetres
m^2	Square Metres
m^3	Cubic Metres
MW	Megawatt
MWh	Megawatt-Hour
MVA	Megavolt-Amperes
t	Tonnes
tCO_2e	Tonnes of Carbon Dioxide Equivalent
$tCO_2e/ha/year$	Tonnes of Carbon Dioxide Equivalent per Hectare per Year
tCO_2e/t	Tonnes of Carbon Dioxide Equivalent per Tonne
tC	Tonnes of Carbon
tC/ha	Tonnes of Carbon per Hectare
%	Percent

1 Introduction

1.1.1 This Climate Change Greenhouse Gas (GHG) Assessment Technical Report presents the methodology and calculations of the GHG emissions for the Bowdun Offshore Wind Farm (OWF) (hereafter referred to as the Project).

1.1.2 The information from this technical report informs the assessment of climate change impacts reported in Volume 1, Chapter 15: Climate Change of the Onshore Environmental Impact Assessment (EIA) Report, and the Climate Change chapter of the Offshore EIA Report.

1.1.3 It is important to note that the offshore and onshore elements of the Project do not operate alone, therefore this technical report presents the calculation of the onshore and offshore GHG emissions[1]. The onshore elements of the Project are referred to throughout as the 'Onshore Transmission Assets' and will be located within the Planning Permission in Principle (PPP) Application Boundary. The offshore elements are referred to as the 'Offshore Transmission and Offshore Generations Assets' and will be located within the Marine Application Boundary. When referring to both the onshore and offshore elements, 'the Project' is referred to.

1.1.4 Key emissions sources included in this assessment are:

- Onshore:
  - land use change (woodland disturbance);
  - embodied carbon emissions in materials for the Onshore Infrastructure required (Offshore Export Cables landward of Mean Low Water Springs (MLWS), Transition Joint Bays (TJBs), Onshore Export Cables, Substation, and onward connection to the National Grid electricity transmission network);
  - onshore use of plant and machinery and the associated emissions from fuel consumption during the construction; and
  - onshore transport emissions during the construction, operation and maintenance (O&M), and decommissioning phases.
- Offshore:
  - land use (seabed) change;
  - embodied carbon emissions in materials for the Offshore Infrastructure required (the Wind Turbines and associated foundations, Offshore Substation Platforms (OSPs), Inter-Array Cables

[1] Greenhouse gases refer to gaseous compounds that absorb infrared radiation and trap heat in the atmosphere and include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3). As each of these GHGs have a different Global Warming Potential (GWP), emissions of GHGs have been expressed throughout this chapter as emissions of carbon dioxide equivalent (CO_2e) i.e. the equivalent amount of CO_2 with the same GWP.

(IACs), Interconnector Cables and Offshore Export Cables seaward of MLWS); and

- offshore transport emissions during the construction, O&M, and decommissioning phases.

1.1.5 There are also avoided emissions associated with the Project which should be considered. This is based on the Project replacing electricity generation by fossil fuel-based electricity generation sources, or in relation to the associated emissions related with the United Kingdom (UK) national grid.

1.1.6 GHG emissions have been estimated by applying published emissions factors to activities in the baseline and to those required for the Project. The emissions factors relate to a given level of activity, or amount of fuel, energy or materials used, to the mass of GHGs released as a consequence.

2 GHG Emissions Study Area

2.1.1 The GHG Emissions Study Area is defined as the Project in the context of the domestic and international scope as developed on the basis of established Institute of Environmental Management and Assessment (IEMA) guidance (IEMA, 2022) utilised throughout this assessment. Domestic scope considers the local and national policy and targets concerning GHG and climate resilience.

2.1.2 GHG emissions have a global (international) effect rather than directly affecting any specific local receptor. The impact of GHG emissions occurring due to the Project on the global atmospheric concentration of the relevant GHGs (see footnote on page 1), expressed in carbon dioxide equivalents (CO_2e), is therefore considered within this assessment.

2.1.3 The temporal extent of the GHG Emissions Study Area is the full lifetime of the Project, (i.e. construction, O&M and decommissioning phases). Construction is anticipated to commence in 2031 and last 48 months, with first powering occurring in 2035 and full operation in 2036. The operational lifetime of the Project is anticipated to be 30 years, and at the end of the operational lifetime of the Project, it will be decommissioned.

2.1.4 However, as the seabed leases that the wind farm will enter is for up to 60 years, it is anticipated that one re-powering of the Project may be sought during the lease duration in line with the regulations, requirements, guidance and best practice relevant at that time. In this case, new consents are likely to be required for the Project which would require a new assessment undertaken at that time. As such, for the purposes of this assessment, the temporal boundary is for construction to occur over four years (onshore) / five to six years (offshore), operation to occur over 30 years, and decommissioning to occur following the operation. Though the approach for decommissioning is yet to be determined, it is anticipated that the duration of decommissioning will be similar to the duration of construction.

3 Methodology

3.1 Methodology Overview

3.1.1 Published benchmarks have been used to establish the baseline of current and future grid average carbon intensity for the UK. Baseline information has been informed via the following sources:

- Department for Energy Security and Net Zero (DESNZ) (DESNZ, 2023) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to His Majesty's (HM) Treasury Green Book.

3.1.2 GHG emissions caused by an activity are often categorised into 'Scope 1', 'Scope 2' or 'Scope 3' emissions, following the guidance of the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol suite of guidance documents (WRI and WBSCD, 2004). These categories are as follows:

- Scope 1 emissions: direct GHG emissions from sources owned or controlled by the company, (e.g. from combustion of fuel at an installation or combustion of fuel in company-owned vehicles);
- Scope 2 emissions: caused indirectly by consumption of purchased energy, (e.g. from electricity supplied through the national grid); and
- Scope 3 emissions: all other indirect emissions occurring as a consequence of the activities of the company but occur from sources not owned or controlled by the company. For example. upstream emissions from suppliers, such as purchased goods and services and extraction, processing and transport of raw materials). Downstream emissions include use and transport of products sold to customers.

3.1.3 This assessment has sought to include emissions from all three scopes, where this is material and reasonably possible from the information and emissions factors available, to capture the impacts attributable most completely to the Project. These emissions are not separated out by defined scopes (Scope 1, 2 or 3) in the assessment. However, the majority of emissions are Scope 3 emissions (as all construction and decommissioning phase emissions would be considered as Scope 3), with the majority of O&M phase emissions also Scope 3 (i.e. emissions from the consumption of raw materials and fuel consumed by suppliers undertaking the O&M works.

3.1.4 Due to the nature of the Project (i.e. it results in generated electricity from renewable sources being exported to the national grid), its total gross GHG emissions includes consideration of displaced emissions that would have occurred as a result of electricity generation without the Project (i.e. avoided emissions).

3.1.5 The assessment has considered (a) the GHG emissions arising from the Project (during construction, O&M, and decommissioning phases), (b) any GHG emissions that it displaces or are avoided, compared to the current or future baseline, and hence (c) the net impact on climate change due to these changes in GHG emissions overall.

3.1.6 Consideration of GHG emissions over the lifetime of the Project is required in order to quantify its net contribution to climate change and as such the magnitude of change owing to the Project.

3.2 Embodied Carbon

3.2.1 A Whole Life Carbon Assessment (WLCA) comprises an evaluation of the inputs, outputs and potential GHG emissions that occur throughout the lifecycle of a particular project, including its disposal. This WLCA evaluates the emissions resulting from the accounting for construction, O&M, and decommissioning of the Project, otherwise known as a 'cradle-to-grave' approach. This can be further broken down into the following WLCA modules according to the guidance found in Whole Life Carbon Assessment for the Built Environment (Royal Institute of Chartered Surveyors (RICS), 2023), as follows:

- construction (WLCA modules A1-A5);
- O&M (WLCA modules B1-B8); and
- decommissioning (WLCA modules C1-C4).

3.2.2 Key sources relied upon for the assessment are as follows:

- RICS Professional Information, UK Methodology to calculate embodied carbon of materials RICS (2012);
- RICS Professional Standard: Whole Life Carbon Assessment for the Built Environment, 2nd Edition (2023);
- Inventory of Carbon and Energy (ICE) database (Jones and Hammond, 2024); and
- UK Government GHG Conversion Factors for Company Reporting (DESNZ, 2025a).

3.2.3 Methodology specific to the construction of each element comprising the Project is detailed within Section 5.

Onshore

3.2.4 The embodied carbon emissions from the Onshore Transmission Assets include those resulting from the manufacturing and construction of the Substation, Landfall and Transition Joint Bays, 220/275 kV Onshore Export Cables and 400 kV Cables, in addition to fuel use by vehicle movements and plant/machinery. They have been calculated via a range of methodologies, including published benchmark carbon intensities and Life Cycle Assessment (LCA) literature, and the application of material or fuel emission intensities to material or fuel quantities. Detailed information regarding the design parameters assessed is set out in Volume 1, Chapter 15: Climate Change of the Onshore EIA Report.

Offshore

3.2.5 The embodied carbon emissions from the Offshore Transmission Assets and Offshore Generation Assets include those resulting from the manufacturing and construction of the Wind Turbines, OSPs, IACs, Interconnector and Offshore Export Cables, and associated fuel use from vessel and helicopter movements. These have been calculated via the application of material or fuel emission factors to information provided in the Project Description (see Volume 1, Chapter 2: The Proposed Development to be submitted as part of the Offshore EIA Report), approximate material or fuel quantities, and published LCA literature. Detailed information regarding the design parameters assessed (as contained within a defined Maximum Design Scenario) will be set out in the Offshore EIA Report.

