White Cross Offshore Windfarm Environmental Statement

Chapter 23: Climate Change

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Glossary of Acronyms

Acronym	Definition
BEIS	Department for Business, Energy and Industrial Strategy
BSI	British Standards Institution
CCC	Climate Change Committee
CCRA	Climate Change Resilience Assessment
CEA	Cumulative Effect Assessment
CEMP	Construction Environmental Management Plan
COP	Conference of Parties
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
Defra	Department for Environment, Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
GHG	Greenhouse Gas
GWP	Global Warming Potentials
ha	Hectare
HDD	Horizontal Directional Drilling
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management and Assessment
IPC	Infrastructure Planning Commission
IPCC	Intergovernmental Panel on Climate Change
km	Kilometre
kWh	Kilowatt-hour
LCA	Life Cycle Analysis
m	Metre
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
MW	Megawatts
NAP	National Adaptation Programme
NSIP	Nationally Significant Infrastructure Project
NPS	National Policy Statement
NPPF	The National Planning Policy Framework
NRMM	Non-Road Mobile Machinery
OSP	Offshore Substation Platform
RCP	Representative Concentration Pathways

Acronym	Definition
TJB	Transition Joint Bay
UK	United Kingdom
UKCP	UK Climate Projections
UNFCCC	United Nations Framework Convention on Climate Change
WTG	Wind Turbine Generator

Glossary of Terminology

Defined Term	Description
Applicant	White Cross Offshore Windfarm Limited (WCOWL).
Cumulative effects	The effect of the Onshore Project taken together with similar effects from a number of different projects, on the same single receptor/resource. Cumulative Effects are those that result from changes caused by other past, present or reasonably foreseeable actions together with the Onshore Project.
Department for Business, Energy and Industrial Strategy (BEIS)	Government department that is responsible for business, industrial strategy, science and innovation and energy and climate change policy and consent under Section 36 of the Electricity Act.
Department for Energy Security and Net Zero (DESNZ)	Government Department which is responsible for energy policies, with a mandate to maintain energy suppliers, reduce energy bills, ensure the UK is on track to meet its carbon budgets and speed up the delivery of network infrastructure and green energy.
Environmental Impact Assessment (EIA)	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning.
Export Cable Corridor	The area in which the export cables will be laid, either from the Offshore Substation or the inter-array cable junction box (if no offshore substation), to the NG Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor.
Jointing bay	Underground structures constructed at regular intervals along the Onshore Export Cable Corridor to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	Where the offshore export cables come ashore.
Link boxes	Underground chambers or above ground cabinets next to the cable trench housing electrical earthing links.
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean sea level	The average tidal height over a long period of time.

Defined Term	Description
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant effects. Additional mitigation is therefore subsequently adopted by WCOWL as the EIA process progresses.
Offshore Development Area	The Windfarm Site (including wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and Offshore Export Cable Corridor to MHWS at the Landfall. This encompasses the part of the project that is the focus of this application and Environmental Statement and the parts of the project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009.
Offshore Export Cables	The cables which bring electricity from the Offshore Substation Platform or the inter-array cables junction box to the Landfall.
Offshore Export Cable Corridor	The proposed offshore area in which the export cables will be laid, from Offshore Substation Platform or the inter-array cable junction box to the Landfall.
Offshore Infrastructure	All of the offshore infrastructure including wind turbine generators, substructures, mooring lines, seabed anchors, Offshore Substation Platform and all cable types (export and inter-array). This encompasses the infrastructure that is the focus of this application and Environmental Statement and the parts of the project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009.
the Offshore Project	The Offshore Project for the offshore Section 36 and Marine Licence application includes all components offshore of MHWS. This includes the infrastructure within the windfarm site (e.g. wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and all infrastructure associated with the export cable route and landfall (up to MHWS) including the cables and associated cable protection (if required).
Onshore Development Area	The onshore area above MLWS including the underground onshore export cables connecting to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland. The onshore development area will form part of a separate Planning application to the Local Planning Authority (LPA) under the Town and Country Planning Act 1990.

Defined Term	Description
Onshore Export Cables	The cables which bring electricity from MLWS at the Landfall to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from MLWS at the Landfall to the White Cross Onshore Substation and onward to the NG grid connection point at East Yelland.
Onshore Infrastructure	The combined name for all infrastructure associated with the Project from MLWS at the Landfall to the NG grid connection point at East Yelland. The onshore infrastructure will form part of a separate Planning application to the Local Planning Authority (LPA) under the Town and Country Planning Act 1990.
the Onshore Project	The Onshore Project for the onshore TCPA application includes all components onshore of MLWS. This includes the infrastructure associated with the offshore export cable (from MLWS), landfall, onshore export cable and associated infrastructure and new onshore substation (if required).
the Project	the Project is a proposed floating offshore windfarm called White Cross located in the Celtic Sea with a capacity of up to 100MW. It encompasses the project as a whole, i.e. all onshore and offshore infrastructure and activities associated with the Project.
Transition joint bay	Underground structures at the Landfall that house the joints between the offshore export cables and the onshore export cables.
White Cross Offshore Windfarm	100MW capacity offshore windfarm including associated onshore and offshore infrastructure.
White Cross Onshore Substation	A new substation built specifically for the White Cross project. It is required to ensure electrical power produced by the offshore windfarm is compliant with NG electrical requirements at the grid connection point at East Yelland.
Wind Turbine Generators (WTG)	The wind turbine generators convert wind energy into electrical power. Key components include the rotor blades, nacelle (housing for electrical generator and other electrical and control equipment) and tower. The final selection of project wind turbine model will be made post-consent application.
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present.

23. Climate Change

23.1 Introduction

1. This chapter of the Environmental Statement (ES) presents the climate change chapter of the White Cross Offshore Windfarm Project (the Onshore Project) and comprises a Greenhouse Gas (GHG) assessment and a Climate Change Resilience Assessment (CCRA). Specifically, it considers impacts landward of Mean Low Water Springs (MLWS) during its construction, operation and maintenance, and decommissioning phases.

2. This chapter differs slightly to the assessment presented in other topics of the ES, as instead of the impact on a specific receptor being considered, it considers (a) the impacts of the Onshore Project on climate change, through a GHG assessment, and (b) any potential impact of climate change on the Onshore Project, through a CCRA. The GHG assessment predicts the contribution of the Onshore Project to national and regional GHG emissions in the United Kingdom (UK), and its 'net effect' compared to a baseline of 'do nothing'. The CCRA considers the resilience of the design and infrastructure associated with the Onshore Project to the projected effects of climate change over its anticipated lifespan.

3. The ES has been finalised with due consideration of pre-application consultation to date (see **Chapter 7: Consultation**) and the ES will accompany the application to North Devon Council for planning permission under the Town and Country Planning Act 1990.

4. The components of the White Cross Offshore Windfarm Project seaward of Mean High Water Springs (MHWS) ('the Offshore Project') are subject to a separate application for consent under Section 36 of the Electricity Act 1989, and for Marine Licences under the Marine and Coastal Access Act 2009. These applications are supported by a separate ES covering all potential impacts seaward of MHWS.

5. This assessment has been undertaken with specific reference to the relevant policy, legislation and guidance, which are summarised in **Section 23.2** of this chapter. Further information on the international, national and local planning policy and legislation relevant to the Onshore Project is provided in **Chapter 3: Policy and Legislative Context**.

6. Details of the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Effect Assessment (CEA), are presented in **Section 23.2.6.3** of this chapter and **Chapter 6: EIA Methodology**.

7. This assessment has been informed by impacts assessed in climate change and impacts assessed in this chapter informs the following linked ES chapters:

- **Chapter 14 Water Resources and Flood Risk**
- **Chapter 15 Land Use**
- **Chapter 19 Traffic and Transport**.

8. Inter-relationships with these chapters is further described in **Section 23.9**.

9. Additional information to support the climate change chapter includes the GHG assessment methodology undertaken for the Onshore Project, as presented in **Appendix 23.A**.

10. This ES chapter:

- Presents the existing environmental baseline established from desk studies, and consultation
- Presents the potential environmental effects (a) on climate change arising from the Onshore Project and (b) of climate change on the Onshore Project, based on the information gathered and the analysis and assessments undertaken
- Identifies any assumptions and limitations encountered in compiling the environmental information
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects related to the climate change identified in the EIA process.

23.2 Policy, Legislation and Guidance

11. **Chapter 3: Policy and Legislative Context** describes the wider policy and legislative context for the Onshore Project. The principal policy and legislation used to inform the assessment of potential impacts on climate change for the Onshore Project are outlined in this section.

23.2.1 National Planning Policy Framework (NPPF)

12. The NPPF (Ministry of Housing, Communities and Local Government, updated July 2021) is the primary source of national planning guidance in England. The revised NPPF advises that the planning system should support the transition to a low carbon future. Sections relevant to this aspect of the ES are summarised below in **Table 23.1**.

Table 23.1 Summary of NPPF Policy relevant to Climate Change

Summary	How and where this is considered in the ES
"*Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures"* – **NPPF, paragraph 153**	The mitigation of the impact of climate change to the Onshore Project are considered in a CCRA in this chapter, see **Section 23.5.3**.
"*New development should be planned for in ways that:* *a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and* *b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards."* **- NPPF, paragraph 154**	The vulnerability of the impact of climate change to the Onshore Project and reduction of GHG emissions are considered in a GHG assessment and CCRA in this chapter, see **Section 23.4.2.2.2 and Section 23.5.3**.

23.2.2 Local Policies

13. This section considers local policies and their relevance to the climate change assessment. A summary of the local policies is provided in **Table 23.2**.

Table 23.2 Summary of Local Policies relevant to climate change

Policy Name	Summary	How and where this is considered in the ES
North Devon and Torridge Local Plan 2011-2031 (North Devon Torridge, 2011)		
Policy ST02: Mitigating Climate Change	Development will be expected to make a positive contribution towards the social economic and environmental sustainability of northern Devon and its communities while minimising its environmental footprint by: (a) reducing greenhouse gas emissions by locating development appropriately and achieving high standards of design	GHG mitigation is being incorporated into the design development process for the Onshore Project wherever it is practicable to do so, as detailed in **Section 23.1.1. Chapter 2: Need for the Project** details the Onshore Project in supporting the decarbonisation of the energy sector.

Policy Name	Summary	How and where this is considered in the ES
	(d) promoting opportunities for renewable and low-carbon energy generation whilst conserving and enhancing the natural and built environment	
Policy ST03: Adapting to Climate Change and Strengthening Resilience	Development should be designed and constructed to take account of the impacts of climate change and minimise the risk to and vulnerability of people, land, infrastructure, and property by: (a) locating and designing development to minimise flood risk through: (i) avoiding the development of land for vulnerable uses which is or will be at risk from flooding; and (ii) managing and reducing flood risk for development where that has wider sustainability or regeneration benefits to the community, or where there is no reasonable alternative site (g) ensuring development is resilient to the impacts of climate change through making effective use of renewable resources, passive heating and cooling, natural light and ventilation (h) ensuring risks from potential climate change hazards, including pollutants (of air and land) and minimised to protect and promote healthy and safe environments (i) conserving and enhancing landscapes and networks of habitats, including cross-boundary	A CCRA assessment, which considered the potential impacts of climate change to the Onshore project is provided in **Section 23.5.3**.

Policy Name	Summary	How and where this is considered in the ES
	green infrastructure links, strengthening the resilience of biodiversity to climate change by facilitating migration of wildlife between habitats and improving their connectivity	
Braunton Parish Neighbourhood Plan 2018-2031 (Braunton Parish Council, 2022)		
Policy BE3: Building Resilience to Climate Change	Development proposals, where relevant, respond positively to the challenge posed by climate change. They should aim to meet a high level of sustainable design and construction and be optimised for energy efficiency, targeting zero carbon emissions where viable and feasible, and encouraged to: ii) Have open sustainable drainage systems on site to mitigate the increased surface water run-off in line with latest SuDS guidance iii) Demonstrate a minimum net gain of 10% increase in biodiversity on site	**Chapter 18: Water Resources and Flood Risk** presents the flood risk mitigation systems in place for the Onshore Project. Biodiversity net gain assessment is detailed in **Appendix 20.A Biodiversity Net Gain Assessment**.

23.2.3 National Policy Statement (NPS)

14. The assessment of potential impacts upon climate change has been made with specific reference to the relevant NPS. NPSs are statutory documents which set out the government's policy on specific types of Nationally Significant Infrastructure Projects (NSIPs) and are published in accordance with the Planning Act 2008.

15. Although the Offshore Project is not an NSIP, it is recognised that due to its size of 100 Megawatts (MW) and its location in English waters, certain NPS are considered relevant to the Offshore Project. Therefore, to align with the approach to the assessment of the Offshore Project, certain NPS will also be considered as part of the Onshore Project.

16. Those relevant to climate change are set out within the overarching NPS for Energy (EN-1) and NPS for Renewable Energy Infrastructure (EN-3) which are summarised in **Table 23.3**.

17. It is noted that the NPS for Energy (EN-1) and the NPS for Renewable Energy Infrastructure (EN-3) are in the process of being revised. Draft versions were published for consultation in September 2021 (Department for Business Energy and Industrial Strategy (BEIS), (2021a), and BEIS (2021b) respectively). A review of these draft versions has been undertaken in the context of this ES chapter.

18. **Table 23.3** includes a section for the draft version of NPS (EN-1 and EN-3) in which relevant additional NPS requirements not presented within the current NPS (EN-1 and EN-3) have been included. A reference to the requirement's location within the draft NPS and to where within this ES chapter or wider ES it has been addressed has also been provided.

19. Minor wording changes within the draft version which do not materially influence the NPS (EN-1 and EN-3) requirements have not been reflected in **Table 23.3**.

Table 23.3 Summary of NPS EN-1 and EN-3 provisions relevant to climate change

Summary	How and where this is considered in the ES
Current NPS	
"**An increase in renewable electricity is essential to enable the UK to meet its commitments under the European Union (EU) Renewable Energy Directive**. It will also help improve our energy security by reducing our dependence on imported fossil fuels, decrease greenhouse gas emissions and provide economic opportunities." - **EN-1, Paragraph 3.3.1**1.	The purpose of the Onshore Project is to tackle climate change by replacing existing high carbon energy generation, with a renewable form of energy, which will improve energy security and help the UK meet its net zero commitments.
"New energy infrastructure will typically be a long-term investment and will need to remain operational over many decades, in the face of changing climate. Consequently, applicants must consider the impacts of climate change when planning the location, design, build, operation and, where appropriate, decommissioning of new energy infrastructure. The ES should set out how the proposal will take account of the projected impacts of climate change. While not required by the EIA Directive, this information will be needed by the Infrastructure Planning Commission (IPC)." - **EN-1, Paragraphs 4.8.5**. "The IPC should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections available at the time the ES was prepared to ensure they	The impacts of climate change to the Onshore Project are considered in the CCRA which is provided in **Section 23.5.3**.

Summary	How and where this is considered in the ES
have identified appropriate mitigation or adoption measures. This should cover the estimated lifetime of the new infrastructure." - **EN-1, Paragraphs 4.8.6**	
"Part 2 of EN-1 covers the Government's energy and climate change strategy, including policies for mitigating climate change. Section 4.8 of EN-1 sets out generic considerations that applicants and the IPC should take into account to help ensure that renewable energy infrastructure is resilient to climate change." - **EN-3, Paragraph 2.3.1**. "Offshore [and onshore] windfarms are less likely to be affected by flooding, but applicants should particularly set out how the proposal would be resilient to storms." – **EN-3, Paragraph 2.3.4**. "Section 4.8 of EN-1 advises that the resilience of the project to climate change should be assessed in the ES accompanying an application." - **EN-3, Paragraph 2.3.5**.	The impacts of climate change to the Onshore Project are considered in the CCRA in **Section 23.5.3**.
Draft NPS	
Applicant's Assessment "All proposals for energy infrastructure projects should include a carbon assessment as part of their ES (See Section 4.2). This should include: • **A whole life carbon assessment showing construction, operational and decommissioning carbon impacts** • **An explanation of the steps that have been taken to drive down the climate change impacts at each of those stages** • **Measurements of embodied carbon impact from the construction stage** • **How reduction in energy demand and consumption during operation has been prioritised in comparison with other measures** • **How operational emissions have been reduced as much as possible through the application of best available technology for that type of technology** • **Calculation of operational energy consumption and associated carbon emission** • **Whether and how any residual carbon emissions will be (voluntarily) offset or removed using a recognised framework**	This chapter presents the GHG assessment for the Onshore Project. The components included in the GHG assessment at this stage of the application are outlined in **Section 23.4.2.2.2**.

