



Morven Hawthorn Pit Grid Connection Project

Preliminary Environmental Information Report

Volume 4, Annex 4.1: Greenhouse Gas Assessment

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Glossary

Term	Meaning
Alternating Current (AC) connection cables	AC cables that will connect the proposed onshore land substation to the National Grid Hawthorn Pit Substation.
Blue carbon	Organic carbon that is captured, stored, and sequestered by coastal and marine ecosystems, including ocean sediments, kelp, seagrasses, and salt marshes.
Offshore export cables	High Voltage Direct Current (HVDC) cables which bring electricity from either the Morven North or Morven South offshore substation platform (OSP) to the Transition Joint Bay (TJB) at landfall.
Onshore export cables	HVDC cables which bring electricity from the TJB to the onshore land substation (LSS).
Greenhouse gas	A gas that absorbs and emits radiant energy within the thermal infrared range, causing the greenhouse impact. Examples include carbon dioxide and methane.
Maximum Design Scenario (MDS)	The realistic, worst-case scenario, selected on a topic-specific and impact specific basis, from a range of potential parameters for the MHPGC Project.
MHPGC Project Preliminary Environmental Information Report (PEIR)	A report that provides preliminary environmental information in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. This is information that enables consultees to understand the likely significant environmental effects of a project and which helps to inform consultation responses.
Morven Hawthorn Pit Grid Connection Project	The MHPGC Project is comprised of the offshore export cables in Scottish and English waters from the Morven North or the Morven South OSP, landfall, onshore export cables, the onshore LSS and AC connection cables. Also referred to in this report as the MHPGC Project, for ease of reading.
National Grid Hawthorn Pit Substation	The National Grid substation at Hawthorn Pit, County Durham, which the AC connection cables will connect into from the Onshore LSS.
Onshore Land Substation (LSS)	A purpose-built site comprising a compound containing the electrical components for converting the HVDC to High Voltage Alternating Current (HVAC) power. The LSS site associated with the MHPGC Project adjusts the power quality and power factor to meet the requirements of power supply being fed to the National Grid Hawthorn Pit Substation.

Acronyms

Acronym	Meaning
AC	Alternating Current
AIL	Abnormal Indivisible Load
CLV	Cable Lay Vessels
CO ₂ /CO ₂ e	Carbon dioxide / carbon dioxide equivalent
CTV	Crew Transport Vessel
DESNZ	Department for Energy Security and Net Zero
DP	Direct Pipe
DSV	Dive Support Vessel
EPD	Environmental Product Declaration
EIA	Environmental Impact Assessment
ES	Environmental Statement
GHG	Greenhouse Gas
GV	Guard Vessel
GWP	Global Warming Potential
HGV	Heavy Goods Vehicle
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management and Assessment
IPCC	Intergovernmental Panel on Climate Change
ISEP	Institute of Sustainability and Environmental Professionals
ISV	Installation Support Vessel
KPI	Key Performance Indicator
LCA	Life-cycle assessment
LSS	Land Substation
MDS	Maximum Design Scenario
MHPGC	Morven Hawthorn Pit Grid Connection
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
O&M	Operation and Maintenance
OSP	Offshore Substation Platform
PEIR	Preliminary Environmental Information Report
PLGR	Pre-Lay Grapple Run
RICS	Royal Institution of Chartered Surveyors
TJB	Transition Joint Bay

Acronym	Meaning
TSV	Trenching Support Vessel
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change

Units

Unit	Meaning
ha	Hectare
kgCO ₂ e	Kilograms of carbon dioxide equivalent
kgCO ₂ e/kg	Kilograms of carbon dioxide equivalent per kilogram
kgCO ₂ e/km	Kilograms of carbon dioxide equivalent per kilometre
kgCO ₂ e/kWh	Kilograms of carbon dioxide equivalent per kilowatt-hour
kg/m	Kilograms per metre
km	Kilometre
kV	Kilovolt
kWh	Kilowatt-hour
m bgl	Metres below ground level
m/hr	Metres per hour
m	Metre
m ²	Square metres
m ³	Cubic metres
MtCO ₂ e	Million tonnes of carbon dioxide equivalent
tCO ₂ e	Tonnes of carbon dioxide equivalent

1 Introduction

1.1 Overview

- 1.1.1.1 This document forms **Volume 4, Annex 4.1: Greenhouse Gas Assessment, of the Preliminary Environmental Information Report (PEIR)** prepared for the Morven Hawthorn Pit Grid Connection Project (hereafter 'the MHPGC Project') and supports **Volume 4, Chapter 4: Climate Change, of the PEIR**. The PEIR presents the preliminary findings of the Environmental Impact Assessment (EIA) work undertaken to date for the MHPGC Project.
- 1.1.1.2 This annex sets out the calculation methodology, assumptions and data sources applied to estimate the MHPGC Project's greenhouse gas (GHG) emissions. It concludes by presenting the estimated GHG emissions for the construction, O&M and decommissioning phases of the MHPGC Project, covering both the onshore and offshore components (English and Scottish waters). The outputs of this Annex (the total estimated GHG emissions) underpin the GHG assessment that is set out in **Volume 4, Chapter 4: Climate Change, of the PEIR**. This annex should be read in conjunction with the chapter.
- 1.1.1.3 GHG emissions have been estimated by modelling the given materials and quantities from the Maximum Design Scenario (MDS) detailed in **Table 4.1** using One Click LCA and by applying published emission factors relevant to activities associated with the MHPGC Project. The emission 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. This annex presents the technical calculation methodology underpinning the assessment of potential impacts presented within **Volume 4, Chapter 4: Climate Change, of the PEIR**.
- 1.1.1.4 The assessment considers GHG emissions arising during the construction, operation and maintenance (O&M) and decommissioning phases of the MHPGC Project, using a whole life cycle approach. Key sources included are:
- embodied carbon from materials;
 - offshore and onshore transport emissions;
 - construction equipment and plant related emissions;
 - activities to maintain and repair the MHPGC Project assets;
 - emissions associated with deconstruction and disposal of materials.
- 1.1.1.5 The assessment is carried out and expressed in terms of CO₂-equivalent (CO₂e) global warming potential (GWP).