3.3 Land Use Change

Onshore

3.3.1 The calculation of GHG emissions for the Onshore Transmission Assets considers the impact of temporary and permanent habitat loss, which affects the 'carbon balance' of habitats in the onshore GHG Emissions Study Area. 'Carbon balance' in this context refers to the net fluxes of GHG emissions that the habitats present in the onshore GHG Emissions Study Area.

3.3.2 Woodland is a substantial store of organic carbon and is also a carbon 'sink' (i.e. the woodland sequesters carbon over time). The felling and removal of woodland during construction therefore affects the net GHG emissions of the Project. Although replacement and compensatory woodland planting is proposed where appropriate (as discussed in Volume 1, Chapter 2: The Proposed Development of the Onshore EIA Report), some areas of woodland lost during the construction phase, for example, within the proposed Substation Search Area and along the Cable Corridors' permanent easement, will be permanent. Proposals for replanting and compensatory planting and other nature-based mitigation would be set out in appropriate management plan(s), such as the proposed Felling and Replanting Plan, Landscape Management Plan or Habitat Management Plan (including biodiversity) provided at the Matters Specified in Conditions (MSC) stage.

3.3.3 Furthermore, any loss of woodland represents an emission of the stored carbon as the end-of-life use of the felled and removed trees is not known at this stage. Therefore, it is assumed that the stored carbon in any felled woodland trees during construction of the Project (i.e. trees felled and cleared for the cable corridor or within the substation area) would be released to the atmosphere during the construction phase. As much of the felled woodland areas are within the Fetteresso Forest (a managed forestry plantation which would be subject to scheduled felling and replanting as normal practice), assuming that all carbon would be released and that this would be associated with the Proposed Development is a conservative approach. In practice, not all carbon would be released.

3.3.4 GHG emissions may also occur from the disturbance of carbon rich soils (i.e. peatland or soils with high peat content) during construction activities such as excavation and material handling/stockpiling.

3.3.5 Other land use types are assumed to have limited impacts on GHG emissions through disturbance, removal or clearing of habitats and vegetation. For example, agricultural land which is subject to ongoing agricultural practices.

3.3.6 The presence of woodland and peatland/carbon-rich soils were identified within the PPP Application Boundary based on appropriate geospatial datasets and survey data recorded for other environmental topics (as noted in Section 4.1).

3.3.7 Where the Project leads to a change to land use through the felling/clearing of woodland areas or disturbance of carbon-rich soils, the change in emissions have been calculated using published factors for carbon storage, GHG emission rates and GHG sequestration rates, in accordance with the following key source:

- Gregg *et al*. (2021) Carbon storage and sequestration by habitat: a review of the evidence (second edition).

Offshore

3.3.8 The calculation of climate change impacts for the Offshore Transmission Assets and Offshore Generation Assets considers the impact of temporary and permanent habitat loss and disturbance, affecting 'blue carbon' stocks within the baseline. The term 'blue carbon' refers to organic carbon that has been captured and stored through biological processes in the coastal and marine environment.

3.3.9 Blue carbon can be stored within living biomass, root systems and sediments. Within the coastal and marine environment, there are a variety of habitat types that contribute to the global blue carbon stocks, including sediment habitats, such as deep circalittoral coarse sediment and deep circalittoral sand, found in the offshore GHG Emissions Study Area (Cunningham and Hunt, 2023).

3.3.10 Where habitats are disturbed or lost through impacts from a development, this affects the habitat's ability to store and sequester blue carbon. For example, when organic sediments are disturbed and enter the water column, stored blue carbon within these organic sediments can be converted to CO_2 through a process called remineralisation (Cunningham and Hunt, 2023). This CO_2 could be recycled during benthic respiration, laterally transported as particulate organic matter and redeposited, or find its way to the surface and be outgassed to the atmosphere, or a combination of all three (Cunningham and Hunt, 2023).

3.3.11 Site-specific benthic survey data (see the Offshore EIA Report) and published emission factors have been used to calculate the extent of blue carbon stocks within the offshore GHG Emissions Study Area. The resulting impact of the Project upon the blue carbon stocks has been calculated based on the total area of disturbance by the construction, O&M, and decommissioning of the Offshore Infrastructure, alongside published literature values for the overall effects of disturbance. Key sources relied upon for the assessment are as follows:

- Scottish Blue Carbon – a literature review of the current evidence for Scotland's blue carbon habitats. NatureScot Research Report 1326 (Cunningham and Hunt, 2023);
- Re-Evaluating Scotland's Sedimentary Carbon Stocks. Marine Scotland Science (Smeaton *et al.,* 2020); and
- Benthic and Subtidal Ecology Technical Report (see the Offshore EIA Report).

3.4 Operational Avoided Emissions

3.4.1 The assessment also considers the GHGs that would not be emitted (i.e. avoided) during the O&M phase of the Project, using a variety of scenarios to characterise the future baseline (see Section 4.2). Avoided emissions have been calculated by multiplying the quantity of marginal electricity generation sources that the Project displaces by the associated GHG emission factors of those marginal electricity generation sources (see Section 6.3). Key sources relied upon for the assessment are as follows:

- DESNZ (2023) Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book;
- DESNZ (2025a) GHG Conversion Factors for Company Reporting; and,
- DESNZ (2025b) Digest of UK Energy Statistics (DUKES).

3.5 Limitations

3.5.1 Waste has not been considered as part of the construction, O&M or decommissioning assessment for two main reasons. Firstly, there is insufficient information on the design parameters to accurately and meaningfully assess the waste associated with this Project. Secondly, it is suggested that the amount of waste produced would be insignificant in comparison to the emissions resulting from construction, O&M and decommissioning.

3.5.2 Hydrofluorocarbons (HFCs) are gases that provide an efficient and non-toxic means of insulating medium and high-voltage switchgears, for example in substations. While these gases have a high global warming potential, they are being phased out of use and is it highly likely the technology required will be available by the time this Project goes to construction. As such, these have not been considered in the assessment.

3.5.3 Most of the construction phase GHG emissions associated with the manufacturing of components are likely to occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget, policy and governance. However, in recognition of the climate change effect of GHG emissions (wherever occurring), and the need to avoid 'carbon leakage' overseas when reducing UK emissions, emissions associated with the construction phase have been presented within the assessment and quantification of GHG emissions as part of the Project.

3.5.4 There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies, and thereby the future carbon intensity of the electricity generation being displaced by the Project. Government projections consistent with national carbon budget commitments have been used in the assessment ('long-run marginal' projections). It should be noted that latest Government projections include an increase in renewable energy generation (DESNZ, 2025b) and the Project is therefore consistent with the Government's current policy of a low-carbon electricity grid by 2030, with no unabated fossil fuel generation (DESNZ, 2024a). As such, for the Project's O&M lifetime, the long-run marginal projections presented assume that the Project will displace low-carbon sources of electricity, essentially comparing the Project to projects similar to itself. Multiple scenarios have been considered to present a likely range of avoided emissions, including displacement of non-renewable fuels as an upper estimate for the likely avoided emissions, and comparison to the long-run marginal projections as a lower estimate.

3.5.5 The specific Wind Turbine technology and design of associated infrastructure that would be used by the Project has not yet been specified. Thus, there is a degree of uncertainty regarding GHG emissions at all Project phases resulting from the manufacturing and construction of Wind Turbines and infrastructure. This assessment seeks to limit the impact this might have by using the Maximum Design Scenario (MDS) material quantities and material types (i.e. those with the greatest carbon impact), as informed by engineering input, in the calculation of construction phase emissions. It is unlikely that these MDS material quantities will be used in the final design of the Project, owing to improvements in Wind Turbine and associated infrastructure design and refinements to design assumptions. As such, calculated emissions represent a conservative MDS.

3.5.6 Detailed LCA information is not yet available for all items specific to electricity transmission infrastructure. As such, where not available, a conservative estimate of construction materials or fuels has been scaled by relevant emissions factors. These emissions factors do not account for emissions associated with the manufacture of products, and as such may underestimate embodied carbon emissions. However, it is unlikely that this would significantly impact the assessment of effects.

3.5.7 Blue carbon that is released as a result of marine habitat disturbance dissolves into coastal and marine ecosystems, such as the ocean. As such, this impact does not necessarily directly contribute to the global atmospheric mass of CO_2 (the receptor), as there are many potential pathways for organic carbon disturbance (Cunningham and Hunt, 2023). However, it is likely to indirectly impact atmospheric CO_2 concentrations, as an increased concentration of dissolved CO_2 alters ocean and Calcium Carbonate ($CaCO_3$) chemistry. Though interactions between different states of carbon in the oceans is complex, it is likely that increased concentrations of ocean CO_2 will overall reduce the capacity of oceans to absorb CO_2 and cause a greater potential for the ocean to release CO_2 to the atmosphere under certain conditions (Intergovernmental Panel on Climate Change (IPCC), 2021). Therefore, for the purposes of this assessment, remineralisation of blue carbon stocks has been assumed to have the same impact as the release of an equivalent mass of CO_2 to the global atmosphere.

3.5.8 The benthic survey data used in the assessment of impacts to blue carbon stocks (see the Offshore EIA Report) was collected based on industry standard sampling methodologies. It should therefore be noted that there is a natural limitation in the accuracy of interpretations from extrapolating habitat information from samples. However, the samples taken have been deemed sufficient to accurately characterise the habitats present within the site boundary.

3.5.9 Literature used to calculate the blue carbon value of habitats within the Project provide stored blue carbon factors for the top 10 cm of sediment only, as there are limited data available on sediment thickness and organic carbon content of deeper sediments (Cunningham and Hunt, 2023). As organic carbon contained within deeper sediments is likely to be more stable than that found in the top sediment layer, and less vulnerable to remineralisation following disturbance (Smeaton *et al.*, 2020), the baseline characterisation of the blue carbon value of the habitats within the Offshore Transmission Assets and Offshore Generation Assets is deemed to be sufficient.