Summary	How and where this is considered in the ES
• **Where there are residual emissions, the level of emissions and the impact of those on national and international efforts to limit climate change, both alone and where relevant in combination with other developments at a regional or national level, or sector level, if sectoral targets are developed."**	
Secretary of State decision making "The Secretary of State must be satisfied that the applicant has as far as possible assessed the GHG emissions of all stages of the development." - Draft EN-1, Paragraphs 5.3.5 "The Secretary of State should be content that the applicant has taken all reasonable steps to reduce the GHG emissions of the construction and decommissioning stage of the development. The Secretary of State should also give positive weight to projects that embed nature-based or technological processes to mitigate or offset the emissions of construction and decommissioning within the proposed development. However, in light of the vital role energy infrastructure plays in the process of economy wide decarbonisation, the Secretary of State accepts that there are likely to be some residual emissions from construction and decommissioning of energy infrastructure." - **Draft EN-1, Paragraphs 5.3.6** "Operational GHG emissions are a significant adverse impact from some types of energy infrastructure which cannot be totally avoided (even with full deployment of CCS technology). Given the characteristics of these and other technologies, as noted in Part 3 of the NPS, and the range of non-planning policies aimed at decarbonising electricity generation such as UK ETS (see Sections 2.4 and 2.5 above), government has determined that operational GHG emissions are not reasons to prohibit the consenting of energy projects including those which use these technologies or to impose more restrictions on them in the planning policy framework than are set out in the energy NSPs (e.g. the CCRA requirements). Any carbon assessment will include an assessment of the operational GHG emissions, but the policies set out in Part 2, including the UK ETS, apply to these emissions. Operational emissions will be addressed in a managed, economy-wide manner, to ensure consistency with carbon budgets, net zero and our international climate commitments. The Secretary of State does not, therefore need to assess individual applications for planning consent	The GHG assessment has considered emissions during construction, operation and decommissioning of the Onshore Project.

Summary	How and where this is considered in the ES
against operational carbon emissions and their contribution to carbon budgets, net zero and our international climate commitments." - **Draft EN-1, Paragraphs 5.3.7**	
Mitigation "A carbon assessment should be used to drive down GHG emissions at every stage of the proposed development and ensure that emissions are minimised as far possible for the type of technology, taking into account the overall objectives of ensuring our supply of energy always remains secure, reliable and affordable, as we transition to net zero." - **Draft EN-1, Paragraphs 5.3.8** "Applicants should look for opportunities within the proposed development to embed nature-based or technological solutions to mitigate or offset the emissions of construction and decommissioning." - **Draft EN-1, Paragraphs 5.3.9** "To be taken into account in Secretary of State decision making, steps taken to minimise and offset emissions should be set out in a GHG Reduction Strategy, secured under the development consent order." - **Draft EN-1, Paragraphs 5.3.10**	GHG mitigation has been considered as part of the design of the Onshore Project, further details are provided in **Section 23.1.1**.

23.2.4 International Agreements

23.2.4.1 United Nations Framework Convention on Climate Change (UNFCCC)

20. The UNFCCC is an international environmental treaty addressing climate change which entered into force on 21st March 1994. Its main objective is *'to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system'.* In its early years it facilitated intergovernmental climate change negotiations and now provides technical expertise. Its supreme decision-making body, the Conference of the Parties (COP) meets annually to discuss and assess progress in addressing climate change.

21. The first agreement was the Kyoto Protocol, which was signed in 1997 and entered into force in 2005 and committed industrialised countries to limit and reduce GHG emissions in accordance with individual targets to reduce the rate and extent of global warming. It applies to seven GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3) which was incorporated into the

second Kyoto Protocol compliance period in 2012. The Kyoto Protocol recognises that the economic development of a country is an important determinant in the country's ability to combat, and adapt to, climate change. Therefore, developed countries have an obligation to reduce their current emissions particularly due to their historic responsibility for the current concentrations of atmospheric GHGs.

22. Subsequently, the meetings of COP have resulted in several important and binding agreements, including the Copenhagen Accord (2009), the Doha Amendment (2012), the Paris Agreement (2015) and the Glasgow Climate Pact (2022).

23. The Copenhagen Accord raised climate change policy to the highest political level and expressed a clear political intent to constrain carbon and respond to climate change in the short and long term. It introduced the potential commitment to limiting global average temperature increase to no more than 2°C above pre-industrial levels.

24. The Doha Amendment to the Kyoto Protocol in 2012 included a commitment by parties to reduce GHG emissions by at least 18% below 1990 levels in the eight-year period from 2013 to 2020. The UK Climate Change Act 2008 has an interim 34% reduction target for 2020, which would allow the UK to meet and exceed its Kyoto agreement target.

25. The United Nations Climate Change Conference in Paris in 2015 (known as 'COP21') led to the following key areas of agreement (the Paris Agreement):

- Limit global temperatures increases to below 2^{o}C, while pursing efforts to limit the increase to 1.5^{o}C above the pre-industrial average temperature
- Parties to aim to reach a global peak of GHG emissions as soon as possible alongside making commitments to prepare, communicate and maintain a Nationally Determined Contribution
- Contribute to the mitigation of GHG emissions and support sustainable development whilst enhancing adaptive capacity, strengthening resilience, and reducing vulnerability to climate change
- Commitment to transparent reporting of information on mitigation, adaptation and support which undergoes international review
- In 2023 and every five years thereafter, a global stocktake will assess collective progress toward meeting the purpose of the Agreement.

26. At the 22nd Climate Change COP in November 2016, the UK ratified the Paris Agreement to enable the UK to *"help to accelerate global action on climate change and deliver on our commitments to create a safer, more prosperous future"* (BEIS,

2016). At the COP24 meeting, held in Katowice, Poland in December 2018, a set of rules for the Paris climate process were agreed.

27. COP26 was held in 2021 in Glasgow. The four specific objectives that were aimed to be achieved for COP26 were (UK Parliament, 2022):

- Securing global net zero by mid-century and keep 1.5°C within reach by:
  - Accelerating the phase-out of coal
  - Curtailing deforestation
  - Speeding up the switch to electric vehicles
  - Encouraging investment in renewables
  - Adapt to protect communities and natural habitats;
  - Mobilise at least $100 billion in climate finance per year, and
  - Work together to deliver, finalising the Paris Rulebook and accelerate action to tackle the climate crisis.

28. For the first time, nations have been called upon to 'phase down' unabated coal power and inefficient subsidies for fossil fuels (UNFCCC, 2022). The main headlines of COP26 were:

- Signing of the Glasgow Climate Pact, which is a series of decisions and resolutions that build on the Paris Agreement setting out what needs to be done to tackle climate change but does not specify what each country must do and is not legally binding
- Agreeing the Paris Rulebook, which gives the guidelines on how the Paris Agreement is delivered. Agreements in the finalised Rulebook include enhanced transparency framework for the reporting of emissions, common timeframes for emissions reduction targets and mechanism and standards for international carbon markets (UK Parliament, 2022).

29. The most recent COP, was held in Egypt in November 2022 (COP27). Conclusions of COP27 include the decision to establish a fund for responding to loss and damage and the inability to reach agreement on the phasing out of coal and other fossil fuels or setting emission peaking periods. COP28 will be held in Dubai, United Arab Emirates towards the end of 2023.

23.2.5 Other Legislation, Policy, and Guidance

30. In addition to the NPPF, local policies, NPS and international agreements, there are a number of pieces of other legislation, policy and guidance applicable to the assessment of GHGs which are discussed in the following sections. Further detail is provided in **Chapter 3: Policy and Legislative Context**.

23.2.5.1 Legislative Background

31. The requirement to consider climate and GHG emission has resulted from the 2014 amendment to the EIA Directive (2014/52/EU), the Town and Country Planning (EIA) Regulations 2017 and the Infrastructure Planning (EIA) Regulations 2017 ('EIA Regulations'). This includes the requirement to include an estimate of expected emissions and the impact of a project on climate, including consideration of the nature and magnitude of the release of GHGs during constructions and operation.

23.2.5.1.1 The Climate Change Act 2008

32. The Climate Change Act 2008 provides a framework for the UK to meet its long-term goals of reducing GHG emissions to 'net-zero' (i.e. at least a 100% reduction) by 2050 ("climate mitigation"). This target was introduced by the Climate Change Act 2008 (2050 Target Amendment) Order 2019, which amended the previous 2050 GHG target of an 80% reduction compared to 1990 levels. The Climate Change Act 2008 also established a system of carbon budgets were introduced in order to drive progress towards this target.

33. The Climate Change Act 2008 implements the UK's commitments to reducing GHG emission based on its obligations under the UNFCCC. The UK's targets for reducing GHG emissions are in line with the global goals established by the UNFCCC as detailed in **Section 23.2.4.1**.

34. On 12 December 2015, the UK along with 195 other parties signed the 'Paris Agreement', a legally binding international treaty on climate change committing all parties to the goal of limiting global warming to well below 2 degrees Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. The Agreement requires all parties to submit plans to reduce their emission (along with other climate action) every 5-years, starting in 2020. The carbon budgets are set by the Committee for Climate Change and provide a legally binding five-year limit for GHG emissions in the UK. The six carbon budgets that have been placed into legislation and will run up to 2037 and are identified in **Table 23.4**.

Table 23.4 The Six UK Carbon Budgets

Budget	Carbon Budget Level (Mt CO_2e)	Reduction Below 1990 Level	
		UK Targets	Achieved by the UK
1st Carbon Budget (2008 to 2012)	3,018	25%	30%
2nd Carbon Budget (2013 to 2017)	2,782	31%	38%
3rd Carbon Budget (2018 to 2022)	2,544	37% by 2020	44%
4th Carbon Budget (2023 to 2027)	1,950	51% by 2025	-
5th Carbon Budget (2028 to 2032)	1,725	68% by 2030	-

Budget	Carbon Budget Level (Mt CO_2e)	Reduction Below 1990 Level UK Targets	Achieved by the UK
6th Carbon Budget (2033 to 2037)	965	78% by 2035	-

35. The UK outperformed its emission reduction targets set by the first, second and third Carbon Budgets, achieving a 30%, 38% and 44% reduction compared to 1990 levels in 2011, 2015 and 2019 respectively.

36. In December 2020, the UK set a Sixth Carbon Budget, recommending a reduction in UK GHG emissions of 78% by 2035 relative to a 1990 baseline (a 63% reduction from 2019) (CCC, 2020). This target which has already been enshrined in UK law has been set in line with the UK commitments in relation to the Paris Agreement and with the goal of achieving a target of reaching net zero GHG emissions by 2050.

37. As part of this budget, the role of the offshore wind sector and the construction industry are both the focus of action to contribute to meeting these targets. **Chapter 2: Need for the Project**, provides further details on the need for the Onshore Project in contributing to meeting these targets.

38. The Climate Change Committee (CCC) publishes annual progress reports on the UK's progress against GHG emissions reduction targets to 2050. The most recent published report 'Progress in reducing emissions: 2022 Report to Parliament' (CCC, 2022). This target which has already been enshrined in UK law has been set in line with the UK commitments in relation to the Paris Agreement and with the goal of achieving net zero GHG emissions by 2050.

39. As part of this Budget, the role of the offshore wind sector and the construction industry are both the focus of action to contribute to meeting these targets.

40. The Climate Change Act 2008 requires the UK Government to produce a Climate Change Risk Assessment every five years. The Climate Change Risk Assessment assesses current and future risks to, and opportunities for, the UK from climate change (to inform "*climate adaptation*" actions). In response to the Climate Change Risk Assessment, the Climate Change Act 2008 also requires Government to produce a National Adaptation Programme (NAP) (both discussed further in the following sections).

23.2.5.1.2 Climate Change Risk Assessment 2022

41. In compliance with the requirement in the Climate Change Act 2008 to undertake Climate Change Risk Assessment every five years, the UK Government produced its latest Climate Change Risk Assessment in 2022 (Department for Environment, Food & Rural Affairs (Defra), 2022), the third assessment to be produced for the UK

following the first and second releases in 2012 and 2017 respectively. The report concluded that among the most urgent risks for the UK are risks to people and the economy from climate-related failure of the power systems and multiple risk to the UK from climate change impacts overseas. It identifies suggestions for reducing these risks, including the consideration of climate change in developing new infrastructure.

23.2.5.1.3 National Adaptation Programme

42. The second NAP (Defra, 2018) sets the actions that the UK government will undertake to adapt to the challenges of climate change in the UK as identified in the Climate Change Risk Assessment. The NAP forms part of the five-yearly cycle of requirements detailed in the Climate Change Act 2008. The NAP details the range of climate risk which may affect the natural environment, infrastructure, communities, buildings, and services. Key actions are set out in the NAP which aim to address the identified high-risk areas, which include:

- flooding and coastal risks to communities, businesses and infrastructure
- risks to health, well-being and productivity from high temperatures
- risks in shortages in the public water supply for agriculture, energy generation and industry
- risks to natural capital
- risks to domestic and international food production and trade.

23.2.6 Guidance

43. In demonstrating adherence to industry good practice, this chapter has been compiled in accordance with the following relevant standards and guidance:

- Institute of Environmental Management and Assessment (IEMA) Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022)
- IEMA Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation (2020)
- The British Standards Institution (BSI), PAS 2080:2023 Carbon management in buildings and infrastructure (2023).

23.2.6.1 IEMA Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022)

44. IEMA recently published a guidance document 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (2022) which has been used in this ES chapter for the evaluation and significance of GHG emissions from the Onshore Project. This

guidance is a revision of the first iteration of the guidance released in 2017 (IEMA, 2017).

45. The 2022 IEMA guidance presents guidelines for undertaking GHG assessments to distinguish different levels of significance. The guidance does not update the IEMA's position that all emissions contribute to climate change, however it now provides relative significance descriptions to assist assessments specifically in the EIA context (detailed further in **Section 23.3.2**).

23.2.6.2 IEMA Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation (2020)

46. IEMA has also published a framework for the consideration of climate change resilience and adaptation in the EIA process. The guidance advises that the future climate at the development have been built into a design of a development (IEMA, 2020).

23.2.6.3 BSI PAS 2080:2023 Carbon management in building and infrastructure (2023)

47. BSI published standard, PAS 2080:2023, outlines a carbon management process applicable for buildings and infrastructure to support organizations reduce their GHG emission and meet climate change commitments (British Standards institution, 2023). The PAS2080:2023 standard categorises emissions according to the following stages:

- Before Use Stage (A0 – A5)
- A0 Preliminary studies, consultants
- A1 Raw material supply
- A2 Transport
- A3 Manufacture
- A4 Transport to works site
- A5 Construction installation process
- Use Stage (B1 – B9)
- B1 Use
- B2 Maintenance
- B3 Repair
- B4 Replacement
- B5 Refurbishment
- B6 Operational energy use
- B7 Operational water use
- B8 Other operational processes

- B9 Users utilisation of infrastructure
- End of life stage (C1-C4)
- C1 – Deconstruction
- C2 – Transport
- C3 – Waste processing for recovery
- C4 – Disposal
- Supplementary information beyond the infrastructure lifecycle (D).

23.3 Assessment Methodology

23.3.1 Study Area

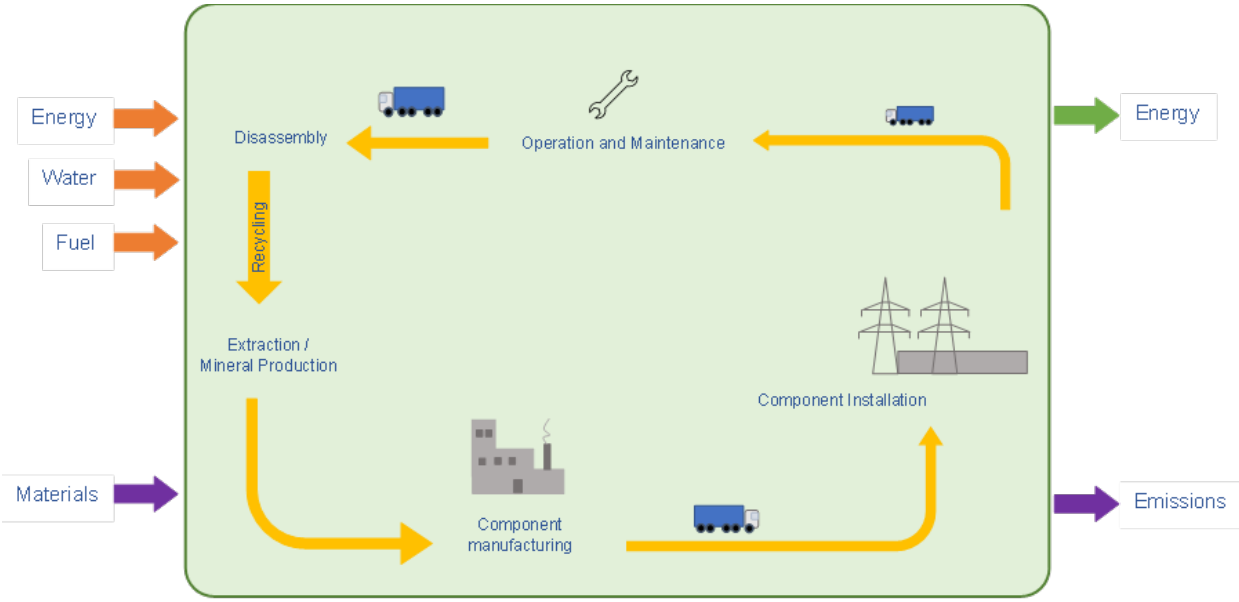
48. Details of the location of the Onshore Project and the onshore components are set out within **Chapter 5: Project Description**.