2 Background

2.1 Introduction

- 2.1.1.1 This assessment of GHG emissions considers the onshore and offshore components during different phases of the MHPGC Project.
- 2.1.1.2 The MHPGC Project GHG emissions include those resulting from manufacturing (i.e. embodied carbon) and installation of the offshore export cables, transition joint bay (TJB), onshore export cables, onshore land substation (LSS), alternating current (AC) connection cables and associated infrastructure.
- 2.1.1.3 The GHG emissions assessment includes both the onshore and offshore components. This approach ensures that the reporting is consistent, conservative and aligned with the principle that the sum total of lifecycle emissions is the key metric for the MHPGC Project assessment.
- 2.1.1.4 The GHG emissions estimation has been undertaken using industry standards, benchmarks, estimations and professional judgement. Key sources relied upon for the assessment are as follows:
- OneClick Life Cycle Assessment (LCA);
 - Inventory of Carbon & Energy (ICE) database (Burrow *et al.*, 2025);
 - Royal Institution of Chartered Surveyors (RICS), Whole life carbon assessment for the built environment (2024);
 - Department for Energy Security and Net Zero (DESNZ) conversion factors (2025);
 - Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (2023).
- 2.1.1.5 The GHG emissions reported here capture all gases (as relevant to the reported activities) as defined under the Kyoto Protocol and subject of international action to address global warming. Specifically:
- Carbon dioxide (CO₂)
 - Methane (CH₄)
 - Nitrous Oxide (N₂O)
 - Hydrofluorocarbons (HFCs)
 - Perfluorocarbons (PFCs)
 - Sulphur Hexafluoride (SF₆)
 - Nitrogen trifluoride (NF₃)

2.2 Whole life carbon assessment framework

- 2.2.1.1 The GHG assessment comprises an evaluation of emissions occurring throughout the lifecycle of the MHPGC Project, consistent with the modular framework set out in BS EN 15978 and BS EN 17472, and as referenced by PAS 2080:2023 and RICS (2024). This includes the construction, O&M and decommissioning of offshore, landfall and onshore electricity transmission infrastructure. The whole life carbon modules assessed are presented in **Table 2.1**.

Table 2.1: Whole life carbon modules assessed

Life Cycle Stage		Module	Description
Product Stage		A1-A3	Extraction and processing of raw materials, transport of raw materials to the manufacturing site, and emissions from product manufacturing process.
Construction Stage	Process	A4	Transport – transport of materials and products to the construction site
Construction Stage	Process	A5	Construction/installation process – on-site construction activities including plant and equipment energy use, personnel travel, water consumption and waste management
Use Stage		B2	Maintenance – routine maintenance activities
Use Stage		B3	Repair – corrective repair activities

Life Cycle Stage	Module	Description
Use Stage	B4	Replacement – like-for-like replacement of components
Use Stage	B5	Refurbishment – not applicable (see assumptions)
End of Life Stage	C1	Deconstruction and demolition
End of Life Stage	C2	Transport – transport of waste to processing/disposal
End of Life Stage	C3	Waste processing for reuse, recovery and/or recycling
End of Life Stage	C4	Disposal – final disposal of waste materials

2.2.1.2 As the MHPGC Project is currently in the early stages of design, data relating to site specific design details, such as the LSS design, are not yet available. Accordingly, where required, data has been extracted from similar comparable projects or estimated based on approximate material quantities and associated materials carbon intensity figures, to provide estimated figures for each life cycle module.

2.2.1.3 GHG emissions have been calculated using the following general formula:

$$\text{GHG Emissions (tCO}_2\text{e)} = \text{Activity Data} \times \text{Emissions Factor}$$

where 'Activity Data' is the quantitative measure of an activity that results in GHG emissions (e.g. quantity of material in kg, distance travelled in km, energy consumed in kWh) and 'Emissions Factor' is a coefficient that relates the activity data to the mass of GHGs emitted (e.g. kgCO₂e/kg, kgCO₂e/km, kgCO₂e/kWh).

2.2.1.4 Where project-specific activity data is not yet available (due to the early design stage), Key Performance Indicators (KPIs) and benchmark data from recognised industry sources have been applied. These are based on floor area or other proxy metrics to provide reasonable estimates. As the design progresses and more detailed data becomes available, the emissions estimates will be refined at the Environmental Statement (ES) stage using project-specific data where practicable.

2.3 Emissions factor sources

2.3.1.1 The principal emissions factor sources used in the GHG assessment are:

- Embodied carbon of materials: One Click LCA, ICE Database (Burrow *et al.*, 2025), which provides cradle-to-gate (A1–A3) emissions factors for a wide range of construction materials;
- Transport emissions: One Click LCA;
- Energy consumption and Fuel usage (for vessel movements and construction equipment): DESNZ (2025) conversion factors for grid electricity, diesel, marine oil and other fuels; One Click LCA;
- Waste disposal: One Click LCA;
- Electrical equipment: Environmental Product Declarations (EPDs) and manufacturer data.

2.3.1.2 Where multiple emissions factor sources are available for the same material or activity, the most conservative (i.e. highest emissions) factor has generally been selected to present a reasonable worst-case scenario, unless a more specific or representative factor is available.

2.4 Land use change

2.4.1.1 The estimation of GHG emissions related to land use change have not been estimated at this stage. As outlined in **Volume 4: Chapter 4: Climate Change, of the PEIR**, it is anticipated that the information required to estimate emissions from onshore land use change will be available at the ES stage.

2.4.1.2 Current land use habitat classification does not identify any areas of peatland or peaty soils within the onshore study area defined by the MHPGC Project PEIR Red Line Boundary: Onshore. It is not anticipated, therefore, that installation of the LSS and cables will directly affect any significant carbon stores and therefore the change in carbon storage value of the land would be minimal. This is considered to be the case for both temporary land use change, where the habitat is anticipated to be returned to its pre-development state after construction, and permanent land use change where the habitat may not be restored.

2.4.2 Seabed change

- 2.4.2.1 Some disturbance of seabed habitats is anticipated across the lifetime of the MHPGC Project. The construction phase is likely to create the largest extent of disturbance during the installation of offshore cables and connection works at landfall. Less disturbance is anticipated in the O&M phase associated with cable replacement and reburial. In the decommissioning phase disturbance is likely to be similar to construction.
- 2.4.2.2 Where seabed habitats are disturbed, this has the potential to affect 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 CO₂ through a process called remineralisation (Cunningham and Hunt, 2023). However, not all blue carbon stocks that are disturbed will be remineralised to CO₂ (Smeaton and Austin, 2022).
- 2.4.2.3 Further details will be included within the ES. Details from benthic surveys will be combined with published literature values (Smeaton et al, 2020) to calculate an average blue carbon per hectare baseline figure for habitats within MHPGC PEIR Red Line Boundary seaward of MHWS. Literature value for remineralisation potential in offshore sediments (Smeaton and Austin, 2022) will then be used to calculate potential GHG emissions. These will be contextualised within Scotland's estimated blue carbon stocks (Smeaton et al, 2020; Cunningham et al, 2023).