4 Baseline Characterisation

4.1 Current Baseline

Land Use Baseline

Onshore

4.1.1 The current baseline land use within the PPP Application Boundary primarily comprises of agriculture (predominantly focussing on arable farming, with livestock farming also present), and areas of woodland and commercial forests (Fetteresso Forest, part of the larger Mearns Forest). This is detailed in Volume 1 Chapter 6: Land Use, Agriculture and Public Access of the Onshore EIA Report.

4.1.2 As set out in Section 3.3, woodlands are substantial stores of organic carbon. As detailed in Volume 2, Appendix 6.1: Arboriculture Report of the Onshore EIA Report, forestry and woodland are recorded along the Cable Corridors, with the main area of woodland being the Fetteresso Forest and Mearns Forest within which the Substation Search Area is located. There is a mix of woodland types across the Cable Corridors and Substation Search Area, which includes coniferous forest and broadleaved woodland. The woodland within the PPP Application Boundary is both for amenity and commercial purposes, and no areas have been designated as Ancient Woodland. The total area of woodland within the Onshore Transmission Assets area (the PPP Application Boundary) is 162.5 ha. As set out in Volume 2, Appendix 6.1: Arboriculture Report of the Onshore EIA Report, a scenario was developed to determine a more realistic area of woodland within a representative 'construction corridor'. For the 220/275 kV cable route, this would be a maximum 50 m wide corridor and for the 400 kV cable route, this would be a maximum 35 m wide corridor. This results in a total woodland area of 46.95 ha (i.e. which represents the total woodland area that would be felled and cleared). For the purposes of this assessment, the representative 'construction corridor' has been used to determine the baseline and potential impacts from land use change.

4.1.3 As noted in Volume 1, Chapter 10: Geology and Ground Conditions of the Onshore EIA Report, the PPP Application Boundary is broadly underlain by soils with no or limited peat content. There is a relatively small area of 'Class 5' soils (areas of high-carbon and deep soil but no peatland habitat recorded) within the Onshore Cable Corridor to the south of the Substation. It is assumed that the cable route could avoid this area in line with relevant embedded mitigation of siting the Proposed Development on poorer quality land avoiding areas of peat (see Table 12.14 of Volume 1, Chapter 10: Geology and Ground Conditions). Volume 1, Chapter 10: Geology and Ground Conditions also notes that relatively thin deposits of peat (up to a maximum of 0.5m in thickness) were identified at 15 locations in the Substation Search Area. Given the limited presence of peaty soils, Volume 1, Chapter 10: Geology and Ground Conditions concluded that the impact on peat due to soil sealing at the Substation Search Area would be of minor adverse significance. On this basis, the impact of peat disturbance was scoped out of the assessment of GHG emissions. Therefore, the GHG emissions land use baseline, and any changes to baseline GHG emissions due to the

Project, is based only on the activities to clear wooded areas, and does not consider soil disturbance.

Offshore

4.1.4 Benthic surveys classified nine different sediment types within the offshore GHG Emissions Study Area, which are set out in Table 5.2. The majority of the area comprises slightly gravelly sand. Refer to the Offshore EIA Report for further information. The standing blue carbon stock in the subtidal sediments present is presented below in Section 5.1. of this Appendix.

GHG Baseline – Electricity Generation

4.1.5 With regards to the current baseline concerning the national grid at the time of writing, the conversion factor for companies reporting UK electricity generation carbon intensity resides at 222.9 $kgCO_2e/MWh$ (including scope 3 but as generated, i.e. excluding transmission and distribution losses) (DESNZ, 2025a).

4.2 Future Baseline

Onshore

4.2.1 As set out in Paragraph 3.3.2, woodland is a net carbon sink. As such, the stored organic carbon present within the woodland within the PPP Application Boundary is likely to increase over time through sequestration. However, the woodland, in terms of area, are assumed to remain constant in future.

Offshore

4.2.2 The future baseline GHG emissions for existing land use (seabed) without the Offshore Transmission Assets and Offshore Generation Assets are expected to remain similar to the current baseline identified in Section 4.1. There is limited published data available regarding blue carbon sequestration rates for sedimentary marine habitat types. However, it is acknowledged that blue carbon sequestration rates in marine habitats are lower than those of terrestrial habitats, in particular sediment-based habitats. Some sediment areas of the North Sea, for instance, experience almost no sediment accumulation and associated carbon sequestration (Cunningham and Hunt, 2023). As such, no material change to the blue carbon stocks currently present within the Project is anticipated in the future baseline.

Electricity Generation

4.2.3 The future baseline for electricity generation that would be displaced by the Project depends broadly on future energy and climate policy in the UK, and more specifically (with regards to day-to-day emissions) on the demand for the operation of the Project, compared to other generation sources available; this will be influenced by commercial factors and the National Energy System Operator (NESO, formerly National Grid Electricity System Operator's) needs.

4.2.4 The carbon intensity of baseline electricity generation is projected to reduce over time and so too would the intensity of the marginal generation source, displaced at any given time.

4.2.5 DESNZ publishes projections of the carbon intensity of long-run marginal electricity generation and supply that would be affected by small (on a national scale) sustained changes in generation or demand (DESNZ, 2023). DESNZ projections over the O&M phase of the Project's lifetime (2036 to 2065) are used to estimate the potential avoided emissions as a result of the Project.

4.2.6 Historically, combined cycle gas turbine plants have been the long-run marginal electricity generators, and previous marginal emissions factors reflect the as generated emissions of a typical Combined Cycle Gas Turbine plant. However, as the power sector decarbonises in line with current UK policy, low-carbon generation will increase significantly both as a proportion of total and marginal generation. Long-run marginal projections reflect these anticipated changes, and as there remains much uncertainty in the pace of innovation, demand and technical feasibility, are indicative projections rather than prescriptive forecasts (DESNZ, 2023).

4.2.7 DESNZ also publishes projections of the grid average emissions factor, which is the carbon intensity of all sources of electricity generation, at the point of generation (i.e. excluding transmission and distribution losses). The marginal factor is assumed to converge to the grid average emissions factor by 2050 and both projections are assumed to be constant after that point.

4.2.8 NESO publishes 'Future Energy Scenario' (FES) projections (NESO, 2025) of grid average carbon intensity under several possible evolutions of the UK energy market. Figure 4.1 illustrates both the DESNZ and FES projected carbon intensity factors for electricity generation. The DESNZ grid average projection sits generally above all the FES projections until 2049. As illustrated in Figure 4.1, all of the FES carbon intensity projections achieve close to net zero by 2050. It should be noted that the values presented exclude Carbon Capture and Storage, meaning the values never reach net zero.

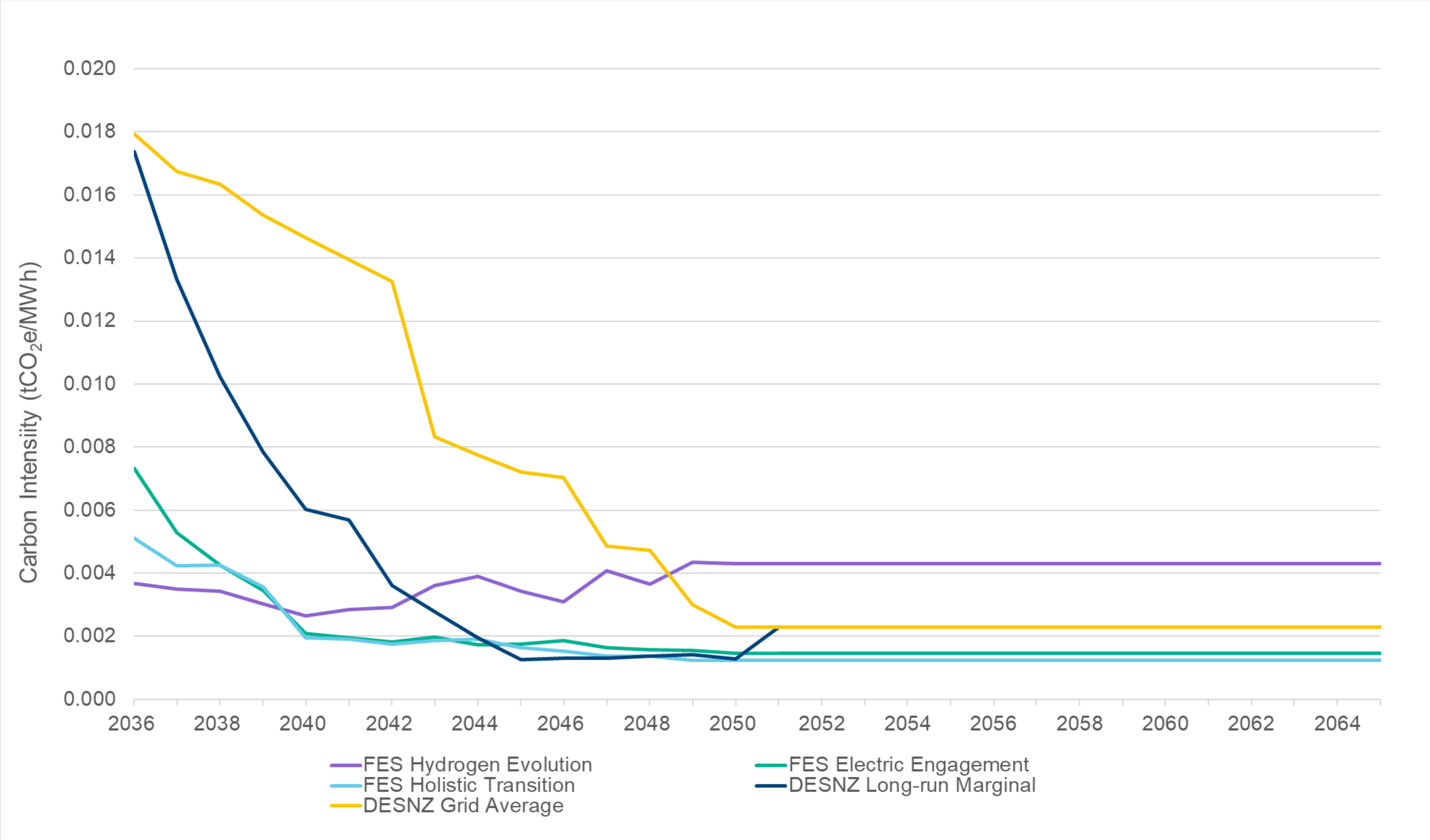

Figure 4.1: DESNZ and FES Future Grid Carbon Intensities

5 Assessment of Construction Effects

5.1 Land Use Change

Onshore

5.1.1 The infrastructure components of the Onshore Transmission Assets that will alter the onshore land use comprise:

- Landfall and TJBs;
- Onshore Export Cable Corridor;
- Substation;
- 400 kV Cable Corridor; and
- any ancillary onshore infrastructure required for the construction phase (such as construction compounds and access).