23.3.1.1 GHG Assessment

49. The scope of the assessment quantified GHG emissions from all the Onshore Project components (i.e., Landfall to MLWS, Onshore Export Cable Corridor, compounds, access routes and Onshore Substation), including material extraction and manufacturing, transportation and installation, operational and maintenance, and end of life and decommissioning.

50. A schematic diagram of the boundary of the Onshore Project in the context of the GHG assessment is provided in **Figure 23.1**. Emissions with the pale green box are included within the assessment. The study area is defined both geographically, as the asset project area, and by the processes that create the onshore components of the Project (i.e., construction), and its operation and maintenance, and decommissioning.

Figure 23.1 System boundary for the Onshore Project's GHG assessment



23.3.1.2 CCRA

51. The study area for the CCRA is defined as the Onshore Development Area, which includes landfall (to MLWS), the onshore cable route and onshore substation.

23.3.2 Approach to Assessment

52. **Chapter 6: EIA Methodology** provides a summary of the general impact assessment methodology applied to the Onshore Project. However, a topic-specific assessment methodology and approach to determining impact significance is provided within IEMA guidance (IEMA, 2022), as set out in the following sections.

53. The climate change assessment comprised two separate assessments: a GHG assessment and a CCRA. The methodologies for both assessments are detailed in this **Section 23.3.3** and **Section 23.3.4**.

54. The GHG assessment was undertaken to predict emissions arising from construction, operational and decommissioning phase activities associated with the Onshore Project, and to determine the GHG effects of the provision of renewable energy to the grid. Although it is acknowledged that the Town and Country Planning Application is being submitted for the Onshore Project only, the GHG assessment accounts for the both the Onshore and Onshore components. The Onshore Project consists of the components which enables the onshore exportation of the Offshore Project generated electricity and transportation into the national grid. Therefore, to determine the emissions saved from the Project as a whole, and therefore the significance of effects, energy production and emissions released from activities

associated with the Onshore Project and Offshore Project are considered together within the GHG assessment.

55. To determine the significance and contextualise the outcomes of the GHG assessment, emissions from a 'do nothing' or 'without Project' scenario are quantified (see **Section 23.4.1**). These scenarios account for the provision of renewable energy from the Project as a whole (i.e. both onshore and offshore infrastructure) and the displaced emissions from the replacement of fossil fuel generation in the UK grid. Therefore, the GHG assessment presented in **Section 23.5** shows the predicted emissions from the Onshore Project only. The significance of effects for the GHG assessment for the Project as a whole is presented in the cumulative section within **Section 23.7**.

56. A CCRA was undertaken to evaluate the resilience and vulnerability of the design and infrastructure of the Onshore Project to the projected effects of climate change during the operational phase. The construction phase is anticipated to be up to 28 months (18 months for cable installation and 16 months for the White Cross Onshore Substation construction) for the Onshore Project, commencing as early as 2025. Effects of climate change, as distinct from weather, are **not** considered to be **significant** during construction and are therefore excluded from consideration in the CCRA.

23.3.3 GHG Assessment Methodology

57. The purpose of this assessment is to consider the impact on climate change as a result of the Onshore Project. The following sections describe the methods used to assess any likely significant effects on climate change and GHG emissions, both offset and created by the Onshore Project.

23.3.3.1 GHG Emission Sources for Offshore Windfarms

58. The construction, operation and maintenance and decommissioning of the onshore components of an offshore wind farm project results in the generation of GHG emissions, both from the standpoint of:

- Embedded carbon and GHGs from the Onshore Project
- Emissions caused by the extraction and refinement of raw materials and their manufacture into the commodities and products that make up the onshore components such as onshore cables, substation, etc
- Carbon and other GHG emissions arising from the combustion of fuels and energy used in constructing, operating and maintaining the Onshore Project components over its lifetime and in decommissioning
- These are associated with road transport vehicles and onshore plant and equipment.

59. The release of emissions from the sources listed above in paragraph 58 are small in comparison to emissions from fossil fuel generation of energy, therefore the emissions saved during the generation of electricity from wind (when compared to fossil fuel sources) outweigh the total emissions released during an construction, operation and maintenance, and decommissioning activities.

60. There are inherent uncertainties associated with carrying out GHG footprint assessments for offshore wind power projects such as embodied emissions from materials can vary depending on the specific manufacturer/supplier and the operational emission from operating plant and equipment can be difficult to predict and may vary over time. However, the approach to determine emissions from individual source groups is well defined and are adopted in this assessment. In addition, the assumptions and limitation of the GHG footprint assessment are detailed in **Section 23.3.9**.

61. A report published by the University of Edinburgh in 2015 (Thomson & Harrison, 2015) examined the lifecycle costs and GHG emissions associated with offshore wind energy projects, comparing data gleaned from the analysis of some 18 studies carried out over the period between 2009 and 2013 (Thomson & Harrison, 2015).

This report provides a useful context for the GHG assessment, and benchmark figures which were used to verify the outcomes of the assessment. It is acknowledged that advancements and efficiencies have been gained in the offshore wind sector since this study was undertaken, however the figures and details within this study are assessed to be applicable and provide useful context for the GHG assessment.

62. **Table 23.5** provides a summary of the percentage of total GHG emissions associated with the different phases of an offshore windfarm development as provided within the report (Thomson & Harrison, 2015).

Table 23.5 Summary of Offshore Windfarm GHG Emissions (Thomson & Harrison, 2015)

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

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

23.3.3.2 GHG Intensity of Offshore Wind Energy

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

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

66. It is noted that these studies were undertaken in 2012 and 2015, and there have been significant advances in the technology, infrastructure and components used

for offshore windfarms. Therefore, other available published sources were reviewed to evaluate average GHG intensity of energy produced offshore windfarms, and these are presented in **Table 23.6**. As shown, the range of energy intensities for offshore windfarms across the range of studies is 7.8g to 25.5g CO_2e/kWh.

Table 23.6 Review of Average Carbon Emissions per kWh

Windfarm sizes	Energy intensity (gCO_2e/kWh)	Source
15x 5 MW	32	Chen et al. (2011), referenced in Bhandari *et al.* (2020)
N/A	6	IEA World Energy Outlook (2012), referenced in Siemens Gamesa (no date) and Orsted (2021)
100X 2.5 MW	13.7	Arvesen & Hertwich (2012), referenced in Bhandari *et al.* (2020)
80x 4 MW	10.9*	Bonou *et al.* (2016), referenced in Bhandari *et al.* (2020)
100x6 MW	7.8*	Bonou et al. (2016), referenced in Bhandari *et al.* (2020)
28x 3.6 MW	25.5*	Yang et al. (2018), referenced in Bhandari *et al.* (2020)
*offshore windfarm studies published from 2016 onwards		

67. To place these metrics into context, comparable values for electricity generation by gas and coal are approximately 372g and 1,002g CO_2e/kWh respectively (BEIS, 2021d). These values also do not take account of emissions associated within construction materials (e.g. concrete), and transportation of fuels required for the power stations.

68. Although robust and fit for the purposes of an EIA, this assessment should not be taken to be a comprehensive, detailed Life Cycle Analysis (LCA) of the Project. This is because it is not possible to fully define the supply chain for the Onshore Project at this stage, and some information will be refined as the design progresses. Therefore, assumptions and simplifications to the methodology were made in certain areas and a precautionary approach was adopted for the assessment to allow for this. These assumptions and simplifications are referred to in **Section 23.1.1** and the worst-case scenario is set out in **Table 23.13**.

23.3.3.3 GHG Assessment Approach

69. In this assessment the term 'GHG' or 'carbon' encompasses CO_2 and the six other gases as referenced in the Kyoto Protocol (CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3). The

results in the assessment are expressed in carbon dioxide equivalent (CO_2e), which recognises that different gases have notably different global warming potentials (GWPs).

70. GHG emissions arising from the construction and operational phase of the Onshore Project were predicted within a defined 'project boundary', in accordance with the GHG Protocol (World Resource Institute and World Business Council on Sustainable Development, 2015), explained in further detail in **Section 23.3.1.**

71. As noted in **Section 23.2.6.3**, the approach to determining the significance for the GHG assessment considered the Onshore and Offshore Projects together, to enable a comparison between a 'do nothing' and 'with Project' scenario and account for the effect of providing renewable energy to the grid. Therefore, **Section 23.5** presents the results from the quantification of emissions from the Onshore Project only, but the significance of effects is presented in the cumulative assessment (**Section 23.7)**.

72. To assist with the determination of the significance of the Onshore Project in relation to GHG emissions (as discussed in **Section 23.3.3.5**), three parameters were calculated to contextualise the GHGs emitted during the lifecycle of the Onshore Project in relation to the benefits of providing renewable energy. These include:

- The emissions saved as a result of the Onshore Project when compared to fossil generated sources
- The GHG intensity of the energy produced by the Onshore Project, which takes into account the amount of energy generated by the Onshore Project over its lifetime in relation to its total GHG emissions
- GHG 'payback' period, which is the time it would take for electricity generated by fossil fuels to be displaced.

23.3.3.4 Emission Calculations

73. GHG emission sources arising from activities associated with the Onshore Project were categorised into three main source groups, as detailed in **Table 23.7.**

Table 23.7 Emission Source Groups Considered in the Assessment

Source Name	Phase	Definition	Project Sources	PAS 2080 Stages
Embodied carbon in materials	Construction (and spare parts in operation	Embodied emissions within materials	Embodied emissions were quantified, where possible, for the main construction	Materials in construction – A1, A3

Source Name	Phase	Definition	Project Sources	PAS 2080 Stages
	and maintenance)	comprise GHGs released throughout the supply chain, and includes the extraction of materials from the ground, transport, manufacturing, assembly and its end-of-life profile.	materials to be used for the components of the Onshore Project. Where specific information on the quantity of materials in cables could not be supplied, assumptions were made based on the cable diameter and the quantities of cable materials used on other offshore windfarm projects.	Spare parts in operation and maintenance – B2
Road vehicles	Construction and operation and maintenance	Emissions associated with the movement of road vehicles.	Emissions associated with the movement of heavy goods vehicles (HGVs) and staff travel during construction and operation were calculated.	Road vehicles during construction – A2 Road vehicles in operation and maintenance – B2
Plant and equipment	Construction	Emissions are released from fuel combustion by non-road mobile machinery (NRMM).	Emissions from the use of NRMM during construction of the Onshore Project were calculated. This included the landfall, trenchless crossing, cable installation and onshore substation works.	Plant and equipment during construction – A5

74. Details on the activities that will take place during the construction, operation and maintenance and decommissioning phases are not fully known at this stage, therefore some assumptions have been made in order to quantify GHG emissions, as detailed in **Section 23.3.9**. These assumptions are based on indicative data from similar projects provided by the project's design team or professional judgement. Emissions from decommissioning were derived from previous studies

(Thomson & Harrison, 2015), which qualified them to be approximately 1.2% of the carbon footprint.

75. The approach to quantifying GHG emissions for each of the source groups detailed in **Table 23.7** are provided in **Appendix 23.A.** The total operational life of the Onshore Project in anticipated to be 50 years. However, the operational life of the Offshore Project is 25 years, and therefore for the purposes of this assessment, the temporal scope for the Project is assumed to be 25 years.

23.3.3.4.1 Embodied Carbon in Materials

76. The emissions of 'cradle to (factory) gate', a term which includes the extraction, manufacture and production of materials to the point at which they leave the factory gate of the final processing location, were calculated for the Onshore Project. GHG emissions were derived from quantities or volumes of known materials (at this stage of the application) that will be used in construction, including the following infrastructure:

- The key onshore components comprise:
- Onshore export cables installed underground from the landfall (to MLWS) to the onshore substation
- Joint bays (concrete)
- Onshore substation (concrete and steel).

77. The approach to determining embodied emission from materials used for the project is detailed in **Appendix 23.A.**

23.3.3.4.2 Road Vehicles

78. Road vehicle movements associated with the construction and operation, and maintenance phases of the Onshore Project will result in the release of GHG emissions. GHG emissions were calculated from the total kilometres travelled by HGVs and staff transport to and from the onshore construction sites, and also during the operation and maintenance phase. Full details of the methodology are provided in **Appendix 23.A.**

23.3.3.4.3 Plant and Equipment

79. Fuel consumption associated with the operation of NRMM for the Onshore Project were calculated based on the estimated use of each item of plant and equipment, with representative engine sizes were provided by the design team. Indicative construction plant and equipment types for construction activities at landfall (to MLWS), along the onshore cable corridor and at the onshore substation were provided by the design team for the Onshore Project, and some assumptions were made regarding the number and specification of each type of plant based on other

projects of a similar nature. The approach to determining emissions construction plant and equipment is detailed in **Appendix 23.A**.

23.3.3.4.4 Carbon Storage and Sequestration

80. As stated in **Chapter 15: Land Use**, soils hold a large reserve of organic carbon, which may be lost because of land use change and changes as a result of human activity (including climate change), resulting in the release of GHG emissions. The ability for natural environment to take up and store significant amount of carbon in soils, sediment and vegetation can support in tackling climate crisis (Natural England, 2021).

81. The loss of natural environment from activities such as the construction and operation of infrastructure can have negative impacts in the direct loss of carbon stored. The Onshore Project area covers a range of habitats, as detailed in **Chapter 16: Onshore Ecology and Ornithology**, including, sparsely vegetated land, woodland and forest, cropland, grassland, heathland and shrub and intertidal sediment.

82. Different habitats have varying ability for carbon storage and sequestration per area (Natural England, 2021). Peatland (blanket bogs, raised bog and fens) areas hold the largest carbon stores of all habitats (Natural England, 2021). **Chapter 15: Land Use** outlines the different types of soils in the Onshore Development Area, which identifies that a portion of the northern extent of the onshore cable corridor crosses wet grassland with peaty surface near the Taw Estuary. However, these areas are not blanket bogs, raised bog and fens which have the highest concentration of carbon storage.

83. The impact of the Onshore Project on the natural environment ability to store and sequester carbon in support of mitigating climate change is considered in this assessment. There will be temporary loss of land, soil degradation and loss of soil to erosion, during the construction phase due to the footprint of the onshore cable corridor and temporary construction compounds. However, Onshore Project will reinstate most of the land to its pre-construction condition. The onshore cables will be buried to an indicative depth of 1.9m and the natural environment reinstated after the construction phase the Onshore Project. Permanent land take will occur because of Onshore Substation, associated flood attenuation and landscaping during the operational phase of the Onshore Project. The footprint of these areas is yet to be defined and will be subject to further design, however for the purpose of this Onshore Project the maximum parameters for the substation, flood attenuation and landscaping will be utilised.

84. Most of the affected areas during the construction phase will regain the ability to store and sequester carbon in the operational phase of the Onshore Project, supporting as a natural climate change solution. The Onshore Project's Outline Landscape & Ecological Management Plan outlines landscaping and environmental mitigation including reinstating of habitats, tree planting and habitat creation to mitigate the loss of habitat due to construction of permanent above ground infrastructure. Therefore, it is considered that any permanent change to the land use affecting the natural environment ability to store and sequester carbon will be negligible and a quantitative assessment of the GHG emission from land use change has not been undertaken in this assessment.

23.3.3.5 GHG Assessment: Impact Assessment Criteria

85. This assessment was undertaken in accordance with the general methodology presented within **Chapter 6: EIA Methodology**; however, a topic-specific assessment methodology and approach to determining significance of effects is provided within IEMA guidance (2022), and is detailed in the Sections below.

23.3.3.5.1 Sensitivity

86. The receptor for the GHG assessment is the global atmosphere. As such, it is affected by all global sources of GHGs, and is therefore considered to be of 'high' sensitivity to additional emissions.