2.5 System boundary

- 2.5.1.1 In accordance with PAS 2080:2023, the system boundary for the GHG assessment encompasses the following:
- Spatial boundary:
 - All onshore and offshore infrastructure within the MHPGC Project PEIR Red Line Boundary, including the offshore export cables, TJB, onshore export cables, LSS and AC connection cables. Details are provided in **Table 4.1**.
 - Temporal boundary:
 - Construction phase: the period of construction and commissioning of the MHPGC Project;
 - O&M phase: the operational design life of the MHPGC Project;
 - Decommissioning phase: the period of decommissioning and site restoration at the end of the MHPGC Project's operational life.
 - Life cycle boundary:
 - Modules A1–A5 (product and construction process stages), B1–B5 (use stage) and C1–C4 (end of life stage), as detailed in **Table 2.1**
- 2.5.1.2 The following emissions sources have been excluded from the assessment, on the basis that they are considered minor, unquantifiable at this stage, or outside the defined system boundary:
- Pre-construction activities (Module A0): GHG emissions associated with pre-construction activities (e.g. environmental surveys, geotechnical investigations and demolition of existing structures) have been excluded on the grounds that their contribution to total whole life carbon is considered to be minor;
 - Module D (beyond system boundary): benefits and loads beyond the system boundary, such as credits for recycled materials at end of life, have not been assessed at this stage. This aligns with the ISEP guidance, which states that module D refers to wider impacts that may not be appropriate to attribute, in part or whole, to the MHPGC Project when calculating net impacts within the study boundary but are nevertheless relevant context to consider. It is also consistent with PAS 2080, which requires module D to be reported separately from life cycle modules A–C and not aggregated with emissions within the MHPGC Project boundary. The assessment of likely significant effects is based on the Project's gross whole life carbon emissions (modules A1–A5, B and C1–C4), ensuring a robust and precautionary basis for decision-making that maximises reported cumulative net GHG emissions;
 - Operational energy use emissions (Module B6) have been excluded from the assessment due to the absence of sufficient design and operational information at the current stage of the project;

- Operational water use emissions (Module B7) have been excluded from the assessment. Based on the nature of the proposed infrastructure, operational water consumption is anticipated to be minimal and not a significant contributor to whole life carbon emissions;
- Indirect or supply-chain emissions outside the scope of Modules A1–A5, B1–B5 and C1–C4 have not been included. This is consistent with PAS 2080 modular approach to whole life carbon quantification, which defines the project/programme boundary through a standardised set of life cycle modules. Emissions that fall outside these defined life cycle modules (such as corporate or organisational overhead emissions of value chain members (e.g. office energy use, employee commuting), emissions associated with the manufacture of construction plant and equipment itself (as distinct from its fuel use during construction, which is captured in A5), or wider economic multiplier effects) are not within the scope of a whole life carbon assessment as defined by PAS 2080 or the applicable calculation standards. This approach ensures that the whole life carbon assessment focuses on the emissions that the MHPGC Project and its value chain can directly control or influence (consistent with PAS 2080's emphasis on identifying carbon hotspots and targeting reduction efforts where the greatest opportunity for decarbonisation exists) while maintaining a proportionate and robust assessment in line with the ISEP (formerly IEMA) guidance on delivering proportionate climate EIA chapters.

2.6 Assumptions and limitations

- 2.6.1.1 Due to the relatively early stage in the development design, there is a degree of uncertainty regarding the construction stage GHG emissions resulting from the manufacturing and construction of the Project. The assessment has sought to limit the impact this may have by assessing a maximum design scenario (MDS). The MDS considers the scenario resulting in the greatest potential for GHG emissions (i.e. the greatest number and size of structures, resulting in the greatest consumption of fuel and materials).
- 2.6.1.2 The assessment is based on the quantities presented within MDS (see **Table 4.1**) and therefore represents a conservative estimate of potential whole life carbon impacts. Actual material quantities may vary as the design develops.
- 2.6.1.3 Where project-specific EPDs or detailed material specifications were unavailable, the closest representative datasets available within One Click LCA were selected using professional judgement. Consequently, the results may not fully reflect the impacts of the products ultimately procured.
- 2.6.1.4 Embodied carbon emissions associated with the onshore substation buildings were estimated using industry benchmark carbon intensity factors ($\text{kgCO}_2\text{e/m}^2$) applied to the available floor area data. In the absence of detailed designs and material schedules, these estimates should be considered indicative.
- 2.6.1.5 A4 emissions are based on the transportation assumptions contained within the selected One Click LCA datasets and EPDs. For the offshore elements, A4 emissions are calculated based on the percentage of A1 to A3 emissions in the absence of specific transportation data.
- 2.6.1.6 A5 construction process emissions associated with plant and equipment were estimated using a list of plant and equipment anticipated to be required to carry out the works based on current understanding of the MHPGC Project, together with assumed fuel consumption rates and operating durations derived from comparable projects.

2.7 Inclusions

- 2.7.1.1 Key inclusions and exclusions related to each whole life carbon module are summarised in **Table 2.2**.

Table 2.2: Whole life carbon modules – summary of inclusions

Life Cycle Stage	Module	Onshore	Offshore
Product Stage	A1-A3	Extraction, manufacture and fabrication of construction materials. This includes the materials and components listed for the onshore and offshore elements mentioned within the MDS (Table 4.1).	
Material Transportation	A4	Transportation of construction products and materials from the manufacturer or supplier to the project site. This includes road-based transport for the onshore elements calculated using OneClick LCA default scenarios.	Transportation of construction products and materials from the manufacturer or supplier to the project site. A4 transport emissions were estimated as a percentage of A1-A3 embodied carbon.
Construction Process Stage	A5	Emissions arising from site construction activities, including plant and equipment use, temporary works, material wastage, waste transport, and waste treatment/disposal.	Emissions arising from site construction activities, including plant and equipment use, temporary works, material wastage, waste transport, and waste treatment/disposal. Also includes vessel movement related emissions for offshore cable installation process during the construction stage.
Use Stage	B2	Activities undertaken to maintain the asset in its required condition, including routine maintenance and servicing. This has been based on default OneClick LCA values for onshore elements.	Activities undertaken to maintain the asset in its required condition, including routine maintenance and servicing. Also covers the vessel movement related activity during the operational phase of 35 years.
Use Stage	B3	Repair activities required to restore damaged or degraded elements to their intended function. This has been based on default OneClick LCA values for onshore elements.	For offshore elements, repair and refurbishment frequency and other details have been provided in Table 4.1 , based on which the emissions related to repair have been calculated.
Use Stage	B4	Replacement of building or infrastructure components during the asset's service life.	For offshore elements, repair and refurbishment frequency and other details have been provided in Table 4.1 , based on which the emissions related to repair have been calculated.
Use Stage	B5	Any refurbishment, renovation, or upgrade works undertaken during operation. Often reported along with B2 to B4 stages.	Any refurbishment, renovation, or upgrade works undertaken during operation. Often reported along with B2 to B4 stages.
End of Life Stage	C1	Emissions associated with dismantling, demolition, or decommissioning activities at end of life.	
End of Life Stage	C2	Transportation of demolished materials and waste from the site to treatment, recycling, recovery, or disposal facilities.	
End of Life Stage	C3	Processing of waste materials for reuse, recycling, or recovery prior to final disposal.	