5.1.2 It is anticipated that any woodland will be felled and cleared within the above areas to facilitate the construction. On completion of construction, the felled/cleared areas will be replanted with trees, except for those areas which contain above ground infrastructure such as the Substation or require a permanently unplanted easement such as the Cable Corridors (assumed to be 35 m for the 220/275 kV Cable, and 15 m for the 400 kV Cable). As noted in Section 4.1, the area of woodland that would be required to be felled and cleared (based on the representative 'construction corridor') for the construction phase is 46.95 ha. The area of woodland that would not be able to be replanted and would be permanently lost within the representative 'construction corridor' is 15.28 ha. To note, this assessment does not take individual tree loss into consideration and focusses on identified woodland areas and parcels.

5.1.3 As stated in Volume 2, Appendix 6.1: Arboriculture Report of the Onshore EIA Report, an area of woodland equivalent to the area of woodland permanently lost will be created to offset the permanent loss. Therefore, it was assumed that the compensatory planting would be undertaken at the commencement of the O&M phase to replace the permanently lost woodland within the construction corridor or a suitable alternative location agreed with relevant landowners, Forestry and Land Scotland and Aberdeenshire Council.

5.1.4 To determine the construction phase land use change emissions, the total lost woodland area of 46.95 ha was multiplied by the emissions factor for the carbon content of 100-year mixed broadleaved native woodland 203 tC/ha (Gregg *et al.*, 2021), to determine the carbon content of the woodland to be felled and removed. This resulted in total GHG emissions of 46,320 tCO_2e.

5.1.5 The temporary loss of carbon-fixing/sequestration potential of the felled and removed woodland was calculated similarly, using the total area of woodland loss (46.95 ha) multiplied by the sequestration rate for 100-year mixed broadleaved woodland of 7 tCO_2e/ha/year (Gregg *et al.*, 2021). This was calculated to occur for the 4-year construction period (i.e. based on the assumption that the woodland would be felled at the start of the construction phase). This resulted in a total effective GHG emission of 1,315 tCO_2e during construction, which can be understood as the total amount of carbon that would have been sequestered by the woodland, had they not been felled.

5.1.6 A summary of the total GHG emissions from onshore land use change during construction is shown in Table 5.1.

Table 5.1: Total emissions from onshore land use change (construction phase)

Emissions source	Emissions (tCO_2e)
Construction – felling and clearing of woodland	46,320
Construction – loss of carbon-fixing/sequestration	1,315
Total	47,634

Note totals may not sum due to rounding

Offshore

5.1.7 Emissions associated with disturbance to blue carbon stocks during the construction phase of the Offshore Transmission Assets and Offshore Generation Assets have been calculated based on the total area of seabed disturbance, sediment types present, published associated carbon stock values and published literature values of the effect of disturbance on the fate of organic carbon stocks.

5.1.8 During construction, it is anticipated that there will be disturbance from the installation of the Wind Turbine foundations, OSP foundations, Interconnector Cables, IACs and Offshore Export Cables, cable protection and scour. The total disturbance of the seabed within the Offshore Transmission Assets and Offshore Generation Assets is calculated to be 1,982 ha, informed by values provided in the Project Description (see the Offshore EIA Report). A full inventory of information from the Project Description, that has informed this report, can be found in Annex A1.

5.1.9 The table below (Table 5.2) presents the sediment types and relative distribution across the Offshore Transmission Assets and Offshore Generation Assets. Blue carbon factors assigned to each sediment type (Folk classification (Folk, 1954)), ranging from 7.3 tC/ha for “slightly gravelly muddy sand” to 1.8 tC/ha for “sandy gravel” (Smeaton *et al*., 2020) were scaled by the relevant areas of each sediment type, resulting in an average blue carbon content across the Offshore Transmission Assets and Offshore Generation Assets of 3.9 tC/ha. When the average blue carbon content is scaled by the area of disturbed seabed, this corresponds to a total of 7,693 tC across the Offshore Transmission Assets and Offshore Generation Assets that has the potential to be disturbed during construction. A breakdown is provided in Table 5.2.

Table 5.2: Blue Carbon Emissions During Construction

Sediment Type (Folk classification)	Carbon Content (tC/ha) (Smeaton *et al.*, 2020)	Percentage of total Array Area and Export Cable Corridor (%)	Total disturbed carbon (tC)
Slightly gravelly sand	3.3	52%	3,416
Gravelly sand	3.5	28%	1,927
Gravelly muddy sand	6.8	2%	300
Slightly gravelly muddy sand	7.3	10%	1,447

Sediment Type (Folk classification)	Carbon Content (tC/ha) (Smeaton *et al.*, 2020)	Percentage of total Array Area and Export Cable Corridor (%)	Total disturbed carbon (tC)
Sand	3.6	2%	159
Muddy Sand	7.1	1%	156
Muddy Sandy Gravel	2.4	2%	106
Sandy Gravel	1.8	1%	40
Sandy Mud	6.5	1%	143
Total	3.9 (weighted average)	100%	7,693

Note totals may not sum due to rounding

5.1.10 While a maximum of 7,693 tonnes of blue carbon stock (equivalent to 28,207 tCO_2 when converted from carbon to CO_2) may be disturbed during the construction phase, not all carbon disturbed is likely be remineralised. Though estimates vary, the majority of blue carbon found in marine sediments further than 5 km from the shore is likely to be unreactive and is more likely to be redeposited as organic carbon deposits elsewhere, with limited remineralisation of CO_2 (Smeaton and Austin, 2022). Approximately 20% of the blue carbon stocks in marine sediments may be reactive and have the potential to be converted to CO_2 following disturbance (Smeaton and Austin, 2022).

5.1.11 Uncertainty remains with the values presented above however, as alternative studies have suggested a higher percentage of conversion to CO_2 (Cunningham and Hunt, 2023). Therefore, it is conservatively anticipated that between 20% and 100% of the blue carbon stock disturbed within the Array Area will be converted to CO_2, corresponding to between 5,641 tCO_2 and 28,207 tCO_2.

5.1.12 To provide a conservative assessment, the greatest emissions value of blue carbon has been reported below.

5.2 Embodied Carbon - Onshore

5.2.1 The following sections detail the methodology used to calculate the construction stage embodied carbon emissions associated with the Onshore Transmission Assets.

5.2.2 The construction stage covers the WLCA life cycle stages A1-A5 (Royal Institute of Chartered Surveyors (RICS), 2023) as summarised below:

- Embodied carbon emissions associated with raw material supply, transport and manufacturing of the required materials and assets (product stage (WLCA life cycle stages A1–A3)).
- Transport of materials to the construction site (construction process stage (WLCA life cycle stage A4)).
- Transport of construction workers and on-site staff to and from the construction site (construction process stage (WLCA life cycle stageA5)).
- Operation of construction plant and on-site activities (construction process stage (WLCA life cycle stage A5)).

Substation

5.2.3 As the application for the Onshore Transmission Assets will be consented through a PPP Application, there is limited information concerning the Substation and few published LCAs from which to calculate associated embodied carbon emissions. Data from an Environmental Product Declaration (EPD) for a 16 kVA – 1000 MVA transformer (ABB, 2003), has therefore been used to provide an approximation of the potential order of magnitude of emissions, as transformers are among the major substation plant components and have a relatively high materials and carbon intensity.

5.2.4 The LCA (ABB Group, 2003) listed a manufacturing Global Warming Potential (GWP) of 2,190 $kgCO_2e$ per MW. This was scaled by the grid connection rating of 1,005 MW, to give an estimated embodied carbon value of 2,201 tCO_2e. This value includes lifecycle stages A1-A3. Although the theoretical maximum generating capacity of the Project is reported in Volume 1, Chapter 1: Introduction as 1,008 MW, the practical maximum of 1,005 MW (67 turbines, each with 15 MW capacity) was used as the basis of the assessment. This aligns with the MDS assessed for the Offshore Infrastructure in this report and within the Offshore EIA Report.

5.2.5 The Substation elements are to be housed within a number of main and secondary concrete buildings which will sit upon concrete foundations. As such, the total material volumes were assumed for required concrete and rebar according to the information available in the Project Design Envelope (PDE). These volumes were then converted to carbon emissions using values in the National Highways Carbon Tool v2.7 (National Highways, 2025), which incorporates emissions factors from the Institute of Carbon & Energy (ICE) database version 4.0 (Jones and Hammond, 2024); see Table 5.3.