23.3.3.5.2 Effect Significance

87. Guidance on the assessment of GHG emissions was first released by IEMA in 2017 (IEMA, 2017), which stated that "…in the absence of any significance criteria or defined threshold, it might be considered that all GHG emissions are significant…". However, the recently updated IEMA guidance (IEMA, 2022) recognises "when evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project's emissions should therefore be based on its net impact over its lifetime, which may be positive, negative or **negligible**".

88. Significance can be evaluated in a number of ways depending on the context of the assessment, i.e. sector-based, locally, nationally, policy goals or against performance standards. The IEMA guidance recommends that significance criteria align with Paris Agreement, the UK's Carbon Budgets up to 2037 and net zero commitments, and states "*the crux of significance is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it*

contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050' (IEMA, 2022).

89. The updated IEMA guidance provides significance descriptions to assist assessments, specifically in the EIA context. Section VI of the updated IEMA guidance (IEMA, 2022) describes five distinct levels of significance which are not solely based on whether project emits GHG emissions alone, but how the project makes a relative contribution towards achieving a science-based 1.5°C aligned transition towards net zero. These are presented below in **Table 23.8**.

90. Significance in this assessment was determined by comparing a baseline 'do nothing' scenario, described in **Section 23.4.1**, with a 'with development' scenario whereby the project is implemented. This accounts for emissions released from activities associated with the project, during construction, operation and maintenance and decommissioning, and the emissions saved by the provision of renewable energy to the grid in comparison to fossil fuel generation. As previously noted, the significance was determined for the Project as a whole (incorporating the Onshore and Offshore components), and is presented in the cumulative assessment **Section 23.7**.

Table 23.8 Significance of Effect Criteria (IEMA, 2022)

Source	Summary
Major adverse	The project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards net zero.
Moderate adverse	The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's trajectory towards net zero.
Minor adverse	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's trajectory towards net zero.

Source	Summary
Negligible	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.
Beneficial	The project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

91. For the purposes of the EIA, major and moderate impacts are deemed to be significant.

23.3.4 CCRA Methodology

92. An assessment of the resilience and vulnerability of the design and infrastructure to the projected effects of climate change was undertaken over the operational lifespan of the Onshore Project. This assessment identifies the likelihood of climate hazards occurring within the study area, and the consequences of the impact will be highlighted. An assessment of the resilience and vulnerability of the design and infrastructure of Offshore Project, which are being applied for separately to the Marine Management Organisation (MMO) under a separate Section 36 Consent, have been assessed in that assessment (MMO Reference: MLA/2023/00113).

23.3.4.1 Approach

93. The methodology for the assessment is informed by IEMA guidance, Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation (IEMA, 2020). The methodology varies from the general EIA approach presented in **Chapter 6: EIA Methodology**.

94. A four-step methodology was adopted for the CCRA which is in line with best practice for assessments of climate resilience. The initial stages of the assessment aim to identify the climate variables to which the Onshore Project could be vulnerable to during its lifetime. If deemed necessary, a more detailed risk assessment would then be undertaken following the identified of influencing climate variables, to assess the level of risk associated with the hazards posed by the predicted changes in climate variables.

95. The approach carried out for each step of the CCRA is provided below.

23.3.4.1.1 Step 1: Identifying Receptors, Climate Variables and Hazards

96. The first step of the CCRA was to identify the receptors which may potentially be impacted by climate variables and associated hazards. The identified receptors includes those known to have already experienced a climate-related event (i.e. flooding), and unknown receptors which are yet to be impacted according to available data and literature.

23.3.4.1.2 Step 2: Climate Vulnerability Assessment

97. The second step consisted of a qualitative assessment, (informed by professional judgement and supporting literature, of the Onshore Project to changes in the climate variables. Vulnerability is considered to be a function of:

- The sensitivity of the Onshore Project and any associated offshore infrastructure to climate change, and
- The exposure (both spatially and temporally) of the Onshore Project and its associated offshore infrastructure to climate variables.

98. Both the sensitivity and the exposure of the Onshore Project and its associated offshore infrastructure to climate variables were considered in the vulnerability assessment. This approach attributes either a high, moderate or low sensitivity/exposure categorisation to each vulnerability.

99. Overall vulnerability is determined by considering the interrelationships between the exposure and the receptor sensitivity, as set out in **Table 23.9**.

Table 23.9 CCRA: Sensitivity/Exposure Matrix for Determining Vulnerability Rating

Sensitivity	**Exposure**		
	Low	**Medium**	**High**
Low	Low vulnerability	Low vulnerability	Low vulnerability
Moderate	Low vulnerability	Medium vulnerability	Medium vulnerability
High	Low vulnerability	Medium vulnerability	High vulnerability

100. Climate change projection data was obtained from the UKCP18 database, which was used to identify the climate variables within the study area for three representative concentration pathways (RCP) (RCP 2.6, RCP 6.0 and RCP 8.5). Data was obtained for the 10^{th}, 50^{th} and 90^{th} percentiles for each RCP, in accordance with the requirements of the NPS.

101. Further information related to the vulnerability of the Onshore Project to the projected effects of climate change were obtained from the other topic chapters

including **Chapter 14: Water Resources and Flood Risk, Chapter 15: Land Use** and **Chapter 24: Accidents and Disasters**.

102. For those vulnerabilities categorised as medium or high, the risk of climate change to the design and infrastructure of the Onshore Project, and consequently to its operation was then determined through Steps 3 to 4 of the assessment process.

23.3.4.1.3 Step 3: Risk Assessment

103. For those vulnerabilities categorised as medium or high, climate-related hazards were identified through professional judgement. The risks of the Onshore Project and its associated infrastructure to the occurrence of a hazard event were qualitatively identified through a hazard likelihood and consequence matrix, as detailed in **Table 23.10**.

Table 23.10 Likelihood/Consequence Matrix for Determining Risk Rating

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	Medium	High	Extreme
Moderate	Low	Low	Medium	High	Extreme
Unlikely	Low	Low	Medium	Medium	High
Very unlikely	Low	Low	Low	Medium	Medium

23.3.4.1.4 Step 4: Mitigation

104. For climate risks to the Onshore Project identified as 'medium' or higher, further mitigation measures were identified by professional judgement. With the proposed mitigation measures taken into consideration, a residual risk rating was assessed.

105. For each hazard, a resilience rating is identified as one of the following:

- High – strong degree of climate resilience. Remedial action or adaptation may be required but it is not a priority
- Moderate – a moderate degree of climate resilience. Remedial actions or adaptation
- Low – a low level of climate resilience. Remedial action or adaptation is required as a priority.

23.3.4.2 CCRA: Impact Assessment Criteria

106. The significance of the CCRA was determined through consideration of the residual risk (identified in Step 3) and resilience rating (identified in Step 4), applied to each hazard identified. **Table 23.11** presents the matrix used to identify the overall

significance of CCRA. This risk and resilience matrix is obtained from best practice for risk assessment procedures in relation to the consideration of climate resilience.

Table 23.11 CCRA Significance Criteria

Risk Rating	Resilience Rating		
	High	**Moderate**	**Low**
Extreme	Significant	Significant	Significant
High	Not significant	Significant	Significant
Medium	Not significant	Not significant	Significant
Low	Not significant	Not significant	Not significant

23.3.5 CEA Methodology

23.3.5.1 In-combination with the Offshore Project

107. It has already been noted that this chapter provides a GHG assessment for the Onshore Project only, which does not take into consideration GHG emissions associated with the Offshore Project (i.e. Wind Turbine Generators (WTGs), Offshore Export Cables or Offshore Substation Platform (OSP) construction materials, vessel movements, etc.). The Offshore Project (i.e. seaward of MLWS) is being applied for under a separate Section 36 Consent Application to the MMO. As detailed in **Section 23.3.4**, an assessment of the resilience and vulnerability of the design and infrastructure of the Onshore Project has been assessed in the Section 36 Consent Application assessment to the MMO (MMO Reference: MLA/2023/00113), as required.

108. It is expected that the Offshore Project would be the most intensive in GHG terms due to the embodied GHGs within the offshore infrastructure. In order to provide a complete GHG assessment for the Project, emissions associated with the Offshore Project have also been considered and are presented in **Section 23.3.8**, where relevant project information is available at this stage of the Application.

109. The methodology for including the Offshore Project within the GHG assessment is the same as the approach detailed in **Section 23.3.2**. The additional sources considered within the Offshore Project assessment are detailed in **Table 23.12,** and an overview of the methodology is provided in the following sections and **Appendix 23.A**.

Table 23.12 Additional Onshore Emission Source Groups Considered as part of the in-combination CEA for the Project

Source Name	Phase	Definition	Project Source
Embodied carbon in materials	Construction (and spare parts in operation and maintenance)	Embodied emissions within materials comprise GHGs released throughout the supply chain, and includes the extraction of materials from the ground, transport, manufacturing, assembly, and its end-of-life profile.	Embodied emissions were quantified for the main construction materials to be used for the Offshore Project. The components that were considered included the main infrastructure associated with the Offshore Project, such as WTGs (including tower, nacelle, rotor, blades), foundations, scour protection, cables (inter-array and export cables) and the OSP.
Marine vessels	Construction and operation and maintenance	GHG emissions are released in exhaust gases from the combustion of fossil fuels on marine vessels.	Emissions associated with the movement of marine vessels for the Offshore Project were calculated. Vessels associated with installation of foundations, WTGs and cables, as well as supply and support, accommodation and commissioning vessels were also quantified.

23.3.5.1.1 Offshore Project: Emission Calculations

23.3.5.1.1.1 CEA with Other Projects

110. The global atmosphere is the receptor for the GHG assessment, and emissions released from the Project as a whole have the potential to contribute to climate change, and therefore the effects are global and cumulative in nature. This is taken into account in defining the receptor (i.e., the global atmosphere) as **high** sensitivity. Likewise, any emissions saved as a result of implementation of the Onshore Project will have contribution towards global climate mitigation.

111. The IEMA guidance (IEMA, 2022) states that effects of the GHG emissions from specific cumulative projects should therefore not be individually assessed, as there is no basis for selecting which projects to assess cumulatively over any other. The GHG assessment is therefore considered to be inherently cumulative, and no additional consideration of cumulative effects is required.

112. The CCRA focuses on the potential for climate change to impact the infrastructure and assets associated with the Onshore Project. Due to the onshore location, the

impact with other developments in close proximity to the Onshore Project from the identified climate hazards are considered in **Section 23.7**.

23.3.5.1.1.2 Embodied Emission in Materials

113. Emissions of 'cradle to (factory) gate' were calculated for the Offshore Project. GHG emission were derived from quantities or volumes of known materials that will be used in construction, including the following infrastructure:

- The key offshore components of the Offshore Project comprise:
    - WTGS (i.e., tower, nacelle, blades) and mooring system
    - OSP and (sub-)structure
    - Scour protection (i.e., rock)
    - Offshore export and inter-array cables.

114. The approach to determining embodied emission from materials used for the Offshore Project is detailed in **Appendix 23.A**.

23.3.5.1.1.3 Marine Vessels

115. Marine vessels will be used to bring materials and components to the windfarm site, install infrastructure (WTGs and mooring structures, OSP, substructure and cables), provide crew accommodation and support during construction, commissioning and for operation and maintenance activities. The current working assumptions for offshore vessel logistics during have been supplied by the Applicant's design team.

116. Full details of the approach undertaken to determine GHG emission from marine vessels is detailed in **Appendix 23.A**.

23.3.6 Worst-Case Scenario

117. In accordance with the assessment approach to the 'Rochdale Envelope' set out in **Chapter 6: EIA Methodology**, the impact assessment for climate change has been undertaken based on a realistic worst-case scenario of predicted impacts. The Project Design Envelope for the Onshore Project is detailed in **Chapter 5: Project Description**.

118. Using the project design envelope approach means that receptor-specific potential effects draw on the options from within the wider envelope that represent the most realistic worst-case-scenario. It is also worth noting that under this approach the combination of project options constituting the realistic worst-case scenario may differ from one receptor to another and from one effect to another.

119. The realistic worst-case scenario (having the most impact) for each individual impact is derived from the Project Design Envelope to ensure that all other design scenarios will have less or the same impact.

120. **Table 23.13** presents the realistic worst-case scenario components considered for the assessment of climate change.

Table 23.13 Definition of realistic worst-case scenario details relevant to the assessment of impacts in relation to climate change

Impact	Realistic worst-case scenario	Notes
Construction		
GHG emission during construction	**Indicative construction programme:** • 2025 to 2027 (onshore and offshore infrastructure) – • Landfall Horizontal Directional Drilling (HDD): 99 days • Golf Course HDD: 365 days • River Taw crossing HDD: 365 days • Onshore Export Cable Corridor: 432 days	Maximum duration of construction

	Infrastructure:
	• Landfall (to MLWS):
	  ○ HDD
	  ○ Generators: 328 kW powerpack and 70 kVa generator
	  ○ Located inside 50m x 50m HDD drill compound
	  ○ Number of transition joint bays (TJB): 1
	  ○ TJB area: 20m (l) x 8m (w) x 2m (h)
	• Installation of an onshore cable route:
	  ○ Technology: HVAC
	  ○ cable length: 6km
	  ○ Construction corridor width: 30m
	  ○ Number of jointing bays: 30
	  ○ Number of link box locations: 30
	  ○ Main construction compound: 2,500m^2 (50m x 50m)
	  ○ Secondary construction compounds: 1,200m^2 (three compounds each 20m x 30m)
	• Onshore substation:
		Maximum amount of construction materials required

Impact	Realistic worst-case scenario	Notes
	○ Construction compound: 5,000m^2.	
Operation and maintenance		
GHG emission during operations	• Operational life = 25 years • Total maximum capacity of up to 100MW	n/a
CCRA assessment	• Consideration of high emissions scenario (RCP8.5) for climate change projection data in **Section 23.4.2.2**.	n/a
Decommissioning		
GHG emission during decommissioning	The decommissioning policy for the Onshore Project infrastructure is not yet defined however it is anticipated that some infrastructure would be removed, reused or recycled; other infrastructure could be left in situ. The following infrastructure is likely be removed, reused, or recycled where practicable: • Onshore substation • Export Cables. The following infrastructure is likely to be decommissioned and could be left in situ depending on available information at the time of decommissioning: • Transition joint bays • Cable joint bays • Cable ducting. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time. Decommissioning arrangements will be detailed in a Decommissioning Plan, which will be drawn up and agreed with relevant consenting body/stakeholder prior to decommissioning. For the purposes of the worst-case scenario, it is anticipated that the impacts will be comparable to those identified for the construction phase. The contribution from decommissioning was scaled based on the total GHG contribution, as detailed in **Section 23.3.2**.	n/a

23.3.7 Summary of Mitigation

121. This section outlines the mitigation relevant to the climate change assessment, which has been incorporated into the design of the Onshore Project. Further information is detailed in **Chapter 5: Project Description**.

23.3.7.1 Embedded Mitigation

122. The IEMA GHG guidance (IEMA, 2022) notes the importance of incorporating embedded mitigation in minimising GHG emission from a development or project. The IEMA GHG Management Hierarchy sets out a structure to eliminate, reduce, substitute, and compensate IEMA, 2022).

123. In response to these principles, the need for the Onshore Project in relation to achieving net zero targets by 2050 for the UK and decarbonisation of the energy sector is well established and set out within **Chapter 2: Need for the Project**. Furthermore, project level GHG mitigation is being incorporated into the design development process for the Onshore Project wherever it is practicable to do so. Taking into account that the primary purpose of the Project is to generate low carbon renewable energy, the process of reducing GHG emissions from the Project itself is guided by the hierarchy summarised in **Table 23.14**.

Table 23.14 IEMA GHG Guidance (IEMA, 2022) – Mitigation Hierarchy Specific to the Project

	Hierarchy	Principle	Project Response
	Do not build (Eliminate)	Evaluate the basic need for the proposed project and explore alternative approaches to achieve the desired outcome(s).	The purpose and rationale for the Project is to tackle climate change by replacing existing high carbon energy generation. So, in this case of 'do not build' could have the effect of perpetuating and exacerbating climate change.
	Build less (Reduce)	Realise potential for re-using and/or refurbishing existing assets to reduce the extent of new construction required.	Offshore windfarms and their onshore components by their design are efficient in their use of materials. Minimising the use of steel is a key design feature of the approach to project design and procurement.
	Build clever (Substitute)	Apply low carbon solutions (including technologies, materials and products) to minimise resource consumption	The Project will use the latest, most efficient and effective turbines, offshore substation

	Hierarchy	Principle	Project Response
		and embodied carbon during the construction, operation, user's use of the project, and at end-of-life.	platforms, and onshore substation.
	Construction efficiently (compensate)	Use techniques (e.g. during construction and operation) that reduce resource consumption and associated GHG emissions over the life cycle of the project.	Offshore windfarm and its onshore components construction is by its nature expensive and relies on the use of highly specialised, efficient vessels and equipment with a dedicated and highly trained workforce.