Life Cycle Stage	Module	Onshore	Offshore
End of Life Stage	C4	Final disposal of waste materials, including landfill, incineration without energy recovery, or other disposal routes.	

3 GHG Calculation Methodology

3.1 Construction Phase

- 3.1.1.1 The following sections detail the methodology used to estimate the construction phase embodied carbon associated with the MHPGC Project.
- 3.1.1.2 The construction phase emissions cover the whole life carbon modules A1-A5 – materials, transport, and construction, i.e., emissions associated with the extraction, processing, manufacturing, transport, and installation of materials. Additional assumptions and key KPIs used to estimate these emissions can be found in **Section 2.6** of this annex.

3.1.2 A1-A3 product stage

- 3.1.2.1 The assessment of A1-A3 embodied carbon emissions (Product Stage) was undertaken covering the potential impacts associated with raw material extraction, transport to manufacturing, and manufacturing processes for the materials included within the project scope.
- 3.1.2.2 GHG emissions associated with materials have been estimated using key material quantities provided by the design team and supplemented by industry benchmarks where design information is not yet available. The closest representative material and product datasets were selected within One Click LCA to reflect the anticipated material composition and associated emissions. Material selections were based on professional judgement and alignment with the specifications described in the MDS (see **Table 4.1**). Where project-specific EPDs were unavailable, generic or industry-average datasets available within One Click LCA were used.
- 3.1.2.3 Limited design information was available for the proposed onshore substation. Consequently, a rule-of-thumb estimation approach was adopted to estimate the A1-A3 embodied carbon emissions associated with these structures based on similar projects.

Offshore Infrastructure

- 3.1.2.4 For offshore assets and associated electrical infrastructure, quantities reported within **Table 4.1** were directly modelled in One Click LCA. The assessment included the embodied carbon impacts associated with:
- Reinforced and concrete elements;
 - Cables and cable protection systems (including conductor, insulation and protection materials);
 - Electrical equipment and ancillary infrastructure;
 - Other construction materials identified within **Table 4.1**.
- 3.1.2.5 Each material quantity was assigned to the most representative One Click LCA dataset available, ensuring consistency across the assessment. The resulting A1-A3 emissions were calculated using the underlying life cycle inventory and emission factors embedded within the selected datasets.

Onshore Infrastructure

- 3.1.2.6 Onshore elements listed within **Table 4.1**, have been modelled within One Click LCA.
- 3.1.2.7 At this stage of the design, material estimates have not yet been specified for the LSS in terms of the quantities and specific products to be used. As such, embodied carbon emissions associated with construction of the LSS and associated buildings have been estimated based on information in **Table 4.1**, including:
- The number of buildings that would make up the LSS;
 - The indicative height of the LSS;
 - The total permanent footprint of the LSS
- 3.1.2.8 Based on this information, emissions for one representative building have been estimated using the OneClick LCA Carbon Designer 3D tool (OneClick, 2021) and applying the RICS 2nd edition-aligned life cycle assessment methodology. The emissions were then linearly scaled based on the number

of buildings expected to make up the LSS. For modelling the LSS related emissions, the estimated footprint of the LSS is multiplied by the associated carbon emissions per unit area.

3.1.2.9 Additional elements modelled within the onshore section are as follows based on the detail provided within the MDS:

- Onshore Export Cables (HVDC)
- AC Connection Cables (HVAC)
- Joint Bays
- Link Boxes
- Other associated infrastructure as mentioned in **Table 4.1**

3.1.3 A4 construction process stage - transport of materials to site

Onshore Infrastructure

3.1.3.1 A4 emissions were calculated within One Click LCA using the transport assumptions embedded within the selected EPD datasets and generic material datasets. For each material modelled, the software automatically applies the relevant transportation parameters associated with the chosen dataset.

3.1.3.2 Distances used in One Click LCA default scenarios for various modelled materials range from 50 to 80 km by road for locally or regionally manufactured materials and 100 to 120 km for nationally manufactured materials. Where the origin of materials is unknown, the most conservative transport scenario has been assumed.

Offshore Infrastructure

3.1.3.3 Project-specific transportation distances and logistics information for offshore elements were unavailable at the time of assessment. Based on published embodied carbon guidance and similar projects, it is assumed that transport-to-site emissions (Module A4) are generally small relative to manufacturing emissions (Modules A1-A3), often representing only 1 to 5% percent of A1-A3 emissions. Therefore, a conservative screening assumption of 3% of A1-A3 emissions was adopted for calculating Module A4.

3.1.4 A5 construction process stage - personnel travel

3.1.4.1 GHG emissions associated with personnel travel during construction have not been included in this assessment at PEIR. Further details will be included in the ES.

3.1.5 A5 construction process stage - plant and equipment energy consumption

3.1.5.1 The GHG emissions associated with the energy consumption of construction plant and equipment during the A5 construction process stage were estimated using an indicative plant list provided by the design team. The list identifies the types and tonnage of equipment anticipated to be used during construction activities. To quantify emissions, average fuel consumption rates were assigned to each item based on equipment type and capacity, using publicly available resources. Estimated operating durations were then derived using the anticipated construction programme and benchmarks from comparable offshore wind projects. These inputs were used to calculate the fuel consumption and associated emissions attributable to construction activities.

3.1.5.2 For the construction and installation of offshore elements, vessel movement related emissions have also been assessed, using the vessel movement and trip numbers provided within **Table 4.1**. The vessel fuel consumption and hours of operation were then derived using publicly available sources and comparable data from similar projects. The marine oil related carbon emission factor was then used from DESNZ carbon emissions database (2025) in order to calculate the vessel movement related emissions.

3.1.6 A5 construction process stage - water consumption

- 3.1.6.1 GHG emissions associated with water consumption have been scoped out given the minimal water requirements associated with construction activities.

3.1.7 A5 construction process stage - waste management

- 3.1.7.1 GHG emissions associated with waste generation and management during the A5 construction process stage were estimated using the default material wastage rates embedded within One Click LCA. These wastage factors were applied to the materials and products included within the A1-A3 assessment, based on the quantities identified in **Table 4.1**. The default wastage rates in One Click LCA represent typical industry assumptions for material losses arising during construction activities, including material offcuts, breakages, handling losses, and other construction-related waste streams. The resulting waste quantities were then allocated to the relevant default waste treatment processes within OneClick LCA to calculate the associated GHG emissions. As project-specific waste management plans, construction practices, and material handling procedures were not available at the time of assessment, the use of One Click LCA default wastage rates provides an indicative estimate of construction-stage waste impacts.