Table 5.3: GHG emissions from bulk materials associated with substation construction

Material type	Material quantity (t)	Emissions factor (tCO_2e/t)	Total carbon emissions (tCO_2e)
Concrete	31,451	1.03	32,520
Steel rebar	1,526	1.99	3,037
Total			**35,557**

Onshore Export Cables and 400 kV Cables

5.2.6 Construction stage emissions associated with the Onshore Export Cables and 400 kV Cables have been calculated using estimated dimensions of each cable, with indicative designs being used to estimated quantities of aluminium and polyethylene. These quantities were there scaled by relevant emissions factors (6.67 $kgCO_2e/kg$ for aluminium and 2.54 $kgCO_2e/kg$ for polyethylene (Jones and Hammond, 2024)). Construction stage emissions associated with the Onshore Export Cables and 400 kV Cables total 17,874 tCO_2e.

5.2.7 The Onshore Export Cables and 400 kV Cables will be installed within cable ducts. Emissions associated with such ducts were estimated based on duct dimensions and material quantities (119,040 m based on 22 km Onshore Export Cable with six ducts total, 2,400 m based on 1.2 km 400 kV Cable with two ducts total, 0.25 m maximum diameter, 7 mm wall thickness, construction from Unplasticized Polyvinyl Chloride (UPVC)). Material quantities of UPVC were then scaled by the relevant material intensity factor (3.23 $kgCO_2e/kg$, Jones and Hammond, 2024), resulting in an emissions total of 3,144 tCO_2e.

Cable Protection

5.2.8 Construction stage emissions associated with onshore cable protection ('Tapetile' warning tape and 'Stokbord' cover tiles) were calculated by scaling the volume of cable protection (1,279 m^3, calculated based on total length of Onshore Export Cables (22 km), total number of Onshore Export Cables (nine), total length of 400 kV Cables (1.2 km), total number of 400 kV Cables (nine), dimensions of warning tape (200 mm width, 2.5 mm thickness) and dimensions of cover tiles (450 mm width, 12.5 mm thickness)) by the material density of the tape and cover tiles to estimate the total weight of material, totalling 1,200,623 kg. This value was then scaled by the relevant material emission factor for general polyethylene (2.54 $kgCO_2e/kg$, Jones and Hammond, 2024). Resultant emissions total 3,216 tCO_2e.

Bulk materials

5.2.9 It is anticipated that the Project will include the construction of 33 access roads composed of imported subbase material, each with an associated bellmouth composed of asphalt and subbase material. The access roads have been assumed to be 5m wide and 0.3m deep, with a total length of 27,414m. With a bulking factor of 1.25, this constitutes 51,401m^3 subbase material imported to site. Meanwhile, each of the bellmouths are assumed to be 10m long, 30m wide, and to have a depth of 0.56m asphalt and 0.2m subbase material. With the bulking factor of 1.25, this constitutes a total of 1,444m^3 subbase material and 4,043m^3 asphalt imported to site for the 33 bellmouths.

5.2.10 It is anticipated that the cable trenches will include associated thermally stable bedding material. At this early stage in design, there is no decision yet on the type of thermally stable bedding material, therefore this assessment has assumed sand will be used. The volume of this material was calculated by assuming the cable trenches will be 4m wide, have a total length of 17,881m, and be 0.75m deep, per the (PDE). Therefore, with a bulking factor of 1.25, the thermally stable bedding material will be of a volume of 67,054m^3 imported material.

5.2.11 These volumes were converted into carbon emissions using values in the National Highways Carbon tool v2.7 (National Highways, 2025) (Table 5.4). Total carbon emissions for the material associated with access roads and bellmouths are 771 tCO_2e and 536 tCO_2e respectively, and 930 tCO_2e for thermally stable bedding material.

Table 5.4: Carbon emissions associated with bulk materials

Asset	Sub-asset	Material type	Material quantity (t)	Emissions factor (tCO_2e/t)	Total carbon emissions (tCO_2e)
Access road	Subbase	Aggregate	102,803	0.0075	**771**
Bellmouth	Subbase	Aggregate	2,888	0.0075	**22**
	Asphalt	Asphalt	9,298	0.0553	**514**
Cable trench	Thermally stable bedding material	Sand	124,049	0.0075	**930**
Total					**2,237**

Note totals may not sum due to rounding

Landfall and Onshore Cable Crossings

5.2.12 The Onshore Export Cable Corridor will cross existing infrastructure and obstacles such as roads, railways and rivers, using Horizontal Directional Drilling (HDD) techniques. Additionally, the Offshore Export Cable Corridor will be installed by HDD at landfall. Material quantities associated with the construction of the HDD crossings (using High Density Polyethylene (HDPE)) were estimated based on the duct dimensions (total length of onshore crossings equal 19,440 m, based on 18 crossings for nine ducts, each measuring 120 m in length, 0.35 m maximum diameter and 29 mm wall thickness; total length of landfall crossings equal 2,280 m, based on 3 crossings across 760 m length, 2.2 m maximum tunnel diameter, 800 mm maximum duct diameter, and 29 mm wall thickness) and HDPE volume to weight ratio of 970 kg/m^3. Material quantities were then scaled by the relevant material intensity factor (2.52 kgCO_2e/kg, Jones and Hammond, 2024). Associated emissions total 1,494 tCO_2e for landfall crossings and 1,390 tCO_2e for onshore cable crossings.

Transition Joint Bays, Joint Bays and Link Boxes

5.2.13 Material quantities associated with the construction of transition joint bays, joint bays and link boxes were estimated based on their dimensions (three transition joint bays, each at 20 m x 4 m x 4 m, 63 no. joint bays, each at 14.5 m x 4 m x 4 m, 63 no. link boxes, each at 2 m x 2 m x 2 m, with all assumed thickness of 0.3 m). Material quantities were then scaled by the relevant material intensity factor (0.103 kgCO_2e/kg, Jones and Hammond, 2024). Total emissions were estimated at 942 tCO_2e.

Vehicle Movements

5.2.14 In line with the RICS WLCA guidance, vehicle movements have been calculated for the transport modules A4 and A5 (RICS, 2023). Materials transport (A4) and personnel transport (i.e., construction workers) (A5) to and from site (when associated with the construction of the Onshore Export Cables, 400 kV Cables and Substation) have been used to assess this.

5.2.15 For materials transport, an assumption was made for the type and volume of material to be delivered to each access point, based on the characteristics of the associated proximal design elements. This was converted into bulk material movements and articulated flatbed movements, as it was assumed that the more specialised items to be carried via articulated flatbed vehicles (i.e., Substation and Cable components, construction site requirements), would be sourced from further away than bulk materials (i.e., aggregate, sand). These items/material types correspond to suggested transport distances in the RICS guidance, and 80 km and 50 km were assumed respectively (RICS, 2023). A separate fully laden and unladen diesel emissions factor for "Articulated (<3.5 - 33t) (kgCO_2e/km)" heavy goods vehicles from the 2025 DESNZ conversion factors (DESNZ, 2025a) was applied to reflect the impact of load on the fuel consumption rate of heavy goods vehicles (HGVs), resulting in a holistic view of the emissions associated with materials transport. See Table 5.5 for further detail.

5.2.16 It should be noted that these calculations for materials transport assume that materials are delivered to the closest access point to where they are needed and does not assume any internal HGV movements for materials transport once at an access point.

Table 5.5: Total GHG Emissions from Materials Transport A4

Load type	Total round trips	Assumed distance travelled (km)	Total distance per leg (km)	0% laden conversion factor ($kgCO_2e/km$)	100% laden conversion factor ($kgCO_2e/km$)	Total emissions (tCO_2e)
Bulk material	38,894	50	1,944,700	0.62775	0.93552	**3,040**
Articulated flatbed	2,481	80	198,480	0.62775	0.93552	**310**
Total						**3,350**

5.2.17 For personnel transport, an assumption was made on the average number of construction workers required on site on a daily basis, based on the proposed construction timeline. This was extrapolated to find the total number of round trips, based on a 6-day work week. The distance travelled was multiplied by 2 to reflect the outward and return journey and assumed to be 50 km each way. The DESNZ 2025 conversion factor for an average petrol car was applied (DESNZ, 2025a) to reach the total emissions for personnel travel to and from the construction site, as indicated in Table 5.6. No car sharing or other forms of transport have been incorporated.

Table 5.6: Total GHG Emissions from Personnel Transport A5

Total round trips	Assumed distance travelled per leg (km)	Total distance travelled (km)	Conversion factor: average petrol car ($kgCO_2e/km$)	Total emissions (tCO_2e)
116,928	50	11,692,800	0.17329	2,026

Plant Use

5.2.18 Plant use for construction (WLCA module A5) has been assessed by developing a plant and equipment list, based on the proposed construction activities in the PDE. These are consistent with the plant types and numbers set out in Volume 1, Appendix 13.2: Assumed Construction Phases and Plant and the phases are summarised below:

- Compound construction (assumed duration 6 months)
- Compound operation (assumed duration 48 months)
- Cable route devegetation works and fencing (assumed duration 9 months)
- Cable route soil strip (assumed duration 9 months)
- Cable route haul route (assumed duration 9 months)
- Cable route ductwork (assumed duration 12 months)
- Horizontal directional drilling (assumed duration 15 months)
- Road access points, bellmouths, and road surfacing (assumed duration 15 months)
- Cable route reinstatement (assumed duration 6 months)
- Cable pulling (assumed duration 6 months)
- Substation Groundworks (assumed duration 6 months)

- Substation Building Foundations (assumed duration 18 months)
- Substation Access Road and Car Parking (assumed duration 12 months)
- Substation Building and HV Plant Installation (assumed duration 18 months)

5.2.19 Total fuel consumption was estimated by calculating the total on-time for each plant item and ascribing a fuel consumption rate. This resulted in a total volume of fuel used for the construction programme. The DESNZ conversion factor for 100% mineral diesel (DESNZ, 2025a) was used to convert this volume into total GHG emissions as indicated in Table 5.7. This conversion factor was used as a conservative approach in the absence of further decision-making or commitment on fuel type to be used for construction.