124. In response to these principles, the need for the Project in relation to achieving net zero targets for the UK and decarbonisation of the energy sector is well established and set out within **Chapter 2: Need for the Project**.

23.3.8 Baseline Data Sources

23.3.8.1 Desktop Study

125. The sources of information presented in **Table 23.15** were consulted to inform the climate change assessment.

Table 23.15 Data sources used to inform the climate change assessment

Source	Data set	Summary
Department for Energy Security and Net Zero (DESNZ), 2023	Conversion factors for reporting of GHG emissions	Emission factors for use in the GHG assessment, for fuel consumption.
Dolan and Heath, 2012	Life Cycle GHG Emissions of Utility Scale Wind Power	Benchmarking of results from the GHG assessment.
Jones & Hammond, 2019	Inventory of Carbon and Energy (ICE)	Emission factors for embodied carbon in materials used in construction.
Thompson & Harrison, 2015	Life Cycle Costs and Carbon Emissions of Offshore Wind Power	Benchmarking of results from the GHG assessment and likely contribution of decommissioning activities to the over Project footprint.
Met Office, 2018	UK Climate Projections (UKCP) Database	Climate change projection data. IEMA (2020) guidance recommends the use of these in climate change resilience assessments, however

Source	Data set	Summary
		they are most applicable to coastal and onshore areas.

23.3.8.2 Site Specific Survey

126. No site-specific surveys were undertaken for this Chapter.

23.3.9 Data Limitations

127. A number of assumptions were made in the GHG assessment, as set out in **Table 23.16**. Further details of the methodology adopted to quantify GHG emissions from the Onshore Project are presented in **Appendix 23.A**.

Table 23.16 Assumptions and Limitations for the climate change assessment

ID	Assumptions and Limitations	Discussions
1	Quantities for all materials to be used during construction were not available at the time of the assessment	Quantities of the main and most GHG intensive materials were included in the assessment, and where information specific to the Onshore Project was not available, indicative quantities from other offshore windfarm projects have been utilised. Furthermore, precautionary assumptions were adopted for quantities of known materials (i.e., using the maximum quantity).
2	The recycled content of construction materials is unknown	As an example, it has been assumed that all steel used on the Onshore Project is virgin steel to provide a conservative assessment. It is likely that materials that will be used in construction such as steel will have a high recycled content, and thus a lower embodied carbon content than has been assumed in this assessment.
3	Lack of emission factors for future year activities, such as fuel consumption and material extraction.	The most recent and available emissions factors were used in the assessment to provide a precautionary assessment.
4	The specific nature and composition of some materials, such as the type of concrete or steel to be used, was unknown which may affect the embodied carbon within a material.	If there was variation across different compositions of the same material, the 'General' option within the ICE database was chosen, if available, or the median value if not.
5	Operation and maintenance emissions	Many sectors are anticipated to decarbonise over the next 25 years, and during operation and maintenance, it is likely that the emissions intensity of producing materials and the movement of road transport/plant and equipment will be less than the present day. Therefore, emissions associated with the operation and maintenance phase of the

ID	Assumptions and Limitations	Discussions
		Onshore Project are likely to be a significant overestimation.
6	Where there are multiple options for possible Project parameters, the worst-case was selected in terms of material quantities	This approach provides a conservative assessment as there may be unrealistic combinations of Project parameters which were used in determining the worst-case scenario.
7	Offshore components of the Project	The GHG assessment presented in **Section 23.5** includes the Onshore Project only (i.e. the Project that is being applied for through the Town and Country Planning Act). As it is expected that the Offshore Project would be the most intensive in GHG terms, to ensure a comprehensive and robust GHG assessment for the Project, GHG emissions associated with the Offshore Project have been quantified and assessed as part of an 'in-combination' CEA, as detailed in Section 150 and presented in **Section 23.6.2**.
8	Climate change projections	A key assumption of the climate change projection data from the UKCP18 is that the model is strongly dependent on future global GHG emissions. The RCP scenarios cover a recent set of assumptions based upon future population dynamics, economic development and account for international targets on reducing GHG emissions. Each RCP scenario has a different climate outcome, given they are based upon different set of assumptions. The three RCP scenarios presented within this chapter (RCP 2.6, RCP 6.0 and RCP 8.5) are considered the most likely to occur over the lifespan of the Project. However, the UKCP18 guidance cautions that the scientific community cannot reliably place probabilities on which scenario of GHG emissions is most likely.

23.3.10 Scope

128. Upon consideration of the baseline environment, the project description outlined in **Chapter 5: Project Description**, and Scoping Opinion (Case reference: EIA/2022/00002). Potential impacts upon climate change have been "Scoped in" are shown in **Table 23.17**. Text from the Scoping Report has been quoted verbatim and this includes some references to onshore effect. No impacts have been "Scoped out" for climate change.

23.3.11 Consultation

129. Consultation has been a key part of the development of the Onshore Project. Consultation regarding climate change has been conducted throughout the EIA. An

overview of the project consultation process is presented within **Chapter 7: Consultation**.

Table 23.17 Summary of impacts scoped in relating to climate change

Potential Impact	Justification
GHG Assessment – assessment of the impact of the Onshore Project (during construction, operation and maintenance and decommissioning) on the global atmosphere receptor	• Quantification of the Onshore Project's GHG emissions • Quantification of GHG Savings or 'Carbon' as a result of the Project as a whole.
CCRA – assessment of the direct impacts of climate change during the operation and maintenance phase of the Onshore Project	• Assessment of the vulnerability of the Onshore Project to climate change.

130. A summary of the key issues raised during consultation specific to climate change is outlined below in **Table 23.18**, together with how these issues have been considered in the production of this ES.

Table 23.18 Consultation responses

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
MMO	MMO Scoping Opinion (2022)	**Climate Impacts** The ES should include a description and assessment of the likely significant effects the Proposed Development has on climate (for example having regard to the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change. Where relevant, the ES should describe and assess the adaptive capacity that has been incorporated into the design of the Proposed Development.	This chapter presents the climate change assessment including the GHG assessment and CCRA for the Onshore Project (i.e. landward of MLWS).
		Natural Environment The ES should identify how the development affects the ability of the natural environment (including habitats, species, and natural processes) to adapt to climate change, including its ability to provide adaptation for	The effects of the Onshore Project on the natural environment in relation is considered in **Chapter 16: Onshore Ecology and Ornithology**.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		people. The ES should set out the measures that will be adopted to address impacts.	
		Carbon sequestration The ES should also identify how the development impacts the natural environment's ability to store and sequester greenhouse gases, in relation to climate change mitigation and the natural environment's contribution to achieving net zero by 2050.	The effects of the Onshore Project on carbon sequestration is discussed in **Section 23.3.3.4.4**.
		Vulnerability of infrastructure to climate change during construction and decommissioning. The Applicant states that as the construction phase is anticipated to occur within the next 2-4 years, the impact of effects arising from climate change on construction activities to the project is considered to be unlikely and is scoped out of the assessment. The MMO considers that there is potential for climate change impacts to have likely significant effects on the construction phase, for example in respect of increased flood risk that may require mitigation in the planning of construction compounds and temporary drainage strategies. The operational lifetime of the windfarm is expected to be a minimum of 25 years and on that basis would expect the decommissioning to occur in 2050. The decommissioning phase may be vulnerable to the impacts of climate change given the timescales involved.	Effects of climate change, as distinct from weather, are not considered to be significant during construction. Climate conditions are considered to be averages of weather parameters over a 20 and 30 year horizon. Therefore, although the effects of climate change are likely to be experienced in present day conditions, it is considered unlikely that climate conditions will change significantly within a 2-4 year window. Therefore, the construction phase has been excluded from consideration in the CCRA as detailed in **Section 23.5.3**. Climate change has been assessed in the relevant topic chapters of the ES, for example, in **Chapter 14: Water Resource and Flood Risk**.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		Potential cumulative effects The Scoping Report states that a cumulative assessment of GHG emissions with other projects is proposed to be scoped out of the ES as the proposed development will be responsible for GHG emissions associated with its activities only. This approach is in line with IEMA guidance 'Assessing Greenhouse gas Emissions and Evaluating Their significance' (IEMA, 2017). The MMO considers the ES should include a description of the likely significant cumulative effects of the proposed development with other projects scoping into the assessment, including in relation to GHG emissions where significant effects are likely to occur.	Standard practice for GHG assessments is to only consider the development itself, as the 'receptor' for the assessment is the global atmosphere. IEMA guidance (2022) states that *"effects of GHG emissions from specific cumulative projects... in general should not be individually assessed, as there is no basis for selecting any particular (or more than one) cumulative project that has emissions for assessment over any other."* Therefore, a cumulative assessment of GHG emissions has not been carried out, in accordance with the approach detailed in IEMA guidance.
		Assessment methodology The MMO notes that a GHG assessment will be prepared to support the assessment of effects during construction, operation and decommissioning of the Proposed Development. It is unclear from the Scoping Report as to which components or activities will be specifically included within the GHG assessment, e.g. whether this will road traffic emissions, materials, energy used, any supporting activities or infrastructure, and which gases would be considered, given that there a range of gases that are considered to be GHGs. This should be explained in the ES and	The GHG assessment presented in this chapter has included embodied carbon in materials and vessels during construction, operation and maintenance and decommissioning. The sources considered in the assessment are detailed in **Section 23.3.2** and in **Appendix 23.A**. To ensure a robust and comprehensive GHG assessment, the CEA has included in-combination GHG emissions associated with the Onshore Project. This is detailed further in **Section 23.3.2** and **Section 23.3.8**.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		justification should be provided for any exclusions.	

23.4 Existing Environment

131. This section describes the existing environment in relation to climate change associated with the White Cross study area.

23.4.1 GHG Assessment - Baseline 'do nothing' scenario

132. The Town and Country Planning (EIA Regulations 2017 require that "an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge" is included within the ES (EIA Regulations, Schedule 4, Paragraph 3). From the point of assessment, over the course of the development and operational lifetime of the Project (operational lifetime of the Offshore Project is anticipated to be 25 years), long-term trends mean that the condition of the baseline environment is expected to evolve. This section provides a qualitative description of the evolution of the baseline environment, on the assumption that the Onshore Project is not constructed, using available information and scientific knowledge of climate change and GHG emissions.

23.4.1.1 Energy Produced by the Offshore Project

133. The approximate amount of energy produced by the Offshore Project, both annually and over the anticipated 25 year lifetime of the was quantified from the approach advocated by RenewableUK (2022). Under this approach, the installed capacity (assumed to be 100 MW) was multiplied by the hours in the year (8,760) and by the appropriate average load or capacity factor for the Project. For new build floating offshore wind farms, BEIS advises that the load factor is 57.1% for those delivered between 2025 and 2029 (BEIS, 2021c).

134. The anticipated energy produced by the Project is:

- Approximately: 500,196 MWh/year
- Approximately: 12,504,900 MWh over the 25 year lifetime of the Offshore Project.

23.4.1.2 GHG Emissions from the 'do nothing' scenario

135. In the 'do nothing' scenario, where the Project is not constructed, it has been assumed that the energy would otherwise be produced using gas instead, as this is the most common form of new plant in terms of fossil fuel combustion. An alternative approach would be to use the future electricity emission factors of the UK grid, for which projections are available from BEIS (2021d). However, these projections will account for renewable energy projects such as White Cross becoming operational and decarbonising the UK electricity grid. Therefore, the use of the future projection of the UK grid is not considered to be reasonable approach when determining a 'do nothing' or without Project baseline scenario.

136. The GHG emissions resulting from the same levels of anticipated electricity production from the Project by gas combustion in the 'do nothing' scenario if the Project is not built is presented in **Table 23.19**. This has been quantified by multiplying the anticipated energy generated by the Offshore Project by the estimated CO_2 emissions from gas supplied electricity (372 t CO_2/GWh) (BEIS, 2021d). It is noted that the electricity supplied by gas emission factor is in units of CO_2, whereas emissions quantified from the Project are in units of CO_2e. However CO_2 is likely to be the main GHG released from the generation of electricity from gas, and the factor would be higher if other GHGs to be included, therefore presenting a conservative scenario.

Table 23.19 Do Nothing Scenario Baseline GHG Emissions

Timeframe	Anticipated energy produced by Project	GHG emissions from electricity generated from gas (tonnes CO2)
Per year	500 GWh/year	186,198
Duration of the Offshore Project (25 years)	12,505 GWh/25 years of Project	4,654,959

23.4.2 CCRA

23.4.2.1 Existing Climate

137. Annual average temperatures over the most recent decade (2009 to 2018) have been on average 0.3°C warmer than the 1981-2010 average, and 0.9°C warmer than the 1961-1990 average. All the top ten warmest years for the UK, in the series from 1884, have occurred since 2002. The most recent decade (2009-2018) has been on average 1% wetter than 1981-2010 and 5% wetter than 1961-1990 for the UK overall (Met Office, 2022a).

138. The Onshore Project area is located in north-west Devon. Existing climate data for the period 1991 to 2020 has been obtained from the Chivenor (Devon) onshore meteorological recording station, which is the closest station to the Onshore Project, located approximately 2.9km east of the onshore cable corridor and approximately 2.6km north-east of the onshore substation. The Met Office UK Climate Averages (2022b) are only publicly available for onshore meteorological sites. Climate data for Chivenor, England and the UK are provided in **Table 23.20**.

Table 23.20 Existing local, regional and national climate for the 1991 to 2020 period (Met Office, 2022)

Climate Variable	Units	Annual Average			
		Chivenor	England South	England	UK
Maximum temperature (average over 12 months)	ºC	14.69	14.36	13.82	12.79
Minimum temperature (average over 12 months)	ºC	7.97	6.42	6.12	5.53
Days of air frost	Days	20.77	41.89	45.14	53.36
Rainfall	mm	1,669	1,594	1,538	1,403
Days of rainfall ≥ 1mm	Days	934	808	870	1,163

139. **Table 23.20** displays the influence of the coastal setting of the Onshore Project. Annual average maximum and minimum temperatures are both higher than the south of England, England and UK averages, and there are fewer days of air frost. As the Onshore Project is located on the west coast of England, it experiences a wetter climate than the regional and national average, however the UK has more days on average with rainfall greater than 1mm. Mean wind speed (at 10 m) is greater than the England South and England average, but slightly lower than the UK average.

23.4.2.2 Projected Climate Change

140. Climate change projections were used to identify the future change to climate variables within the study area. It is anticipated that the Onshore Project will have an operational lifespan of at least 25 years. As such, climate forecasts and impacts to the baseline conditions arising from the operation of the Onshore Project have been based on a 30-year lifespan (assuming a construction period of approximately five years).

141. The UKCP database uses RCP which align with the emissions scenarios used in the IPCC's 5th Assessment report (AR5) (IPCC, 2014). The likelihood of individual RCPs occurring is dependent on current and future GHG emissions and the

implementation of mitigation strategies. Data were obtained for RCP scenarios, which are defined in **Table 23.21**. For each of these RCPs, where relevant and available, three probabilities were considered, 10% (unlikely), 50% (central estimate of projections) and 90% (projections unlikely to be less than).

Table 23.21 Summary of the RCP emission scenarios

RCP	Scenario Description	Increase in global mean surface temperature (°C) by 2081-2100	Parameters
2.6	Stringent mitigation scenario	1.6 (0.9 – 2.3)	GHG emissions stay at present levels until 2020, and then start to decline
4.5	Intermediate scenario 1	2.4 (1.7 – 3.2)	GHG emissions peak around 2040 and then start to decline
6.0	Intermediate scenario 2	2.8 (2.0 – 3.7)	Decline of global GHG emissions begins around 2080
8.5	Very high GHG emission scenario	4.3 (3.2 – 5.4)	Increasing global GHG emissions throughout the 21^{st} century

142. Future climate projections are modelled projections and are strongly dependent on future global GHG emissions, and uncertainties associated with these are detailed in **Table 23.16**. Where possible, climate changes over the 25 year operational phase of the Onshore Project are detailed. In some cases, projections to the year 2100 (or later) are presented, as this is the only data available for some climate variables.