3.1.8 A5 construction process stage - waste transportation

- 3.1.8.1 GHG emissions associated with the transportation of construction waste were estimated using the default waste transportation scenarios embedded within One Click LCA. These default assumptions assign representative transport distances, vehicle types, and waste management routes based on the selected waste streams and treatment processes, providing a consistent approach to the assessment of waste-related transport emissions.
- 3.1.8.2 The waste quantities used in the assessment were derived by applying One Click LCA default material wastage rates to the materials and products included within the A1-A3 assessment. The resulting waste arisings were then linked to the relevant waste transportation and treatment scenarios available within the software.
- 3.1.8.3 Consequently, the results should be considered indicative and appropriate for the current stage of design. The assessment may be refined as more detailed information on construction waste management arrangements and site-specific logistics becomes available.

3.2 Operation and maintenance activities

- 3.2.1.1 Emissions during the O&M phase of the MHPGC Project include activities contributing to the operation and high-level management of the assets. These have been assessed under Modules B2 (maintenance), B3 (repair) and B4 (replacement) of the whole life carbon framework.
- 3.2.1.2 Maintenance activities can be categorised as follows:
- Preventative maintenance: proactive repair to, or replacement of, known wear components based on routine inspections or monitoring systems;
 - Corrective maintenance: reactive repair or replacement of failed or damaged components.
- 3.2.1.3 The MHPGC Project's maintenance activities related to the offshore elements would largely involve inspection, remote monitoring, repainting, removal of marine growth, reburial of cables, and geophysical surveys. Emissions associated with such activities would largely be generated by transport (vessels) related emissions, although emissions associated with materials used (e.g. new paint and coatings) would also occur.
- 3.2.1.4 The MHPGC Project's onshore maintenance activities would primarily include inspections and maintenance of the land substation, associated buildings, joint bays, link boxes and the onshore cable route. Activities may include testing and servicing of electrical equipment, routine building maintenance, and periodic replacement of minor components. Emissions would mainly arise from maintenance vehicle movements, personnel travel, and the manufacture and replacement of equipment, materials and consumables. Onshore maintenance activities are generally less carbon intensive than offshore activities due to the limited requirement for specialist marine vessels and equipment.

3.2.2 B1 use stage - land use change

- 3.2.2.1 GHG emissions associated with onshore land use change have not been estimated at the PEIR stage. In the O&M phase any land use change will be temporary, relating to specific maintenance works or repair works required at the LSS or within a section of the onshore cabling. In any such cases land will be restored to its pre-works state following completion of works. The net change in carbon will therefore be zero.

3.2.3 B2 use stage - maintenance

- 3.2.3.1 GHG emissions associated with maintenance have been estimated using the RICS (2024) KPI of 1% of A1-A5 emissions.
- 3.2.3.2 Additionally, for the offshore elements, B2 emissions were calculated using the project-specific vessel movement data provided for O&M activities. The assessment considered the anticipated vessel trips provided within **Table 4.1** for the operational phase. Emissions were calculated based on the relevant vessel activity assumptions and associated fuel consumption based on similar projects and emission factors from DESNZ, thereby providing a more representative estimate of maintenance-related operational impacts for the offshore infrastructure.

3.2.4 B3 use stage - repair

- 3.2.4.1 For the onshore elements, GHG emissions associated with repair have been estimated using the RICS (2024) KPI of 25% of B2 maintenance emissions and 10% of A1-A3 emissions for mechanical, electrical and plumbing, in accordance with the Chartered Institution of Building Services Engineers (2021) TM65 methodology. This includes operational transport emissions. For the offshore elements, the GHG emissions related to repair are calculated using the information about total lifetime cable repairs required provided in **Table 4.1**.

3.2.5 B4 use stage - replacement

- 3.2.5.1 GHG emissions associated with replacements have been estimated from the default scenario in OneClick LCA. Emissions associated with the production, transportation to site and installation of the replacement items have been included. The replacement frequencies reflect the design life of each component relative to the overall project design life.

3.2.6 B5 use stage - refurbishment

- 3.2.6.1 GHG emissions associated with this stage have not been estimated, as it is assumed that no alterations or improvements to the physical characteristics or performance of the MHPGC Project are planned. The GHG emissions associated with any necessary refurbishment are considered to have already been accounted for under the use stage - replacement (B4).

3.2.7 B6 Use stage - operational energy use

- 3.2.7.1 GHG emissions associated with this stage are related to electricity demand and back-up emergency power for the LSS, equipment and personnel facilities. The emissions are expected to be of minimal contribution and so the emissions are not included within the current assessment.

3.2.8 B7 use stage - operational water use

- 3.2.8.1 The GHG emissions associated with water consumption have not been estimated, as the operational water use for both the offshore and onshore components is considered negligible.

3.3 Decommissioning Phase

- 3.3.1.1 GHG emissions during the decommissioning phase relate to the following activities:

- Deconstruction and disassembly of infrastructure (C1);
- Transportation of waste materials from the decommissioning site (C2);
- Waste processing for reuse, recycling and/or energy recovery (C3);

- Final disposal of the decommissioning site waste materials (C4).

3.3.1.2 All cables and cable protection will be removed using similar techniques to those employed during installation. GHG emissions are therefore assessed as the reverse of relevant installation emissions.

3.3.1.3 In many cases it may be less environmentally impactful to leave assets in place. The decommissioning approach will be reviewed at the time of decommissioning following the most up to date and best available guidance.

3.3.1.4 For onshore components, all plant, structures and foundations would be dismantled and disposed of in accordance with the most up to date guidance and prevailing waste management regulations. Onshore cables will remain in-situ.

3.3.2 C1 end of life stage - deconstruction

3.3.2.1 For the onshore elements, GHG emissions associated with deconstruction have been assumed to be 25% of the energy consumed by plant and equipment during construction (A5). This has been considered keeping in regard the equipment technology and fuel efficiency which are expected to be improved by the decommissioning phase in line with the UK's net zero transition.

3.3.2.2 For the offshore elements, C1 emissions have been calculated assuming that vessels and support vessels would be utilised for carrying out the cable removal during the deconstruction phase. The vessel related emissions have been calculated accordingly assuming the same number of trips would be required as for the construction phase.

3.3.3 C2 end of life stage - waste transport

3.3.3.1 For the onshore elements, GHG emissions associated with the transport of waste at the end-of-life stage have been calculated as per the default scenarios in One Click LCA. All materials removed at the end of life have been considered as waste.

3.3.3.2 For the offshore elements, C2 emissions have been assumed to be similar to the A4 emissions for material transportation, in the absence of specific information.

3.3.4 C3 end of life stage - waste processing for reuse, recycling and/or energy recovery

3.3.4.1 GHG emissions associated with this stage have been considered for the onshore elements as per the OneClick LCA default scenario values.