Table 5.7: Total GHG Emissions from Plant Use

Total consumption of diesel (litres)	Conversion factor: 100% mineral diesel ($kgCO_2e$/litre)	Total emissions ($kgCO_2e$)	Total emissions (tCO_2e)
3,221,783	2.66155	8,574,935	8,575

5.3 Embodied Carbon - Offshore

5.3.1 The following sections detail the methodology used to calculate the construction phase emissions associated with the Offshore Transmission Assets and Offshore Generation Assets. Each section groups relevant elements of the Offshore Transmission Assets and Offshore Generation Assets by methodology used to calculate resultant emissions.

5.3.2 The construction phase emissions cover the WLCA modules A1-A5, materials and construction, (i.e. emissions associated with the extraction, processing and manufacturing of materials). In addition, emissions associated with the transport of materials and technology to site (within the UK) have been analysed.

5.3.3 The materials involved in the offshore components of the Offshore Transmission Assets and Offshore Generation Assets are the initial elements to consider within the cradle-to-grave approach towards completing this LCA. Emissions are derived from the raw material production required to manufacture the Wind Turbines, Wind Turbine foundations, OSPs and OSP foundations, Interconnector Cables, IACs and Offshore Export Cables, and it is the phase where the majority of embodied carbon is emitted.

Wind Turbines, OSPs and Cables

5.3.4 The construction phase emissions associated with the following elements of the Offshore Transmission Assets and Offshore Generation Assets have been calculated using approximate material quantities, and relevant material emission factors:

- Wind Turbines (including blades, towers and foundations);
- OSP topside structures and foundations;
- Interconnector and IACs (including cable protection); and
- Offshore Export Cables (including cable protection).

5.3.5 Table 5.8 summarises the relevant material emission intensities sourced from the ICE database (Jones and Hammond, 2024), and corresponding emissions values.

Table 5.8: Emission Factors and Total Emissions for Embodied Carbon of Material Use

Item	Materials	Emissions Factor ($kgCO_2e/kg$)	Emissions Factor Source	Total Embodied Emissions (tCO_2e)	Contribution to Total (%)
Wind Turbine foundations	Steel	2.34	Steel (average), ICE database	712,421	46.5%
	Rock (scour protection)	0.01	Rock, ICE database		
Wind Turbine blades and towers	Steel	2.34	Steel (average), ICE database	411,962	26.9%
	Fibreglass	8.10	Glass reinforced plastic, ICE database		
	Iron	2.03	Iron (general), ICE database		
	Aluminium	6.67	Aluminium (general), ICE database		
	Copper	2.71	Tube and sheet copper, ICE database		
IACs (including scour protection)	Copper	2.71	Tube and sheet copper, ICE database	79,564	5.2%
	Aluminium	6.67	Aluminium (general), ICE database		
	Polyethylene	2.54	Polyethylene (general), ICE database		
	Rock (Scour protection)	0.01	Rock, ICE database		
Interconnector cables (including scour protection)	Copper	2.71	Tube and sheet copper, ICE database	19,794	1.3%
	Aluminium	6.67	Aluminium (general), ICE database		
	Polyethylene	2.54	Polyethylene (general), ICE database		
	Rock (Scour protection)	0.01	Rock, ICE database		
Offshore Export cable (including scour protection)	Copper	2.71	Tube and sheet copper, ICE database	113,055	7.4%
	Aluminium	6.67	Aluminium (general), ICE database		

Item	Materials	Emissions Factor ($kgCO_2e/kg$)	Emissions Factor Source	Total Embodied Emissions (tCO_2e)	Contribution to Total (%)
	Polyethylene	2.54	Polyethylene (general), ICE database		
	Rock (Scour protection)	0.01	Rock, ICE database		
OSP platforms	Steel	2.34	Steel (average), ICE database	14,040	0.9%
OSP foundations	Steel	2.34	Steel (average), ICE database	42,417	2.8%
	Rock (Scour protection)	0.01	Rock, ICE database		

OSP Plant

5.3.6 Emissions associated with OSP electrical plant have been calculated in accordance with the methodology in Paragraph 5.2.4. Emissions total 2,201 tCO_2e. This value includes lifecycle stages A1-A3.

Vessel Movements

5.3.7 Indicative vessel and helicopter movements were used to calculate emissions associated with their activities during the construction phase. Emissions associated with vessel movements were calculated using approximate fuel consumption rates alongside indicative vessel movements and typical activity timescales, using data provided by the project team and data contained within the Project Description (see the Offshore EIA Report).

5.3.8 Where approximate fuel consumption rates were not available, emissions were calculated by estimating total main engine capacity requirements, vessel speed and distance from port, based on indicative vessel specifications provided by the project team.

5.3.9 These variables were used to calculate total fuel use for vessel movements during the construction phase. This value was then scaled by the emission factor for marine gas oil (0.258 $kgCO_2e/kWh$, or 3,245 $kgCO_2e/tonne$) (DESNZ, 2025a), totalling 109,393 tCO_2e.

5.3.10 Helicopter movements and their associated emissions were calculated by determining the anticipated fuel consumption, informed by their predicted movements. An indicative number of return trips and assumed distance (200 km) from a potential helicopter base, alongside average fuel consumption (430 kg/hr) and fuel economy data (145 kg/hr) (obtained from example manufacturers specifications) were used to estimate fuel consumption. Emission factors for aviation turbine fuel (2.54 $kgCO_2e/l$) (DESNZ, 2025a) were then scaled by the fuel consumption to give associated emissions, totalling 236 tCO_2e for the Offshore Transmission and Offshore Generation Assets.

5.4 Summary

5.4.1

5.4.2 Table 5.9 summarises the calculated construction phase emissions associated with the Project, which totals 1,662,931 tCO_2e.

Table 5.9: Construction phase emissions summary (tCO_2e)

Project element	Item	Value (tCO_2e)
Onshore Transition Assets	Substation	37,758
	Cables – including Onshore Export Cables and 400 kV Cables	17,874
	Cables – Ducting	3,144
	Cables – Cable Protection	3,216
	Bulk materials	2,237
	Onshore crossings and landfall crossings	2,884
	Transition joint bays, joint bays, and link boxes	942
	Vehicle movements	5,377
	Plant use	8,575
	Land use change emissions	47,634
	Total – Onshore transmission assets	**129,640**
Offshore transmission and Offshore generation assets	Wind Turbines (blades and tower)	411,962
	Wind Turbines (foundations) - including scour protection	712,421
	OSP (platforms)	14,040
	OSP (foundations) - including scour protection	42,417
	OSP plant	2,201
	IACs	79,564
	Interconnector cables	19,794
	Export cables	113,055
	Vessel and Helicopter Movements	109,629
	Blue carbon	28,207
	Total – Offshore transmission and Offshore generation assets	**1,533,291**
Total	Total – Construction emissions	**1,662,931**

Note totals may not sum due to rounding

6 Assessment of Operation and Maintenance Effects

6.1 Land Use Change

Onshore

6.1.1 Areas of temporary loss (i.e. those areas felled and cleared during construction) which would be replanted with trees on completion of the construction phase were assumed to have no net change in ongoing sequestration (i.e. were assumed to have the same average annual sequestration rate as 100-year mixed broadleaved woodland of 7 tCO_2e/ha/year (Gregg *et al.*, 2021)). This is likely to be conservative as the sequestration rate of younger trees would be higher (e.g. 30-year mixed broadleaved woodland has an average annual sequestration rate of 14.5 tCO_2e/ha/year (Gregg *et al.*, 2021).

6.1.2 As discussed in Section 5.1, due to the proposed compensatory planting, there would be no overall permanent loss of carbon-fixing/sequestration potential, as those areas which cannot be replanted in-situ will be balanced out by compensatory planting in other locations. As for the areas of temporary loss, it was assumed that there would be no net change in ongoing sequestration rates. As noted above, this is likely to be a conservative assumption.

6.1.3 Any further land use change GHG emissions are not anticipated, given the existing baseline environment would be restored:

- Once the Onshore Export Cable and 400 kV Cable installation work is completed, the ground will be reinstated using stored subsoil and topsoil, the land will be restored to its original condition.
- Transition joint bays and joint bays will be completely buried, with the land above reinstated.

Offshore

6.1.4 The long-term temporary (30 year) footprint of the Offshore Transmission Assets and Offshore Generation Assets, including from OSP foundations, cables and associated scour protection, has the potential to affect the sequestration of blue carbon over its 30-year O&M lifetime. However, evidence on sequestration rates in offshore sediments indicates little to no sediment accumulation in the North Sea (Cunningham and Hunt, 2023). Therefore, it is assumed that there will be negligible effects of loss of sequestration capacity within blue carbon habitats over the Offshore Transmission Assets and Offshore Generation Assets' 30-year lifetime.

6.1.5 Any disturbance during O&M of the Offshore Transmission Assets and Offshore Generation Assets is likely to fall within areas that were previously disturbed during the construction of the Offshore Transmission Assets and Offshore Generation Assets. Given the negligible sequestration rates of sediments in the North Sea (Cunningham and Hunt, 2023), it is considered that there will be negligible additional blue carbon emissions during O&M, as emissions will have been accounted for during the construction phase.

6.2 Fuel and Energy Consumption

6.2.1 Emissions during the O&M phase of the Project refer to activities contributing to the high-level management of the asset. Maintenance can be divided into preventative maintenance and corrective maintenance.

- Preventative maintenance: proactive repair to, or replacement of, known wear components based on routine inspections or monitoring systems.
- Corrective maintenance includes the reactive repair or replacement of failed or damaged components.