23.4.2.2.1 Meteorological Projections – Temperature, Precipitation and Wind Projections (UKCP)

143. By the end of this century, all areas in the UK are projected to be warmer, with more warming expected in the summer than in the winter (Met Office, 2022a). During the summer, probabilistic projections show a north/south contrast, with greater increases in maximum summer temperatures over the southern UK compared to northern Scotland (Met Office, 2019a). Under a high emissions scenario, by 2070 the frequency of hot spells (i.e. maximum daytime temperatures exceeding 30°C for two or more consecutive days) increases. Currently, these are largely confined to south-east UK (Met Office, 2022a). Under a RCP8.5 scenario, where global GHG emissions continue to increase throughout the 21^{st} century, it is projected that annual temperatures by 2070 could increase by between 0.7°C and 4.2°C in the winter and 0.9°C and 5.4°C in the summer, compared to a 1981 to 2000 mean (Lowe et al., 2018).

144. For precipitation, the probabilistic projections provide low (10% probability) to high (90% probability) changes across the UK. These project that by 2070, under RCP8.5, UK average changes are -1% to +35% for winter and -47% to +2% for summer, in comparison to the 1981 to 2000 mean. Negative and positive values indicate reduced and increased precipitation respectively. This means that precipitation levels are expected to continue to increase in the winter but decrease during the summer (Lowe et al., 2018). Future climate change is expected to bring about a change in the seasonality of extremes, such as increases in heavy hourly rainfall intensity in the autumn, and significant increases in hourly precipitation extremes (Met Office, 2022a).

145. Global projections over the UK indicate that the second half of the 21st century will experience an increase in near surface wind speed during the winter season. This is also accompanied by an increase in the frequency of winter storms over the UK (Met Office, 2021).

146. Changes in temperature and rainfall are modelled with a high level of confidence, other climate parameters considered in this assessment such as wind speed have more uncertainty.

147. There has been some debate in recent years as to whether storm events will increase in frequency and/or intensity in the UK due to climate change, which could cause operational disruption and damage to coastal infrastructure and flooding. However, the most recent climate projections for the UK suggest there is still uncertainty regarding the relationship between storminess and future climate change (Met Office, 2018a). Although the future of storm surges remains uncertain, with no evidence to suggest any variation in frequency or intensity, a change in the severity of future storm surges cannot be ruled out (Palmer et al., 2018).

148. Data from the RCP emission scenarios presented within **Table 23.21** were obtained from the 262500, 137500 25km land-based grid cell.

149. Changes in climate variables were compared to a baseline period of 1981 to 2000 and are displayed in **Table 23.22** and **Table 23.23** for the RCP2.6 (stringent mitigation) and RCP8.5 (very high emission) scenarios respectively (Met Office, 2018a).

Table 23.22 Temperature and precipitation projection data under RCP2.6 within the study area in 2050s (2040-2059, from a 1981-2000 baseline), at the 10th, 50th and 90th percentile

Season	Variable	Projected change at 10th percentile	50th percentile	90th percentile
Annual	Mean Temperature (°C)	0.45	1.14	1.91
	Mean Precipitation (%)	-5.15	0.32	5.70
Winter	Mean Temperature (°C)	-0.12	0.91	1.93
	Mean Precipitation (%)	-3.45	7.49	19.97
Summer	Mean Temperature (°C)	0.60	1.60	2.66
	Mean Precipitation (%)	-34.39	-15.09	4.51

Table 23.23 Temperature and precipitation projection data under RCP8.5 within the study area in 2050s (2040-2059, from a 1981-2000 baseline), at the 10th, 50th and 90th percentile

Season	Variable	Projected change at 10th percentile	50th percentile	90th percentile
Annual	Mean Temperature (°C)	0.76	1.64	2.52
	Mean Precipitation (%)	-6.09	0.36	6.91
Winter	Mean Temperature (°C)	0.36	1.44	2.55
	Mean Precipitation (%)	-3.18	10.24	25.51
Summer	Mean Temperature (°C)	0.78	2.09	3.45
	Mean Precipitation (%)	-41.34	-15.98	9.12

150. The in **Table 23.22** and **Table 23.23** highlight that under both RCP2.6 and RCP8.5, annual, summer and winter temperatures are likely to increase. Under RCP8.5, as shown in **Table 23.22,** the probabilistic annual mean temperature projections in the Onshore Project area in the 2050s are predicted to increase by 0.76°C and 2.52°C (10th and 90th percentile respectively) (Met Office, 2018a). The data also shows that temperature increases are likely to be higher in winter compared to summer.

151. There is predicted to be more of a seasonal effect to precipitation patterns. Annual precipitation values are predicted to be relatively similar in the 2050's in both scenarios. However, there is predicted to be more rainfall during the winter months, and less rainfall in the summer months.

152. **Appendix 14.C**, the Flood Risk Assessment for the Onshore Project also refers to peak rainfall intensity allowances, derived from Environment Agency guidance (Environment Agency, 2022). The Onshore Project is located within the North Devon Management Catchment, where, assuming 50 years of operation, the required peak

rainfall intensity allowance is an increase of 30% for the 1 in 100 (1%) year event applying the central allowance. In addition, sensitivity testing should be undertaken for the 1 in 100 year plus 50% allowance for climate change.

23.4.2.2.2 Marine Projection – Sea-Level rise

153. Global sea levels have risen over the 20th century and are projected to continue rising over the coming centuries. Under all emission pathway scenarios, sea levels around the UK will continue to rise to 2100 (Met Office, 2022a), and sea levels are projected to continue rising beyond 2100 even with large reductions in GHG emissions over the 21st century (Met Office, 2019b).

154. Sea level anomalies data from the coastal grid square covering where the export cable corridor reaches landfall (51.17°, -4.25°) were obtained for average sea level rise from 2007 to 2100 for three RCP scenarios and plot graphs of these data are displayed in **Figure 23.2**. Under RCP2.6, average sea level rise of the Onshore Project coastal area by 2050 is predicted to be between 0.16m and 0.32m (5th and 95th percentile respectively). Under RCP8.5, this projection increases to a sea level rise of between 0.20m and 0.39m by 2050 (5th and 95th percentile respectively) (Met Office, 2018b).

155. **Appendix 14.C**, the Flood Risk Assessment for the Onshore Project also refers to extreme sea levels, including the effects of storm surges and astronomical tides. This data are obtained from the Environment Agency Sea Level Rise Allowances (taken from the Environment Agency guidance on flood risk assessments: climate change allowances).

156. The sea level allowance, utilising the Upper End scenario in the Environment Agency guidance, based on a 50 year lifetime (i.e. up to 2075) is:

- 2023 – 2035 = 12 years * 7mm per year = 84mm
- 2036 – 2065 = 342mm
- 2066 – 2075 = 9 years * 16mm = 144mm
- Total = 570mm (0.57m).

23.5 GHG Assessment

157. The potential effects during construction, operation and decommissioning of the Onshore Project have been assessed. This section presents the GHG emissions associated with these phases of the Onshore Project. The carbon benefits of the Project (including the Offshore Project and Onshore Project) such as the amount of GHG emission saved (or offset), and the significance in EIA terms is presented in **Section 23.5.4**.

23.5.1 Quantification of the Onshore Project's GHG Emissions

158. The results of the GHG assessment for the Onshore Project are shown in **Table 23.24**. These values include emission associated with the Onshore Project lifetime, including construction, an operational lifetime of 25 years and decommissioning.

Figure 23.2 Time mean sea level anomaly (m) for years 2007 up to and including 2100, for Project coastal grid square (51.17o, -4.25o), using baseline 1981-2000, and scenarios RCP2.6 (blue), RCP4.5 (green), RCP8.0 (red), showing the 5th to 95th percentiles (Met Office, 2018b)

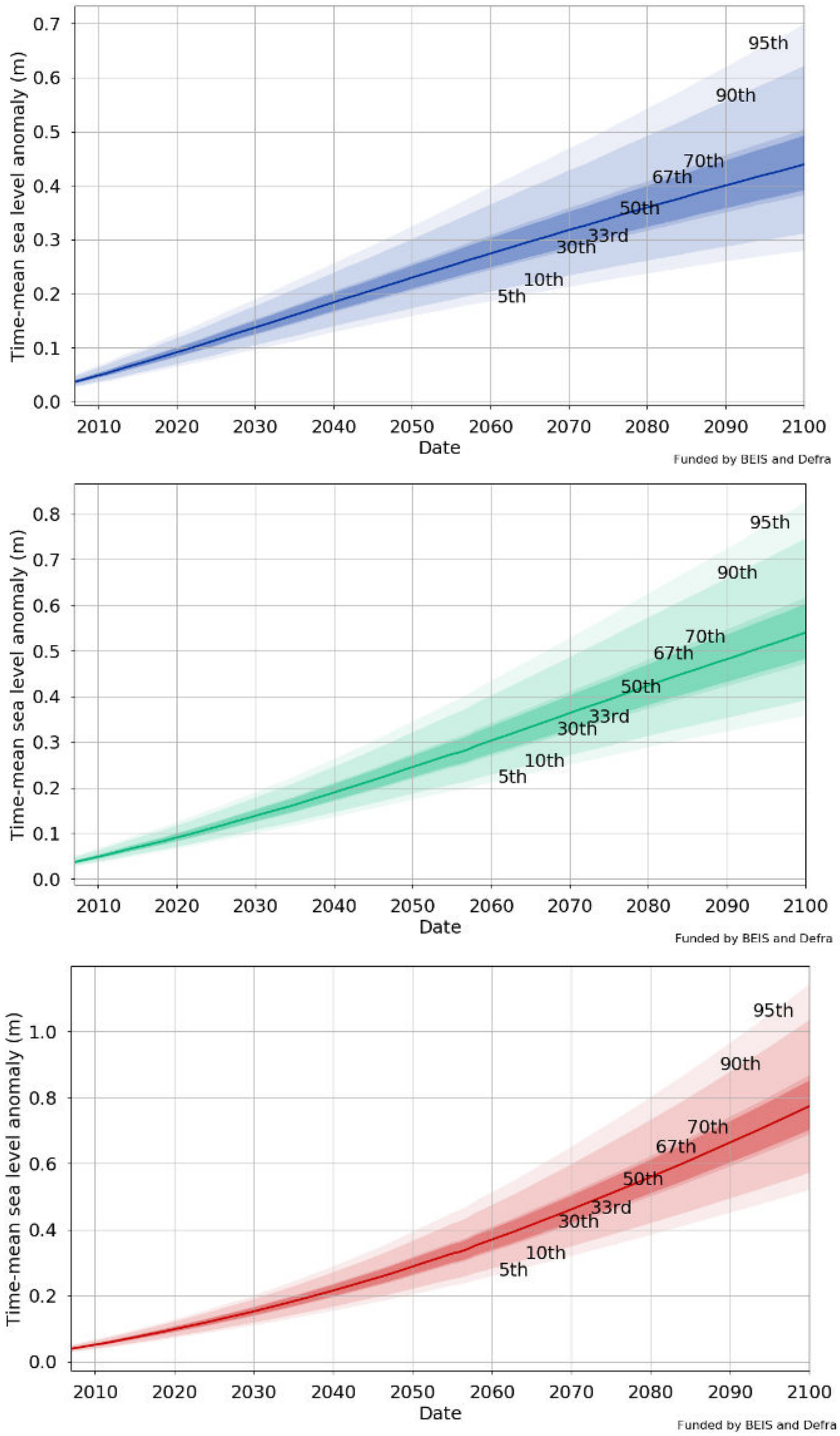


Table 23.24 GHG emissions for the Onshore Project (including a 25 year Operational Phase)

Phase	Source	GHG Emissions (tonnes CO_2e)*	% of Phase GHG Footprint**	Total GHG Emissions per Phase (tonnes CO_2e)*	% of Overall GHG Footprint**
Construction	Embodied Carbon Onshore	123,011	98.4%	124,965	98.8%
	Construction Plant and Equipment	1,720	1.4%		
	Construction Road Vehicles	214	0.2%		
Operation and maintenance	Road Vehicles	4	96.3%	5	0.004%
	Spare Parts	0.2	3.7%		
Decommissioning	1.2% of total***	1,518	1.2%	1,519	1.2%
Total*		126,488			

***Figure presented in this table have been rounded to the nearest whole number
**Percentages rounded to one decimal place
***refer to **Table 23.5**

159. The results in **Table 23.24** show that the construction phase of the Onshore Project is anticipated to have the highest emission contribution. Embodied carbon in construction materials is expected to be the largest source of emission to the overall Onshore Project footprint, contributing approximately 99% of the overall construction phase emissions. As stated in **Appendix 23.A** and **Section 23.1.1**, there is likely to be an overestimation of embodied carbon in materials, particularly as it is likely that recycled materials will be used for some of the Onshore Project.

160. Emissions during operation and maintenance associated with the Onshore Project are predicted to be 4.2 tonnes CO_2e per year, with the majority of GHGs released from the movement of road vehicles.

23.5.2 Significance of effect

161. As noted in **Section 23.3.3.5.2**, the significance of the Project in relation to GHG emissions is derived from comparisons to the 'Do Nothing' baseline scenarios and how the Project would align with the UK's net zero aspirations. The significance of effect for the GHG assessment therefore considered the Onshore and Offshore Project, and is provided in **Section 23.5.4**.

23.5.2.1 Further Mitigation

162. No further mitigation is recommended for the Onshore Project.

23.5.3 In-combination with the Offshore Project

163. This section presents the GHG assessment for the Project, which takes into consideration GHG emissions associated with the Onshore Project and Offshore Project (i.e., WTG, Offshore substation platform and Offshore export and inter-array cables construction materials, vessel movements etc.).

164. The Offshore Project has the greatest impact in terms of the release of GHG emissions, mainly because of embodied carbon in offshore infrastructure materials as shown in **Table 23.25**.

23.5.3.1 Quantification of the Project's GHG Emissions

165. To determine the GHG savings or carbon offset from the Project, and the GHG intensity of electricity production, the Project (Onshore Project and Offshore Project) GHG emissions are required.

166. As stated in **Section 23.1**, the Offshore Project (i.e. seaward of the MWHS) is being applied under a separate application for consent under Section 36 of the Electricity Act 1989, and for Marine Licences under the Marine and Coastal Access Act 2009.

167. The Offshore Project GHG assessment presented in the Offshore Project ES (MMO Reference: MLA/2023/00113) includes GHG emissions calculated for the Onshore Project based on the information available at the time of writing the Offshore Project ES. However, the Onshore Project data has been refined for this ES. In addition, the DESNZ (Formerly BEIS) emission factors, as detailed in **Table 23.15**, have been updated since the submission of the Offshore Project application. Therefore, there are difference between the GHG emissions presented in the Offshore Project and Onshore Project applications; however, it is not anticipated that these differences will change the significance of effects concluded in this chapter.

168. **Table 23.25** presents the Projects GHG emissions, these values include emission associated with the Project lifetime, including construction, an operational lifetime of 25 years and decommissioning.

169. The results in **Table 23.25** show that the construction phase of the Project is anticipated to have the highest emission contribution. Embodied carbon in construction materials is expected to be the largest source of emission to the overall offshore Project footprint, contributing approximately 76% of overall construction phase emissions.

170. As stated in **Appendix 23.A** and **Section 23.1.1**, there is likely to be an overestimation of embodied carbon in materials. In addition, the emission factors used in the assessment such as for manufacturing of materials and the movement of marine vessels are representative of present-day conditions. It is highly likely that the emission factors would reduce as sectors within the UK decarbonise over the temporal scope of approximately 25 years considered in the assessment. The results from the assessment are therefore considered to be conservative.

171. Emissions from the sources for the Project are predicted to be approximately 582,573 tonnes. Contextualisation of the results are presented in the following sections.

172. Emission factors used in the assessment such as for manufacturing of materials and the movement of road vehicles and marine vessels are representative of present-day conditions. It is highly likely that the emission factors would reduce as sectors within the UK decarbonise over the temporal scope of approximately 25 years considered in the assessment. The results from the assessment are therefore considered to be conservative.

Table 23.25 GHG emissions for the Project (25 year Operational Phase)

Phase	Offshore or Onshore	Source	GHG Emissions (tonnes CO_2e)*	% of Phase GHG Footprint**	Total GHG Emissions per Phase (tonnes CO_2e)*	% of Overall GHG Footprint**
Construction	Offshore	Embodied emissions in materials	293,971	66.6%	441,687	75.8%
	Onshore	Embodied emissions in materials	123,011	27.9%		
	Offshore	Marine vessels	22,751	5.2%		
	Onshore	Plant and equipment	1,740	0.4%		
	Onshore	Road traffic	214	0.05%		
Operation	Offshore	Marine vessels	128,934	96.3%	133,892	23%
	Onshore	Road traffic	4	0.003%		
	Offshore	Spare parts	4,954	3.7%		
Decommissioning	Both	1.2% of total***	6,993	1.2%	6,993	1.2%
Total*			582,573			
Offshore Total******			445,656		76.5%	
Onshore Total******			124,970		21.5%	

*Figures presented in this table have been rounded to the nearest whole number
** Percentages rounded to a one decimal place
***refer to **Section 23.3.2**
****** (excluding spare parts and decommissioning as these are a proportion of both the onshore and offshore total)**

23.5.3.2 GHG intensity of the electricity produced for the Offshore and Onshore Project

173. The GHG intensity per unit electricity (kWh) produced by the Offshore Project and Onshore Project was determined as described in **Section 23.4.1**. The anticipated levels and associated GHG intensity of electricity generated by the Offshore Project and Onshore Project is presented in **Table 23.26**.