3.3.4.2 The C3 stage emissions associated with offshore cables at end of life have been calculated using the UK DEFRA¹ waste processing and disposal emission factors. DEFRA emission factors, expressed in kgCO₂e per kg of waste material treated or disposed of, have been applied to the estimated cable mass to determine the corresponding end of life emissions.

3.3.5 C4 end of life stage - waste disposal

3.3.5.1 For the onshore elements, GHG emissions have been estimated on the conservative assumption that all materials used during construction, and accounted for under A1-A3, would become waste and would be sent for disposal. This has been calculated using One Click LCA default values for end-of-life waste disposal. For offshore elements, these emissions have been included within the C3 stage. At the ES stage, consideration will be given to more refined end-of-life scenarios, including material recycling rate.

¹ Department for Energy Security and Net Zero, GHG reporting conversion factors. Available at: <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2025>

4 Maximum Design Scenario

- 4.1.1.1 The MDS used to provide the information and specifications for the offshore and onshore elements being assessed is provided in **Table 4.1**.

Table 4.1: Maximum Design Scenario

Impact	Maximum Design Scenario	Explanation
Construction		
Offshore installation works that result in embodied GHG emissions associated with materials used	The cable length measurements are for the distance between the Morven North or Morven South Offshore Substation Platform (OSP) and trenchless drill exit pit unless otherwise stated. For clarity one trench length is as follows: - OSP to exit pit - 324.67km; - OSP to MHWS – 326.00km; - Scottish waters (OSP – Scottish-English offshore waters boundary) – 98.00km; - English waters (English offshore waters boundary – exit pit) – 226.67km; - English waters (English offshore waters boundary – MHWS) – 228.00km. Sandwave clearance - Sandwave clearance activities undertaken using MFE over an approximate four month duration; - Sediment disturbance rate is 1000kg/s - Surface width of up to 28m per trench and base width of up to 20m per trench; <u>Per trench = 1,484,000m²</u> - Scottish waters: 31km length × 28m width = 868,000m² - English waters: 22km length × 28m width = 616,000m² <u>Total (up to two trenches) = 2,968,000m²</u> - Scottish waters: 1,736,000m² - English waters: 1,232,000m² Cable installation (trenching): - Installation via trenching of up to 324.67km of cable, with a trench width of up to 2.1m and a depth of up to 3m; - Trenching rate is 400m/hr. <u>Per trench = 2,045,421m³</u> - Scottish waters: 98km length × 2.1m width × 3m depth = 617,400m³; - English waters: 226.67km length × 2.1m width × 3m depth = 1,428,021m³. <u>Total (up to two trenches) = 4,090,842m³</u> - Scottish waters: 1,234,800m³;	Details provide maximum number of components or largest scale of asset at upper bound of design envelope.

Impact	Maximum Design Scenario	Explanation
	- English waters: 2,856,042m³. Boulder clearance: <u>Per trench = 1,380,000m²</u> - Scottish waters: 31km length × 20m width = 620,000m²; - English waters: 38km length × 20m width = 760,000m². <u>Total (up to two trenches) = 2,760,000m²</u> - Scottish waters: 1,240,000m²; - English waters: 1,520,000m². Pre-Lay Grapple Run (PLGR): <u>Per trench = 3,246,700m²</u> - Scottish waters: 98km length × 10m width = 980,000m²; - English waters: 226.6 km length × 10m width = 2,266,700m². <u>Total (up to two trenches) = 6,493,400m²</u> - Scottish waters: 1,960,000m²; - English waters: 4,533,400m². Cable protection (English and Scottish waters): - Offshore export cable: up to 8.3% (equivalent to 27km) of the total route length within Scottish and English waters may require external protection using rock installation. Rock installation may be up to 14m wide and 2m high and side slope of 1:3. <u>Area per trench = 378,980m²</u> <u>Total area (up to two trenches) = 757,960m²</u> <u>Volume per trench = 433,120m³</u> <u>Total volume (up to two trenches) = 866,240m³</u> - Export cable crossing: Up to 16 crossings using either rock installation or concrete mattresses within Scottish and English waters. Each crossing will be up to 200m (length) x 18m (wide) x 2m (height). <u>Per crossing = 3,600m²</u> <u>Total (up to 34 crossings) = 122,400m²</u>	
Offshore installation works that result in GHG emissions as a	Construction duration: up to four years. Offshore vessel activity:	Details provide maximum number of components or largest scale of asset at

Impact	Maximum Design Scenario	Explanation
result of construction activities	- There will be up to 550 return trips by installation vessels (including Cable Lay Vessels (CLV), trenching support vessels (TSV), installation support vessel (ISV), guard vessels (GV), survey vessels, PLGR vessel, out of service cable removal vessel, boulder clearance vessel, dredging vessel, crew transport vessel (CTV), rock dumping vessel, construction support vessel, tug/anchor handler and cable barge); - A maximum of 33 vessels may be operational at any one time during the construction phase. Landfall vessel activity: - There will be up to 250 return trips by installation and support vessels (including CLV, ISV, GV, dredging vessels, tug/anchor handlers, cable barge, CTV and dive support vessels (DSV)); - A maximum of 14 vessels may be operational at any one time during the construction phase.	upper bound of design envelope.
Landfall works that result in embodied GHG emissions associated with materials used	Trenchless techniques (landfall) (English waters): - Up to four boreholes via trenchless installation: conduit diameter of 1.6m, conduit length of 2,000m. Drilling fluid discharge up to 180m³ each and up to 1,083m³ total; - Trenchless drill punchout will be up to approximately 1690m offshore of MHWS in water depths up to 20m LAT; - Up to four exit pits (140m long × 50m wide × 5m deep). Area up to 7,000m² each; 28,000m² total. Volume up to 18,667m³ each; 74,668m³ total; - Up to two floatation pits (240m long × 55m wide × 5m deep). Area up to 13,200m² each; 26,400m² total. Volume up to 39,167m³ each; 78,334m³ total. Vessel seabed interactions (English waters): Total = 5,098,259 m² - Up to 127,456 m² anchor seabed disturbance per vessel movement × 40 full anchor spread movements = 5,098,240m², - Up to six jack-up events (2m diameter spud legs × 4), 3.14m² per events, total disturbance = 18.85m². Landfall (trenchless drill) - Landfall trenchless drill installation method: HDD or Direct Pipe (DP); - Maximum burial depth of trenchless drill (per bore): 80m bgl; - Maximum trenchless drill length: 2km; - Duration of trenchless drilling activity: 300 days; - Construction period for Landfall: 3.5 years.	Details provide maximum number of components or largest scale of asset at upper bound of design envelope.