Onshore

6.2.2 The Onshore Transmission Assets' maintenance activities largely involve regular inspection of the Substation and Onshore Export Cable Corridors and required repairs. Emissions associated with such activities are largely captured with maintenance van movements. Where materials are used (i.e. new paint and coatings, fuses etc.), associated emissions are negligible and immaterial, and as such have not been assessed further.

6.2.3 Emissions associated with O&M vehicle movements have been calculated based on a projected monthly visit to the Onshore Transmission Assets. Two-way movements associated with an inspection of the length of the Onshore Export Cable Corridors, and travel to site, have been multiplied by an emissions factor for one van and one car trip per month, using the conversion factors for diesel fuelled "average van" (0.25561 $kgCO_2e/km$) and "average car" (0.17304 $kgCO_2e/km$) respectively (DESNZ, 2025a). Emissions total 35 tCO_2e for the O&M phase.

Offshore

6.2.4 The Generation Assets maintenance activities largely involve cable repairs. Emissions associated with such activities are largely captured with vessel or helicopter movements. Where materials are used (i.e. new paint and coatings, fuses, access ladders, etc.), associated emissions are negligible and immaterial, and as such have not been assessed further.

6.2.5 Emissions associated with the proposed maintenance vessels and helicopter movements (refer to the Offshore EIA Report) follow the methodology detailed in Section 5.3. Such emissions total 304,198 tCO_2e over the total O&M phase of the Offshore Transmission Assets and Offshore Generation Assets.

6.2.6 It is anticipated that the following repair events would take place:

- Inter-Array Cables may have 4,915 m of re-burial and remedial protection per year respectively (on average over the Project lifetime);
- Interconnector Cables may have 2,040 m of re-burial and remedial protection per year respectively (on average over the Project lifetime); and
- Offshore Export Cables may have 6,390 m of re-burial and remedial protection per year respectively (on average over the Project lifetime).

6.2.7 To present the MDS, it has been assumed that each repair event will involve replacing the respective cable lengths and protection described above. Emissions associated with the replacement of such cables and protection were calculated using the methodology detailed in Section 5.3 and in particular Table 5.8. Total emissions from cable and protection replacement over the Project lifetime were calculated to be 291,948 tCO_2e.

6.2.8 Therefore, the total emissions for the O&M phase are the combination of vessel and helicopter movements (304,198 tCO_2e) and cable and protection replacement (291,948 tCO_2e). This is a total of 596,146 tCO_2e. As the project will be operational for 30 years, this corresponds to an annual emissions rate of 19,872 tCO_2e per year (10,140 tCO_2e from movements, 9,732 tCO_2e from repair and replacement of materials).

6.3 Avoided Emissions

6.3.1 The magnitude of impact of the Project is determined by the quantity of marginal electricity generation sources it displaces and associated GHG emissions. The marginal energy generation displaced is determined by the total annual energy output values for the Project. The associated GHG emissions are determined by the GHG intensity of the displaced sources of generation.

6.3.2 Table 6.1 sets out the parameters for the Project and the associated annual energy output. It should be noted that the parameters used are a precautionary estimate. In particular, the capacity factor has been derived from the average of the past 12 years using the offshore data from DESNZ (2025b). This is likely to represent an underestimate of the true capacity factor for the Project, owing to capacity and load factors increasing over time due to technological innovation; indeed, the assumed load factor for new offshore wind farms is 62.3% (DESNZ, 2024b). As such, it is likely that the true output of the Project will be higher than that presented in Table 6.1.

Table 6.1: Energy Flows from the Generation Assets

Parameter	Value	Unit	Source
Input parameter – anticipated rated power	1,005	MW	Practical maximum based on theoretical maximum installed capacity of 1,008 MW (see Volume 1, Chapter 1: Introduction of the Onshore EIA Report)
Input parameter – capacity factor	39.55	%	DESNZ (2025b)
Input parameter – degradation factor	1.60	%	Staffel and Green (2014)
Input parameter – total annual operating hours	8,760	hrs	Volume 1, Chapter 2: The Proposed Development of the Offshore EIA Report
Output parameter – annual energy output (year 1)	3,481,903	MWh	Calculated based on the input parameters
Output parameter – annual energy output (30 years)	83,481,611	MWh	Calculated based on the input parameters

6.3.3 The input and output figures for the O&M phase of the Project are then calculated against the assumptions stated within the DESNZ long-run marginal (DESNZ, 2023). This allows for a direct presentation of the cumulative GHG emissions avoided throughout the operational lifetime of the Project and therefore, how the Project contributes towards reaching net zero targets in the UK and Scotland.

6.3.4 The marginal source displaced may in practice vary from moment to moment depending on the operation of the capacity market, (i.e. led by commercial considerations and NESO's needs at any given time). For the purpose of this assessment, longer-term trends (annual averages) have been used as it is not possible to predict shorter-term variations with confidence. It should be noted that as the UK and Scotland move towards their respective 2050 and 2045 net zero carbon targets, the marginal source of electricity generation will likely become a combination of renewables (predominately solar and wind) and storage. It is important to note therefore that from circa 2030 onwards, long-run marginal projections assume that there is minimal unabated fossil fuel electricity generation, in line with relevant UK Government policies and plans (DESNZ, 2024a). As such, comparing the Project's GHG impacts with the marginal source of generation is likely to represent an underestimation of its true avoided emissions.

6.3.5 The DESNZ long-run marginal grid carbon intensity factors do not properly consider the embedded construction phase GHG emissions of the sources of generation. It is therefore not a like-for-like comparison to compare the lifetime GHG emissions of the Project with the DESNZ long-run marginal or grid average source.

6.3.6 Table 6.2 displays the annual power output and emissions avoidance of the Project when comparing the generation using the DESNZ (2023) long-run marginal carbon intensity for the future national grid.

Table 6.2: Operational Avoided GHG Emissions (DESNZ Long-Run Marginal)

Year of Operation	Year	Output (MWh)	DESNZ Long-Run Marginal emissions factor	Avoided Emissions (tCO_2e)	Cumulative Avoided Emissions (tCO_2e)
1	2036	3,481,903	0.0174	60,472	60,472
2	2037	3,426,192	0.0133	45,667	106,139
3	2038	3,371,373	0.0102	34,487	140,626
4	2039	3,317,431	0.0079	26,043	166,669
5	2040	3,264,352	0.0060	19,667	186,336
6	2041	3,212,123	0.0057	18,258	204,594
7	2042	3,160,729	0.0036	11,429	216,023
8	2043	3,110,157	0.0028	8,643	224,666
9	2044	3,060,395	0.0020	6,004	230,670
10	2045	3,011,428	0.0013	3,783	234,453
11	2046	2,963,246	0.0013	3,843	238,296
12	2047	2,915,834	0.0013	3,795	242,091
13	2048	2,869,180	0.0014	3,942	246,033
14	2049	2,823,273	0.0014	3,974	250,007
15	2050	2,778,101	0.0013	3,577	253,584
16	2051	2,733,651	0.0023	6,242	259,826
17	2052	2,689,913	0.0023	6,142	265,969
18	2053	2,646,874	0.0023	6,044	272,013
19	2054	2,604,524	0.0023	5,947	277,960
20	2055	2,562,852	0.0023	5,852	283,812
21	2056	2,521,846	0.0023	5,759	289,571
22	2057	2,481,497	0.0023	5,666	295,237
23	2058	2,441,793	0.0023	5,576	300,813
24	2059	2,402,724	0.0023	5,487	306,299
25	2060	2,364,281	0.0023	5,399	311,698
26	2061	2,326,452	0.0023	5,312	317,010
27	2062	2,289,229	0.0023	5,227	322,238
28	2063	2,252,601	0.0023	5,144	327,381
29	2064	2,216,560	0.0023	5,061	332,443
30	2065	2,181,095	0.0023	4,980	337,423

Note table totals may not sum due to rounding

6.3.7 The long-run marginal figures, which have been used in Table 6.2, are dynamic and show year-on-year decarbonisation of the UK national electricity grid towards the UK's committed net zero 2050 pledge. The long-run marginal carbon intensity figures account for variations over time for both generation and consumption activity reflecting the different types of power plants generating electricity across the day and over time, each with different emissions factors.

6.3.8 However, as discussed in Paragraphs 6.3.4 and 6.3.5, long-run marginal figures should be treated as indicative projections rather than prescriptive targets, and the projections assume abatement of fossil fuel generation sources within the national electricity grid. By the time the Project is anticipated to be operational (2036), the UK is expected to have made significant progress towards a low-carbon electricity grid, with the current Government policy target year of 2030. Nevertheless, the UK Government has highlighted that some 'transition' fossil fuels will continue to play a part in the UK's energy supply. Therefore, it is likely that the true value of the avoided emissions displaced as a result of the Project's contribution to the national grid would be higher than that of avoided emissions detailed above.

6.3.9 As such, additional analysis has been carried out using the current (2025) national grid carbon intensity (222.9 kgCO_2e/MWh) (DESNZ, 2025b) and current (2024, latest data available) estimated intensity from electricity supplied for 'all non-renewable fuels' (448 kgCO_2e/MWh) (DESNZ, 2025a).

6.3.10 Although the use of the current national grid average and DESNZ 'non-renewable fuels' carbon intensities would conclude greater avoided emissions and an ultimate reduction in carbon payback period, these are static baselines and do not account for future national grid decarbonisation. Future grid projections are also based on the assumption that renewable infrastructure, such as the Project itself, will be developed. As such, the Project would contribute to the long-run marginal projection that it is compared against. The long-run marginal therefore provides a conservative lower estimate of avoided emissions for the purpose of this assessment.