Table 23.26 Electricity generation and GHG intensity for the Offshore Project and Onshore Project

Annual electricity generation (MWh p.a.)	Electricity generated by Project over 25 years (MWh)	GHG Emissions Released from the Project (tonnes CO_2e)	GHG intensity of electricity produced by project (g CO_2e.kWh-1)
500,196	12,504,900	582,573	46.6

174. The GHG intensity of the electricity produced by the Offshore Project is therefore 46.6 g $CO_2e.kWh^{-1}$. As noted in **Section 23.1.1** and **Appendix 23.A**, a number of very conservative assumptions were adopted in the assessment, therefore the GHG footprint of the Project, particularly during the operation and maintenance phase, is likely to be an overestimation.

23.5.3.3 GHG Emission Savings or Carbon Offset for the Offshore Project and Onshore Project

175. In the 'do nothing' scenario, it was assumed that the electricity generated by the Offshore Project and Onshore Project would be produced using gas, as this is the most common form of new plant in terms of fossil fuel combustion. The quantity of GHG emissions produced from the generation of electricity from gas is presented in **Table 23.19**, along with the GHG footprint of the Project as presented in **Table 23.27**. These values are used to derive the total carbon offset by the Project. It is noted that the emission factor for electricity supplied by gas is in units of CO_2 rather than CO_2e, however, CO_2 is likely to form the main contribution to the generation of electricity.

Table 23.27 GHG savings from the Offshore Project

Anticipated energy produced by the Offshore Project (GWh)	GHG emissions from electricity generated from gas (tonnes CO_2)	Project GHG emissions (tonnes CO_2e)	GHG emission saved (tonnes CO_2e)
12,505	4,654,959	582,573	4,072,386

176. The data presented in **Table 23.27** shows that the estimate levels of GHG savings over the lifespan of the Offshore Project and Onshore Project would be approximately 4.1 million tonnes CO_2e.

23.5.3.4 GHG 'payback' period for offshore and onshore aspects of the Project

177. To estimate the 'GHG payback' of the Project, it was assumed that electricity produced by gas is displaced (as detailed in the 'do nothing' scenario in **Section 23.4.1.2**). Using this approach, the GHG payback of the is 2.61 years from the time when the Project becomes fully operational, as set out in **Table 23.28**.

Table 23.28 GHG 'payback' (Offshore Project and Onshore Project)

Parameter	Value	Unit
Energy produced by Project	500	GWh/year
CO_2e intensity of electricity generated by natural gas	372	tonnes CO_2e/GWh
Yearly CO_2e from gas-generated electricity (i.e. saved per year)	186,198	tonnes per year
Total CO_2e released by Offshore Project and Onshore Project (total: construction/25 year operation and maintenance/ decommissioning)	582,573	tonnes
Time taken for Project-generated CO_2e to be paid back	3.13	years

23.5.3.5 Comparison to UK Carbon Budget – the Offshore and Onshore Project

178. The provision of renewable energy will play an important role in meeting the UK Carbon Budgets and contributing to net zero aspirations.

179. During construction, total GHG emissions from the Project (441,687 tonnes CO_2e) were predicted to contribute approximately 0.02% of the 4th UK Carbon Budget (between 2023 and 2027) over the five year period. This assumes that all of the construction activities take place within the period 2023 – 2027, which is likely to be an overestimation as some emission activities will take place in beyond 2027. GHG emissions during construction are temporary and form a relatively small component of the 4th UK Carbon Budget.

180. The total GHG saving associated with the Project is estimated to be 4.1 million tonnes CO_2e. For context, this GHG saving (over a five year period equates to approximately 814,477 tonnes CO_2e) as a result of the Offshore Project and Onshore Project equates to a saving of 0.08% of the 6th UK Carbon Budget (2033-2037).

23.5.4 Significance of effect – Onshore and Offshore Projects

181. As noted in **Section 23.3.3.5.2**, the significance of a project in relation to GHG emissions is derived from comparisons to the 'Do Nothing' baseline scenarios and how the Project would align with the UK's net zero aspirations.

182. As noted in the **Section 23.5.3.5**, the Project would result in a reduction in the release of GHG's to the atmosphere by approximately 4.1 million tonnes CO_2e, compared to the 'do nothing' baseline (i.e. electricity produced by gas), and will provide a renewable source of electricity which beneficially contributes to the UK's goal of achieving net zero emissions by 2050. It was therefore considered that the effects of the Project would be of **beneficial significance** in relation to reducing GHG emissions, which is considered to be **significant** in EIA terms.

183. Due to the extent of GHG emissions saved, the Project and the wider offshore wind sector is anticipated to contribute towards the UK meeting its emission reduction targets set out in the Carbon Budgets and Climate Change Act 2008.

23.5.4.1 Further Mitigation

184. No further mitigation is recommended for the Onshore and Offshore Projects.

23.6 CCRA

185. The potential effects of climate change to the Onshore Project during operation and maintenance have been assessed. This section provides a summary of projected climate change variables and the associated hazards anticipated to interact with the Onshore Project during 25 year lifespan.

23.6.1 Step 1: Identifying Receptors, Climate Variables and Hazards

186. As identified in **Section 23.4.2**, the main climate variables which could be affected by climate change in the study area are temperature, precipitation, wind speeds and extreme weather events.

187. The Onshore Project receptors which may be potentially impacted by the climate change hazards are identified as the following components:

- Landfall to MLWS
- Onshore Export Cables
- Watercourse Crossing
- Onshore Substation.

188. The Onshore Project may be exposed to a range of climate hazards, defined as extreme weather events and chronic climatic changes with the potential to harm human, environmental or infrastructure receptors (IEMA, 2020).

189. Exposure to climate hazards may lead to climate change risks to the Onshore Project such as physical damages to buildings and other infrastructure components. Climate change risks are defined as the potential impacts of climate hazards on the ability of a receptor to maintain its function or purpose, which may result in adverse ecological or human consequences (IEMA, 2020).

190. The Onshore Project climate change receptors, climate variable and the identified climate hazards are detailed in **Table 23.29**.

Table 23.29 Onshore Project Receptor, Climate Variable and Climate Hazard

Climate Variable	Potential Climate Hazards	Receptors Affected
Temperature	**Heatwave –** the climate projection data in **Table 23.22** and **Table 23.23** show that annual temperatures are predicted to rise, particularly during summer months. This may result in more periods of heatwaves or high temperatures.	• Onshore Export Cables • Onshore Substation
	Snow and Ice – the climate projection data in **Table 23.22** and **Table 23.23** shows that average temperatures are predicted to increase in winter months, meaning potential impacts associated with snow and ice conditions are likely to decrease.	As snow and ice conditions are likely to be less frequent due to milder winters, impacts to the Onshore Project receptors are not considered to be likely.
	Sea level rise – sea levels are likely to rise as a result of increased global temperatures, which may affect receptors in coastal areas such as the landfall (to MLWS).	Landfall (to MLWS)
Precipitation	Surface Water Flooding – the climate projection data in **Table 23.22** and **Table 23.23** show that annual precipitation levels in the study area are likely to be similar to the present climate. However, there is projected to be an increase in precipitation during winter months, which could lead to more frequent surface water flooding events during this season.	• Onshore Export Cables • Watercourse Crossing • Onshore Substation
	Drought – the climate projection data in **Table 23.22** and **Table 23.23** show	The identified receptors associated with the

Climate Variable	Potential Climate Hazards	Receptors Affected
	that annual precipitation levels in the study area are likely to be similar to the present climate. However, there is projected to be less in precipitation during summer months, which could lead to drought events during summer.	Onshore Project are not considered to be vulnerable to drought events.
Wind Speeds	**Average wind speeds –** There is uncertainty as to whether climate change will result in differences in annual average wind speeds wind speeds. Potential impacts from higher wind speeds in extreme weather events are considered in the row below.	None identified.
Extreme Weather Events	**Storm events (high winds and flooding) –** although there is uncertainty as to the degree that climate change will lead to more extreme weather events, recent evidence suggests this is becoming more prominent. Potential extreme weather events include storms, where there may be high winds and flooding (as discussed above). These events could therefore result in impacts to above ground infrastructure such as the onshore substation.	• Onshore Substation
	Storm surges – extreme weather events may result in storm surges, which may affect receptors in coastal areas such as the landfall (to MLWS). The Flood Risk Assessment (**Appendix 14.C**) also notes that the Onshore Substation is at risk of tidal flooding, which could be caused by storm surges.	• Landfall (to MLWS) • Onshore Substation
	Tidal flooding – extreme weather events may result in a greater risk of tidal flooding, which may affect receptors in coastal areas such as the landfall (to MLWS). The Flood Risk Assessment (**Appendix 14.C**) also notes that the Onshore Substation is at risk of tidal flooding.	• Landfall (to MLWS) • Onshore Substation

191. The vulnerability, and by extension the resilience, of the Onshore Project receptors to these climate parameters was therefore considered in Step 2 of the CCRA.

23.6.2 Step 2: Climate Vulnerability Assessment

The vulnerability of the identified receptors to each of the climate hazards presented in **Table 23.29** are assessed below.

23.6.2.1 Surface Water and Tidal Flooding, Sea Level Rise

192. Flooding events associated with the climate change to the Onshore Project could be associated with sea level rise and tidal flooding, and rain intensity. **Chapter 14 Water Resource and Flood Risk** states that as a result of sea level rise, more areas of the coastal catchment will be at risk of flooding from the sea, with flood risk controlled more by sea levels and coastal storms than the present situation where the risk of flooding due to fluvial flooding from river watercourse. The Onshore Project will include permanent above ground infrastructure (Landfall, Onshore Substation and Onshore Export Cables) which will lead to change in land use with an increase in impermeable land area. The permanent below ground infrastructure includes buried cable ducting which has the potential to affect land drainage during operation.

193. The Onshore Project infrastructure is assessed in **Chapter 14 Water Resource and Flood Risk** to have a **negligible** effect on the flood risk during operation and maintenance. Additionally, the design of the Onshore Project has accounted for mitigation measures including onshore drainage will be incorporated into the design of the Onshore Project infrastructure.

194. As detailed in **Table 23.23**, the projected worst case annual mean precipitation change is an increase by 25% in winter for the RCP8.5 90th percentile scenario (very high GHG emission scenario) compared with the 1981-2001 baseline (detailed in **Table 23.21**). Based on the worst case projected rainfall, the future climate change is expected to potentially cause increased rain intensity. As stated in **Chapter 14 Water Resource and Flood Risk**, the landfall (to MLWS) and onshore cable area are not considered to be at risk of surface water flooding during the operation and maintenance phase of the Onshore Project. During the operation and maintenance phase, Watercourse Crossings are not considered to be at risk of surface water flooding.

195. Therefore, the receptors, Landfall (to MLWS), Onshore Export Cables, Watercourse Crossing and Onshore Substation, are considered to have medium exposure to flooding and a **low** sensitivity to such climatic change. Based on the criteria identified in **Table 23.9**, the receptors are considered to have low vulnerability to flooding as shown in **Table 23.30**.

Table 23.30 Onshore Project Receptor Climate Change Vulnerability

Receptor	Climate Hazard	Sensitivity	Exposure	Vulnerability
Landfall (to MLWS)	Storm Surges	Low	Moderate	Low Vulnerability
	Tidal Flooding	Low	Moderate	Low Vulnerability
	Sea level rise	Low	Moderate	Low Vulnerability
Onshore Export Cables	Surface Water Flooding	Low	Moderate	Low Vulnerability
	Heatwave	Low	Low	Low Vulnerability
Watercourse Crossing	Surface Water Flooding	Low	Moderate	Low vulnerability
Onshore Substation	Storm Surges	Low	Moderate	Low Vulnerability
	Tidal Flooding	Low	Moderate	Low Vulnerability
	Surface Water Flooding	Low	Moderate	Low vulnerability
	Heatwave	Low	Low	Low vulnerability

196. Given the vulnerability rating of low for the flooding climate hazard, an assessment of the predicted effects and associated risks of the flooding (step 3 of the CCRA methodology) has not been carried out.

23.6.2.2 Storm Surges

197. As highlighted in **Section 23.4.2.2.1**, there is no observational evidence for long-term trend in storminess across the UK or resultant storm surges which could cause operational disruption and damage to coastal infrastructure and flooding. In addition, future climate projections related to wind conditions and storminess are uncertain. Given the location of the Landfall and Onshore Substation receptors, they are considered to have medium exposure to extreme weather events, as key components could experience events such as storm surges and the resulting damage to infrastructure and flooding.

198. **Chapter 14: Water Resource and Flood Risk** highlights the risk of flooding to coastal catchment area of the Onshore Project due to the coastal storms resulting from climate change. However, the design of the Landfall has considered the effect of storm surges as the cable will be buried sufficiently to avoid exposure from coastal erosion during a storm surge event. The Landfall (to MLWS) receptor is considered to have medium exposure to storm surges and a **low** sensitivity to such climatic change. Based on the criteria identified in **Table 23.9**, the Landfall (to MLWS) receptor is considered to have low vulnerability to storm surges as shown in **Table 23.30**.

199. Given the vulnerability rating of low for the storm surges climate hazard, an assessment of the predicted effects and associated risks of storm surges (Step 3 of the CCRA methodology) was not carried out.

23.6.2.3 Heatwaves

200. As noted in **Section 23.4.2.2**, the UK is projected to warmer across all seasons. For the Onshore Project location, for the high emission scenario, RCP8.5, the greatest project temperature increase is in summer with an increase of 3.45^{o}C compared to the 1981-2000 baseline. As a result of the future increasing temperature due to climate change, there is a potential for heatwave to cause damage to the Onshore Project infrastructure, specifically the Onshore Export Cables and Onshore Substation. The Onshore Export Cables and Onshore Substation design has accounted for increases in temperature to reduce the vulnerability to heatwave.

201. Therefore, the Onshore Export Cables and Onshore Substation receptors are considered to have low exposure to heatwave and a **low** sensitivity to such climatic change. Based on the criteria identified in **Table 23.9**, the receptors, Onshore Export Cables and Onshore Substation, are considered to have low vulnerability to heatwave as shown in **Table 23.6**.

202. Given the vulnerability rating of low for the heatwave climate hazard, an assessment of the predicted effects and associated risk of heatwave (Step 3 of the CCRA methodology) was not carried out.

23.6.2.4 Step 2 Summary

203. The output of the climate change vulnerability assessment is shown in **Table 23.30**.

23.6.3 Significance of effects

204. The CCRA identified the vulnerability and resilience, of the Onshore Project to the main identified climate hazards that are likely to occur over its operational lifespan. The assessment determined that the vulnerability rating of each of the climate hazard for the identified receptors would be **low**. Therefore, Steps 3 and 4 of the methodology for the CCRA assessment are not required, and the effects of climate change to the Onshore Project is considered to be **not significant**.

23.6.4 Further Mitigation

205. No further mitigation is recommended for the Onshore Project.

23.7 Potential Cumulative Effects

23.7.1 CEA with Other Projects

23.7.1.1 GHG Assessment

206. As noted in **Section 23.3.5**, the global atmosphere is the receptor for the GHG assessment (which is of **high** sensitivity) and IEMA guidance (2022) states that effects of GHG emissions from specific cumulative projects should therefore not be individually, as there is no basis for selecting which projects to assess cumulatively over any other. The impact of GHG assessment is therefore inherently cumulative, and no specific cumulative assessment of other projects is required to be undertaken.

23.7.1.2 CCRA Assessment

207. There are a number of existing and future project sites (newly approved or pending applications) in the vicinity of the Onshore Project area. The only climate variables identified in **Section 23.6.2** applicable for consideration for cumulative effects is surface water flooding, due to potential impacts to land drainage capacity from projects in close proximity to the Onshore Project.

208. **Table 18.28** in **Chapter 14: Water Resources and Flood Risk**, presents the projects considered in the cumulative effect assessment in relation to water resources and flood risk. The only identified project for consideration in relation to surface water flood is the Yelland Quay development which includes the construction of 250 dwellings with further retail and employment space. As stated in **Chapter 14: Water Resources and Flood Risk**, following the implementation of the mitigation measures specified for the Onshore Project including a Construction Environmental Management Plan (CEMP), a CEMP for the proposed Yelland Quay project, and a surface water strategy to ensure surface water runoff can be attenuated on site for the 1 in 100 year +40% (climate change) rainfall event, the cumulative effect from the two projects is **not significant**.