Impact	Maximum Design Scenario	Explanation
	Landfall Infrastructure onshore (landward of MHWS) - Maximum width of trenchless drill area, west of Durham Coast Line: 400m; - Corridor length: 800m; - Number of trenchless drill entry points: 4 bores; - Material quantities associated with excavation: 130,000m³. Transition Joint Bays - Number of TJBs: 2; - Location of TJBs: Within 150m of landfall trenchless drill entry point; - Working Area for TJB (construction): 750m²; - Depth of TJB: 2.5m. Infrastructure Intertidal (Mean Low Water Springs (MLWS) - Mean High Water Springs (MHWS)) Trenchless drill length intertidal = 60m	
Landfall works result in GHG emissions as a result of construction activities	Landfall Duration of construction and compound operation = 3.5 years Duration of trenchless drilling activity: 300 days Number of main compounds = 1 (48,000m²); Maximum of 2 access tracks (width = 10m) Working hours = 07:00 - 19:00 Mon - Fri and 07:00 - 13:00 on Sat; no activity on Sundays or Bank Holidays, excluding trenchless techniques, which will require 24-hour working. Material arising from excavation activities = 130,000m³ [Assume topsoil and subsoil from site-strip and excavations will be reused on site during backfilling or for reinstatement. Assume bore arisings from HDD/DP will be removed from site] Movements and workforce <i>Landfall</i> Abnormal loads: Heavy Goods Vehicle (HGV) low loader with extendable trailer (70t maximum load) - movement order required. 6 Abnormal Indivisible Load (AILs); Maximum 20 HGV movements per day; 240 vehicle movements per day Up to 48 employees working at site per day	Details provide maximum number of components or largest scale of asset at upper bound of design envelope.

Impact	Maximum Design Scenario	Explanation
	Landfall (Trenchless Drill / Pull-in Operations) Single or multiple cable lay vessels/barges - typically Length = 100 -180m; beam = 20 - 40m Max vessels on site at any one time = 14 [2 x CLV; 2 x ISV; 2 x GV; 1 x dredging vessel.; 4 x Tug Anchor Handler; 1 x Cable Barge; 1 x CTV; 1 x DSV] Number of vessels and number of return trips across construction period = CLV: 2x20 = 40; ISV: 2x20 = 40; GV: 2x20 = 40; Dredging: 1x30 = 30; Tug/Anchor: 4x15 = 60; Barge: 1x10 = 10; CTV = 1x20=20; DSV = 1x10=10. Total: 250 Jack up operations and spud leg dimensions: Single smaller type jack-up potentially required for supporting construction at the trenchless drill exit pit locations. Qty: 1; Barge dimensions typically in the range of 30m x 15m to 60m x 30m. Corresponding leg diameters used below. Qty: 1; Tugs to support barge movements. Qty: 4; Construction Support vessel for use of exit pit construction: Qty: 1; Supply Vessels: Qty 1; Dive Support Vessel for use at bellmouth construction: Qty 1. 2.0m Spud Leg Dia. ; 4 x Spud Legs = 3.14m² seabed interaction per location. 6.28m² seabed interaction for 2no. Exit pits; 18.85m² seabed interaction for 6no. Exit pits Installation Vessels and Support Vessel Anchoring = Anchored cable lay barge holding position with 7no. anchor spread during pull-in operations. Maximum anchor corridor 1000m. 40 potential full anchor spread movements across 20km trench of nearshore lay. Total anchor corridor area: 20km²; Total potential seabed disturbance: 5,098,230m². Landfall construction: Anchored cable Lay barge holding position with 7no. Anchor spread during pull in operations; Maximum anchor corridor 1000m. 4 potential full anchor spread movements across 2km trench of nearshore lay. Total anchor corridor area: 2km²; Total potential seabed disturbance: 509,824m²	
Onshore works that result in embodied GHG emissions associated with materials used	Onshore Export Cable (High Voltage Direct Current (HVDC)) – Blue LSS 1 circuit (2 conductors + 2 fibre optic) = 4 cables in total. Total length of cable route = 4.83km. HVDC cable diameter = 155mm; fibre optic cable Outer Diameter (OD) = 40mm Maximum of 2 trenches - 6.85m cable corridor width (per trench); 14m width for full cable corridor Trench width at base = 4m; width at top = 6.85m; depth = 1.8m with depth of stabilised backfill = 1m. Number of cable route joint bays = 12; volume of material excavated per joint bay = 700m³; 8,400m³ for all joint bays Volume of material excavated per monitoring box: 18m³ Volume of material excavated (for monitoring boxes): 216m³ Construction land take per monitoring box: 64m² Construction land take for all monitoring boxes: 768m²	Details provide maximum number of components or largest scale of asset at upper bound of design envelope.

Impact	Maximum Design Scenario	Explanation
	Grid Connection Export Cable (High Voltage Alternating Current (HVAC)) Total of 24 export cables (4 circuits = 12 power cores + 4 earth continuity conductors + 8 fibre optic/control allowance) HVAC cable diameter = 150mm; fibre optic cable OD = 40mm Length of cable route = 4,260 m; 4 cable trenches - trench width at base = 2.8m; at top = 4.8m; trench depth = 1.8 m; depth of stabilised backfill = 1m Number of cable route joint bays = 32; volume of material excavated per JB = 2,264m³ (total volume = <u>18,112m³</u>) Construction land take for joint bay (surface area): 1,472m² (<u>total = 11,776m²</u>) Volume of material excavated per link box: 12.5m³ Construction land take for link box: 100m² (total = 3200m²) Volume of material excavated (link boxes): 400m³ Infrastructure Number of haul roads = 1; road width = 8m; depth = 0.5m. Construction involves: 400mm topsoil strip; placement of geogrids and 500mm of stone along haul road. Additional engineering / intervention in some sections of the haul road to mitigate impacts on buried utilities or prevent excessive settlement (due to geohazards or compressible materials). Assume areas of hardstanding which will be created at joint bays for drum delivery and winch pads included. Number of main compounds: 2 Main compound dimensions: 7ha Number of secondary construction compounds: 6 Dimensions per secondary construction compound: 10,000m² Total area of secondary construction compounds: 6ha. Trenchless Drill Crossings Major Crossings understood to be: - A, B and Classified unnumbered roads (known as C roads) (including the A19 and B1432); - Hesledon Moor East SSSI. Trenchless drill methodology: HDD, micro-tunnelling (auger bore or direct pipe) Number of trenchless drill compounds: 6 (3 entry and 3 exit trenchless drill compounds)	