6.3.11 Table 6.3 details the potential avoided emissions for the DESNZ long-run marginal, current national grid average for 2025, and DESNZ 'non-renewable fuels' intensity for 2024 scenarios. These are presented for the entire assumed lifetime of 30 years for the purpose of the GHG calculations (whole life). The true avoided emissions value for the Project is likely to lie between the upper and lower limits shown in Table 6.3.

Table 6.3: Total Avoided Emissions Sensitivity Test

Operating years	Output (MWh)	DESNZ long-run marginal total avoided emissions (tCO_2e)	Current national grid average total avoided emissions (tCO_2e)	DESNZ 'non-renewable fuels' total avoided emissions (tCO_2e)
30	83,481,611	337,423	18,608,051	37,399,762

6.3.12 Additionally, variations in capacity factor could have a similar effect on the avoided emissions in addition to other quantifications of emissions. Any change in the capacity factor would vary the MWh output accordingly. As the MWh output has been used as the base for the calculation of avoided emissions, any increase in output or avoided emissions would be proportionately similar to that of the above. For example, if a capacity factor of 62.3% was achieved as discussed Paragraph 6.3.2, the total energy output over 30 years would be approximately 131,500,000 MWh and avoided emissions would range from approximately 530,000 tCO_2e to 59,000,000 tCO_2e.

6.4 Summary

6.4.1 Table 6.4 summarises the calculated O&M GHG emissions associated with the Project, which totals -36,803,580 to 258,758 tCO_2e (depending on how the avoided emissions are represented).

Table 6.4: O&M emissions summary (tCO_2e)

Project element	Item	GHG emissions (tCO_2e)
Onshore Transmission Assets	Land use change	-
	Vehicle movements	35
	Total – Onshore Transmission Assets	**35**
Offshore Transmission and Offshore Generation Assets	Land use change	-
	Vehicle movements	304,198
	Cable repairs	291,948
	Total – Offshore Transmission and Offshore Generation Assets	596,146
Total	**Total – Onshore Transmission Assets & Offshore Transmission and Offshore Generation Assets**	**596,181**
Avoided Emissions	**Total – Avoided emissions**	**-37,399,762 to -337,423**
Total	**Total – O&M emissions**	**-36,803,580 to 258,758**

Note table totals may not sum due to rounding

7 Decommissioning

7.1 Land Use Change

Onshore

7.1.1 It is anticipated that the Onshore Export Cables and 400 kV Cables will be removed via the joint bays. TJBs, joint bays and link boxes will be removed only if it is feasible with as little environmental disturbance as possible or if their removal is required to return the land to its current agricultural use. As such, it is not anticipated that there will be substantial GHG emissions associated with land use change during decommissioning.

Offshore

7.1.2 Given the negligible rates of sediment accumulation and associated carbon sequestration in the Offshore Transmission Assets and Offshore Generation Assets area, there is not anticipated to be any material change to the blue carbon stocks over the Offshore Transmission Assets and Offshore Generation Assets' operational lifetime. As such, any disturbance to the seabed and blue carbon habitats at the decommissioning phase is not likely to result in the release of additional emissions not already presented in the assessment of construction effects. Therefore, this impact is not assessed further.

7.2 Fuel and Energy Consumption

Onshore

7.2.1 Emissions during decommissioning result from plant and machinery used for extracting any materials from the Project that will not be left *in-situ*, processing these materials, and transporting workers, plant, and materials to/from site.

7.2.2 At this early stage, a decommissioning scenario has not yet been fully defined. In the absence of this, a conservative approach for calculating associated GHG emissions is to use the total emissions from construction for these emissions sources. This scenario therefore assumes that all elements of the Project will be removed upon decommissioning and that the associated emissions will be equal to or less than those from construction.

7.2.3 As such, the following will be included in the estimation of emissions resulting from the decommissioning of the Project and will apply the values calculated from the construction phase:

- Transport emissions – materials transport (3,350 tCO_2e)
- Transport emissions – personnel transport (2,026 tCO_2e)
- Plant use emissions (8,575 tCO_2e)

7.2.4 The processing of decommissioned materials was not included in this assessment. This is primarily due to uncertainty regarding the decommissioning strategy. However, it is likely that any materials removed will be highly recyclable (such as Cables or Substation components), or will be reused – especially given advancements in recycling technologies by the time of decommissioning.

7.2.5 The total emissions associated with onshore decommissioning is therefore 13,952 tCO_2e. Given GHG emissions associated with use of plant and fuel is expected to have achieved good levels of decarbonisation by the time of the decommissioning phase of the Project, this is likely to present a conservative estimate.

Offshore

7.2.6 Offshore decommissioning emissions have been calculated in the same way as onshore decommissioning emissions. Total emissions are therefore estimated to be 109,629 tCO_2e, equal to construction phase vessel and helicopter emissions.

7.3 Summary

7.3.1 Table 7.1 summarises the calculated decommissioning phase emissions associated with the Project, which totals 123,581 tCO_2e.

Table 7.1: Decommissioning phase emissions summary (tCO_2e)

Project element	Item	Value (tCO_2e)
Onshore Transmission Assets	Land use change	-
	Vehicle movements – materials and personnel	5,377
	Plant use	8,575
	Total – Onshore transmission assets	**13,952**
Offshore transmission and Offshore generation assets	Land use change	-
	Vessel and helicopter movements	109,629
	Total – Offshore transmission and Offshore generation assets	**109,629**
Total	**Total – Decommissioning emissions**	**123,581**

Note table totals may not sum due to rounding

8 GHG Assessment Summary: Total Project GHG Emissions

8.1.1 It is important to note that the Offshore Generation Assets cannot deliver the avoided emissions detailed in Section 6.3 without the Onshore Transmission Assets and Offshore Transmission Assets to enable connection to the national grid. Therefore, the net emissions from the construction, O&M and decommissioning phases of the Project as a whole must be considered within the cumulative assessment for the Onshore EIA Report and the Offshore EIA Report.

8.1.2 The lifetime GHG emissions of the Project, as detailed within this report, are presented in Table 8.1 below.

Table 8.1: Net Whole Life GHG Emissions

Stage	Area	Resulting GHG emissions (tCO_2e)
Construction	Onshore	129,640
	Offshore	1,533,291
	Subtotal net	**1,662,931**
O&M	Onshore	35
	Offshore	596,146
	Avoided	-37,399,762 to -337,423
	Subtotal net	**-36,803,580 to 258,758**
Decommissioning	Onshore	13,952
	Offshore	109,629
	Subtotal net	**123,581**
Total Project Net emissions		**-35,017,068 to 2,045,270**

Note table totals may not sum due to rounding

8.1.3 Over its lifetime, the net GHG emissions of the Project is estimated to be between -35,017,068 to 2,045,270 tCO_2e. This is a precautionary range derived from the methodology outlined in Section 6.3 above. This net impact considers the GHG emissions associated with disturbance to woodland and blue carbon habitats, materials and energy use during the construction, O&M and decommissioning phases, alongside the avoided emissions from the operation of the Offshore Generation Assets. Negative emissions represent net avoided emissions. The Project would have a carbon payback period of two years (at the earliest) when accounting for construction, O&M and decommissioning phase emissions (see Table 8.2 below). As discussed in Section 6.3 above, the true avoided emissions value is likely to lie between these values (i.e. between -35,017,068 to 2,045,270 tCO_2e). Given the operation of the Project would avoid the need for fossil fuel electricity generation through the provision of renewable electricity, the associated avoided emissions would likely be greater than those presented in the conservative case (i.e. when using the long-run marginal projections) resulting in a reduction to the conservative net effect scenario presented above.

Table 8.2: Summary of Project Net GHG Emissions

	DESNZ long-run marginal	Current national grid average	DESNZ 'non-renewable fuels'
Construction Emissions (tCO_2e)	1,662,931		
O&M Emissions (net) (tCO_2e)	258,758	-18,011,870	-36,803,580
Decommissioning Emissions (tCO_2e)	123,581		
Net Total Project Emissions (tCO_2e)	2,045,270	-16,225,358	-35,017,068
Payback Period (Years)	No payback	3 years	2 years

Note table totals may not sum due to rounding

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A1 Project Description information to inform offshore emissions sources

Project Emissions Source	Information used to calculate emissions
Blue Carbon Footprint	1,982 hectares disturbed
IAC	The maximum total length of IAC (151 km) with 1,370,000 m3 of cable protection, associated material quantities.
OEC	The maximum total length of Offshore Export Cables (210 km) with 5,565,000 m3 of cable protection, associated material quantities.
ICC	The maximum total length of Interconnector Cables (36 km) with 360,000 m3 of cable protection, associated material quantities.
OSP	OSPs (two) and maximum OSP Scour Protection (15,000 m3), associated material quantities.
Turbines	The greatest number of Wind Turbines (67) on 4-legged pile jacket foundations, and maximum Scour Protection of 174,586 m3, associated material quantities.
ICC Crossing	Total volume of crossing protection material across Interconnector Cable crossings (101,250 m3), associated material quantities.
OEC Crossing	Total volume of crossing protection material across Offshore Export Cable crossings (75,000 m3), associated material quantities.
IAC Crossing	Total volume of crossing protection material across IAC crossings (33,750 m3), associated material quantities.
Operation	30 year operating lifetime. Export Capacity of 1,005 MW (67 x 15 MW Wind Turbines). Maximum number of vessel movements (return trips) per year (713). Maximum number of helicopter movements (return trips) per year (12).
Repair and Replacement Rates	4,915 m of repairs per year for IACs. 6,390 m of repairs per year for Offshore Export Cables. 2,040 m of repairs per year for Interconnector Cables.
Transport	Maximum number of vessel movements (return trips) for site preparation and construction activities (2,260). Maximum number of helicopter movements (return trips) for construction activities (290).