Impact	Maximum Design Scenario	Explanation
	Dimensions of trenchless drill compounds: 6,000m² Total trenchless drill compound area: 36,000m² Trenchless depth (excluding landfall): 30m LSS Construction Duration: 4.5 years Main building height: 30 m; width, 100 m; length, 200 m Buildings number: 14 Temporary access number: 2, 15m width (each) Description of foundations: raft or pile caps (suspended structure) or piled foundations and suspended structures Volume of excavation for foundations: 20,000m³ Cut and fill balance: 50,000m³ Material types and quantities associated to excavation: 14,000m³ topsoil, 65,000m³ other materials Estimated waste quantities: 50,000m³ Electrical Components Earth switches = 96; lightning arrestors or surge arrestors = 30; Voltage transformers = 30; current transformers = 30; circuit breakers = 30; electrical isolators = 159; busbars = 54; power transformer = 7; static VAR compensator = 12; harmonic filter bank = 12; shunt reactor = 12; terminal towers/line-cable interface mast = 12	
Onshore works that result in GHG emissions associated with construction activities	Movements and workforce <i>Onshore Export Cable</i> Abnormal loads (Number): 450 Abnormal loads (Type): Cable drums on tractor trailers - low loaded lorry's may be suitable for transport also. Total daily construction traffic movements (HGV): 83 Total daily construction traffic movements (Vehicles): 90 Number of employees working on site: 120 <i>LSS</i> Abnormal loads (Number): 18	Details provide maximum number of components or largest scale of asset at upper bound of design envelope.

Impact	Maximum Design Scenario	Explanation
	Abnormal loads (Type): Cable drums on tractor trailers - low loaded lorry's may be suitable for transport also. Total daily construction traffic movements (HGV): 100 Total daily construction traffic movements (Vehicles): 300 Number of employees working on site: 250 to 350	
Operation and Maintenance		
O& M activities resulting in GHG emissions from surveys or inspections	Seaward of MLWS O&M: Operational lifespan of 35 years. Vessel presence: Routine inspection (no remediation/repair) constitutes survey activity (survey vessel) up to 2 surveys per year per trench; duration 2 weeks per survey; 3 return trips per survey; 2 vessel max at 1 time per survey. Per year for 2 trenches: • Surveys – 4 • Return trip – $4 \times 3 = 12$ • Total vessels at time – 2 Routine inspection (no remediation/repair) constitutes survey activity (USV) up to 2 surveys per year per trench; duration 6 weeks per survey; 110 return trips (up to 4 USV + 1 guard vessel with port call every 4 days) ($55 \text{ per survey} = 110$); up to 4 USV + 1 guard vessel = 5 max at 1 time per survey. Per year for 2 trenches: • Surveys – 4 • Return trips – $4 \times 55 = 220$ • Total vessels at time – 5 • Remediation (up to 13.056km per year per trench, in different locations along route) Vessels on site for remediation activities, for up to two trenches: • Up to four operation and maintenance vessels on site at any one time, comprising a combination of construction support vessel (CSV) and/or Service Operation Vessels (SOV) and/or guard vessel and/or rock dump vessels and/or CTVs/workboats. Vessel movements (remediation), for up to two trenches: • Up to 62 operation and maintenance vessel movements (return trips) each year, consisting of CSV or SOV and/or guard vessel and/or rock dump vessels and/or CTVs/workboats. • Repair (41 lifetime repairs, for up to two trenches)	Details provide maximum number of components or largest scale of asset at upper bound of design envelope.

Impact	Maximum Design Scenario	Explanation
	Vessels on site for repair activities, for up to two trenches: - Up to four operation and maintenance vessels on site at any one time, comprising a combination of CLV and/or barge and/or Barge Handlers/Tugs and/or Jack-Up and/or CSV and/or CTV and/or Rockdump. Vessel movements (repair), for up to two trenches: - Up to 245 operation and maintenance vessel movements (return trips) over the operational lifetime (35 yrs) consisting of CLV and/or barge and/or Jack-Up and/or Barge Handlers/Tugs and/or CSV and/or CTV and/or Rockdump. Landward of MLWS Landfall Typical duration of operation: 35 years Operational land take for TJB (surface area): 25m² Total area of TJB: 150m² Activities anticipated during operation and maintenance: quarterly Onshore Cable Typical duration of operation: 35 years AC Connection Cable Corridor – Blue LSS Length of cable route: 4.26km Width of cable corridor (permanent): 25m HVAC Onshore cable area (permanent): 106,500m² HVAC Operational land take per access cover: 25m² (total = 200m²) Onshore Export Cable Corridor – Blue LSS Length of cable route: 4.83km Width of cable corridor (permanent): 8.65m HVDC Onshore cable area (permanent): 41,780m² HVDC Operational land take per access cover: 6.25m² (total = 75m²) Number of operational access tracks (excluding existing tracks): 6 Operational access track construction: Assume the additional access tracks into the cable route (if required) will use existing access points and unpaved farm tracks where possible. Potential access tracks from the construction works will be retained during operation.	

Impact	Maximum Design Scenario	Explanation
	Activities anticipated during operation and maintenance: quarterly LSS Typical duration of operation: 35 years Area of permanent footprint: 6.5ha Impermeable permanent area: 3.5ha SuDS area: 2,300m² SuDS volume: 3,500m³ Number of permanent accesses: 2 Permanent access width: 15m Permanent access points: 2 Activities anticipated during operation: Monthly day visit inspections; Quarterly detailed inspections/ non-intrusive work; Annual turnaround/shutdown.	
Decommissioning		
<i>Landfall and Export Cables</i>	All cables and cable protection fully removed. The process is anticipated to be the reverse of the construction process, with similar parameters to the equivalent construction phase impact.	
<i>Land Substation</i>	Deconstruction in the inverted sequence of installation, after the LSS has been decommissioned. All equipment and materials including foundations will be demolished and disposed of, in accordance with the latest relevant guidance. The site will be reinstated. Onshore cables will remain in-situ.	

5 Assessment results

5.1.1.1 **Table 5.1** presents the estimated GHG emissions for the construction, O&M and decommissioning phases of the MHPGC Project, covering both the onshore and offshore components (English and Scottish waters). Emissions are presented by whole life carbon module and by project phase.

Table 5.1: Estimated GHG emissions of the MHPGC Project

Phase	Whole Life Carbon Module	Onshore Estimated Emissions (tCO ₂ e)	Offshore Estimated Emissions (tCO ₂ e)	Total Onshore and Offshore Estimated Emissions (tCO ₂ e)
Construction	A1-A3	52,719	163,176	215,895
	A4	1,788	5,798	7,586
	A5	9,202	99,233	108,436
O&M	B2	527	187,694	188,221
	B3	132	35,466	35,597
	B4	11,762	N/A	11,762
Decommissioning	C1-C4	3,848	19,099	22,947
Total		80,272	512,380	592,652

5.1.1.2 A full, detailed breakdown of the GHG assessment, including the assessment of significance and overall assessment conclusions, can be found in **Volume 4, Chapter 4: Climate Change, of the PEIR**.

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