23.8 Potential transboundary impacts

209. As noted, the receptor for the GHG assessment is the global atmosphere, and therefore emissions of GHGs have an indirect transboundary effect. As the GHG emissions arising from the Project were considered in the context of the UK Carbon Budgets and the aspiration to national emissions, the cumulative transboundary effects of GHGs emitted by the Project are not considered to require specific consideration.

23.9 Inter-relationships

210. Inter-relationship impacts are covered as part of the assessment and consider impacts from the construction, operation or decommissioning of the Project on the same receptor (or group). A description of the process to identify and assess these effects is presented in **Chapter 6: EIA Methodology**.

211. The receptor for the GHG assessment is the global atmosphere, therefore there are no inter-relationships with other environmental effects.

212. There are also not considered to be any inter-relationships for the aspects covered in the CCRA, with other environmental effects related to the Onshore Project.

23.10 Interactions

213. The effects identified and assessed in this chapter are not considered to have the potential to interact with each other. Therefore, an assessment of interactions between effect identified in this chapter was not carried out.

23.11 Summary

214. This chapter has investigated the potential effects on GHG emissions arising from the Onshore Project, and the Project as a whole, as well as the climate change effects on the Onshore Project. The range of potential impacts and associated effects considered has been informed by the Scoping Opinion, consultation, as well as reference to existing policy and guidance. The impacts considered include those brought about directly as well as indirectly.

215. **Table 23.31** presents a summary of the impacts assessed within this ES chapter, any commitments made, and mitigation required and the residual effects. The Onshore Project and Onshore Project were predicted to have beneficial effect in the GHG assessment and would contribute towards the UK meeting its emission reduction targets set out in the Carbon Budgets and the 2009 Climate Change Act. This was **significant** in EIA terms, in accordance with IEMA (2022) guidance. In addition, the effects of climate change to the Onshore Project were determined to be **not significant** in the CCRA.

216. The assessment of cumulative effects from the Onshore Project and other developments and activities concluded that there would be no effects to other developments.

Table 23.31 Summary of potential impacts for Climate Change during construction, operation, maintenance and decommissioning of the Onshore Project

Potential impact	Receptor	Sensitivity	Magnitude	Significance	Mitigation measures	Residual effect
Construction, Operation and Maintenance, and Decommissioning (GHG Assessment)						
GHG emissions during construction, operation and maintenance and decommissioning	Global atmosphere	High	N/A*	Beneficial (significant)	Not required as effect is beneficial	Beneficial (significant)
Operation and Maintenance (CCRA Assessment)						
Climate change resilience	Onshore Project infrastructure	Low	N/A**	Not significant	N/A	Not significant
***not defined as part of the assessment methodology **in terms of vulnerability to climate change**						

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White Cross Offshore Windfarm Environmental Statement

Appendix 23.A: Greenhouse Gas Assessment Methodology

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Glossary of Acronyms

Acronym	Definition
AHT	Anchor Handling Tug
DESNZ	Department for Energy Security and Net Zero
GHG	Greenhouse Gas
GRP	Glass Reinforced Plastic
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
IAC	Inter Array Cable
ICE	Inventory of Carbon and Energy
MGO	Marine Gas Oil
MHWS	Mean High-Water Springs
NM	Nautical Mile
NRMM	Non-road Mobile Machinery
OSP	Offshore Substation Platform
SOV	Service Operations Vessel
WTG	Wind Turbine Generator
XLPE	Crosslinked Polyethylene

1. Greenhouse Gas Assessment Methodology

1.1 Introduction

1. This Appendix sets out further technical details for greenhouse gas (GHG) assessment methodology presented in **Chapter 23: Climate Change**. As detailed in **Chapter 23: Climate Change**, the chapter presents the impacts of the Onshore Project on climate change. Specifically, the chapter considers the potential impact of the Project landward of Mean Low Water Springs during its construction, operation and maintenance, and decommissioning phases.

2. As detailed in **Section 27.3.5 of Chapter 27: Climate Change**, the Offshore Project (i.e. seaward of Mean High-Water Springs (MHWS)) is subject to a separate application for consent under Section 36 of the Electricity Act 1989, and for Marine Licences under the Marine and Coastal Access Act 2009. It is expected that the Offshore Project would have the greatest impact in GHG terms and to provide a complete GHG assessment for the Onshore Project, emissions associated with the Offshore Project have been considered. These are presented in **Section 23.7.1** of **Chapter 23: Climate Change** and details on this methodology are provided in **Section 1.3**.

3. This Appendix includes the methodology for quantifying GHG emissions from:

- The Onshore Project (i.e. embodied emissions in materials, road traffic movements, and plant and equipment) (see **Section 1.2**)
- The Onshore Project in-combination with the Offshore Project (i.e. offshore embodied emissions in materials and marine vessel movements) (see **Section 1.3**).

1.2 The Onshore Project

1.2.1 Embodied emissions in onshore materials

4. Emissions of 'cradle to (factory) gate', a term which includes the extraction, manufacture and production of materials to the point at which they leave the factory gate of the final processing location, were calculated for the Onshore Project. GHG emissions were derived from quantities or volumes of known materials that will be used in construction of the Onshore Project, including the following infrastructure:

- Onshore export cables installed underground from the landfall to the onshore substation
- Joint bays (concrete)

- Onshore Substation (concrete and steel).

5. To provide a precautionary assessment, it was assumed that there would be no decrease in the emissions intensity when materials are extracted and manufactured from present day conditions. This is likely to be a conservative approach, as the earliest that construction of the Onshore Project would commence is anticipated to be 2025, where the emissions intensity of some sectors such as transport and industry is likely to have decreased.

6. The quantities of each type of construction material to be used on site were obtained from the Applicant's design team, and the relevant emission factors sources from the Inventory of Carbon and Energy (ICE) database (Jones & Hammond, 2019) where possible. Alternative sources for emission factors were used for more specific components to wind farms (i.e. cables), and are detailed in this Appendix.

7. Precautionary assumptions were adopted with respect to material quantities to be used for each component of the Onshore Project, which include contingency allowing for the worst-case scenario of the maximum design envelope to be accounted for. It has also been assumed that virgin materials will be used, whereas the Onshore Project will seek to use recycled sources for some of the components.

8. The emission factors used in the GHG assessment to calculate embodied emissions in onshore construction materials are presented in **Table 1.1**.

Table 1.1 Emission factors for embodied GHGs in onshore materials

Material	Emission Factor (kg CO_2e/kg, unless otherwise stated)	Source	Comment
Aluminium	6.67	ICE Database, v3.0 November 2019 (Jones & Hammond, 2019)	Europe
Concrete	0.10		N/A
Copper	2.71		Average of embodied carbon dioxide equivalent (CO_2e) virgin and recycled values provided in ICE database
Glass reinforced plastic (GRP) – Fibreglass (proxy)	8.1		Carbon dioxide (CO_2) only.
Iron (cast iron proxy)	2.03		N/A
Nylon	9.14		Used nylon (polyamide) 6 polymer as worst case.

Material	Emission Factor (kg CO_2e/kg, unless otherwise stated)	Source	Comment
Steel (average)	2.47		Average of embodied CO_2e steel values provided in ICE database
Armouring (cable)	1.46	Cableizer (n/a)	
Lead (cable)	1.67		General type.
Polyethylene sheath or filler cable	2.54		General type.
Polypropylene yarn (cable)	3.69		CO_2 only,
Semi-conductor (proxy) (cable)	1.49		
Crosslinked polyethylene (XLPE) (cable)	1.93		

1.2.2 Road vehicles

9. Road vehicle movements associated with the construction, and operational and maintenance phases of the Onshore Project will result in the release of GHG emissions. GHG emissions were calculated from an estimation of the total kilometres travelled by heavy goods vehicles (HGVs) and staff transport to and from the onshore construction sites, and also during the operation and maintenance phase.

10. The total distance of vehicles travelled during the whole construction phase was provided by the Transport Consultants for the Onshore Project. To provide a conservative assessment, the fleet make up (in terms of fuel and Euro standards) for the earliest year of construction (2025) was used in the assessment for employee travel.

11. Emission factors for each vehicle type considered in the assessment were obtained from the Department for Energy Security and Net Zero (DESNZ) (formerly Department for Business, Energy and Industrial Strategy) (2023), in kg CO_2e per km travelled. To provide a conservative assessment, it was assumed that there were no fuel efficiency improvements or reduction in emissions over the Project period for each mode of transport in the assessment.

12. Distances travelled during the construction phase of the Onshore Project were calculated for HGVs and employee movements according to the following assumptions:

- A journey distance of 14km per movement has been adopted as this represents the maximum distance from the proposed access (off Sandy Lane) to the extents of the traffic and transport study area at the A39. Journeys beyond the extent of the A39 are assumed to already be on the highway network and therefore would reassign to service the Onshore Project
- The number of working days during construction assumes the worst case programme duration of 18 months, and 5.5 working days per week
- Assumes a worst case assumption of peak employees working each day.

13. The construction phase movements used to calculate GHG emissions are provided in **Table 1.2**.

Table 1.2 Construction phase traffic movements

Variable	Units	HGV	Light vehicles
Total HGV movements	Movements	7,005	-
Total HGV trips	Trips	14,011	-
Total HGV trips (plus 20% contingency)	HGVs	16,813	-
Total employee vehicle movements	Employees	-	9,606
Total employee vehicle trips	Days	-	19,212
Maximum distance	miles	8	8
Total distance travelled	miles	134,501	153,696
Total distance travelled	km	216,458	247,350

14. The forecasted 2025 fleet composition (i.e. proportion of diesel, petrol and electric cars) was obtained from the Department for Transport (DfT) WebTAG data v1.21 (DfT, 2023). The proportion of diesel, petrol and electric cars in the UK fleet for 2025 was obtained from the DfT (2023) to determine a representative emission factor associated with employee travel. The light vehicle fleet composition used in the assessment, and emission factors associated with each vehicle type are provided in **Table 1.3**. Emission factors for each light vehicle type were obtained from DESNZ (2023).

Table 1.3 Calculation of emission factor used for light vehicles in assessment

Earliest year of construction	Fleet composition (DfT, 2023)			Vehicle emission factor (kg CO_2e/km) (DESNZ, 2023)			Emission factor used in assessment (kg CO_2e/km)
	Diesel	Petrol	Electric	Diesel	Petrol	Electric*	
2025	35.7%	49.6%	14.7%	0.17	0.164	0.066	0.152
*Assumed to be plug-in hybrid electric vehicles, as battery electric vehicle has 0 CO_2e emissions in the 2023 DfT dataset							

15. It was assumed that all HGVs used on the Onshore Project would be diesel powered. The emission factor for HGV movements (50% laden) was obtained from DESNZ (2023) and was 0.81kg CO_2e/km. In the absence of suitable empirical data, it was assumed that the fleet composition of HGVs did not change over the temporal scope of the assessment to provide a precautionary approach.

16. During the operation and maintenance phase of the Onshore Project, traffic movements would be limited to those generated by the daily operation and periodic maintenance at the White Cross Onshore Substation and at link boxes along the Onshore Export Cable Corridor. It was therefore assumed that there would be two traffic movements (i.e. one visit) per week during the 25-year operational phase of the Onshore Project. Although the total operational life of the Onshore Project in anticipated to be up to 50 years. However, the operational life of the Offshore Project is 25 years, and therefore for the purposes of this assessment, the temporal scope for the Onshore Project is assumed to be 25 years. This visit was assumed to a 20km round-trip, i.e. 10km each way, and amounted to approximately 1,040km per annum.

1.2.3 Plant and equipment

17. Fuel consumption associated with the operation of non-road mobile machinery (NRMM) for the Onshore Project were calculated based on the estimated use of each item of plant and equipment. Indicative construction plant and equipment types for construction activities at landfall, along the Onshore Export Cable Corridor and at the White Cross Onshore Substation were provided by the WCOWL design team. In addition, some assumptions were made regarding the number and specification of each type of plant based on other projects of a similar nature.

18. The anticipated fuel demand over the duration of construction was calculated and the emission factor for gas oil consumption was obtained from DESNZ (2023) to derive GHG emissions.

19. The following assumptions were adopted in the assessment:

- Plant and equipment are assumed to operate throughout the consented working hours for the Onshore Project (12 hours per day). On-time factors were applied for each plant and equipment
- Construction plant and equipment were all assumed to use diesel to provide a conservative assessment
- Engine sizes for plant and equipment were either provided by the project team or obtained for NRMM typically required during construction activities, and from

manufacturer specifications. It was assumed that engines operated at a load factor of 75%.

20. An indicative Onshore Project construction programme was provided by WCOWL design team. The summary of the onshore activities and duration of each activity is detailed in **Table 1.4**.

Table 1.4 Onshore Project Construction Schedule

Construction activity	Duration (days)
Landfall Horizontal Directional Drilling (HDD) White Cross	99
Golf Course HDD White Cross	365
River Taw HDD	365
Onshore Cable Corridor Construction	432
Substation Construction	313

21. Plant and equipment used during the construction of the Onshore Project are provided below in **Table 1.5**.

Table 1.5 Indicative Onshore Project plant and equipment requirements

Construction plant and equipment	Indicative number required		
	HDD	Onshore export cable corridor	Onshore substation
250t HDD rig	1	-	-
Power Pack	1	-	-
Control Cabin	1*	-	-
Fuel Tank	1*	1	-
Sedimentation tank	1*	-	-
Fluid mix tank	1*	-	-
Fluid laboratory	1*	-	-
Office	2*	-	-
Toilets	1*	1	-
Meeting room	1*	1	-
Canteen	1*	-	-
Drying room	1*	1	-
70kva generator	1	1	-
30t excavator	4	-	-
T500 Tracstar	1	-	-
40T Tracked telescopic crawler	-	-	-
25t excavator	-	-	-
20t excavator	-	2	-
D6 Bulldozer	-	2	-
5t excavator	-	1	-
Small HDD rig (Ditch Witch for Ditches)	-	1	-

Construction plant and equipment	Indicative number required		
	HDD	Onshore export cable corridor	Onshore substation
14m Telehandler	-	2	-
Hydrema 12T back tipping dumper	-	2	-
Concrete Lorry	-	-	-
M24 Mobile Concrete pump	-	1	-
Vibratory poker	-	2	-
Ramax Vibratory Roller	-	2	-
10t Forward tipping dumper	-	3	-
Drum Cable Winch	-	1	-
25t excavator with vibrating plate attachments	-	3	-
360-degree excavators	-	-	2**
backhoe loaders	-	-	2**
dozers	-	-	2**
swivel skip dumpers	-	-	2**
mobile cranes	-	-	2**
cement mixer trucks	-	-	2**
truck mounted concrete pump	-	-	1**
piling rig	-	-	1**
Generator - large	-	-	1**
Generator - small	-	-	1**
*assumed to have no emissions **assumed equipment as onshore substation equipment details were not available at the time of writing the chapter			

22. The number of daily operational hours for each plant and equipment was provided by the Project team. The HDD equipment will be operational for 12 hours per day for each of the HDD activities detailed in **Table 1.4**. The onshore substation plant and equipment is assumed to be operational for 12 hours per day for 313 working days as detailed in **Table 1.4**. The onshore cable corridor construction equipment will be operational for 12 hours for the respective number of days detailed in **Table 1.6**.

Table 1.6 Onshore Project Cable Corridor Construction Days

Construction plant and equipment	Days for operation	Total operational construction hours
Fuel tank	-	-
40T Tracked telescopic crawler crane (LTR 1040)	432	5,184
Office	-	-
Toilets	-	-

Construction plant and equipment	Days for operation	Total operational construction hours
Meeting Room	-	-
Canteen	-	-
Drying room	-	-
70kva generator	-	-
25t excavator	15	180
20t excavator	20	240
20t excavator	15	180
D6 Bulldozer	20	240
25t excavator	20	240
20t excavator	25	300
5t excavator	25	300
25t excavator	60	720
Small HDD rig (Ditch Witch for Ditches)	45	540
20t excavator	45	540
25t excavator	60	720
20t excavator	45	540
14m Telehandler	45	540
Hydrema 12T back tipping dumper	45	540
Concrete Lorry	45	540
M24 Mobile Concrete pump	45	540
Vibratory poker	45	540
Ramax Vibratory Roller	45	540
10t Forward tipping dumper	45	540
Drum Cable Winch	80	960
40T Tracked telescopic crawler crane (LTR 1040)	80	960
25t excavator with vibrating plate attachments	70	840
Ramax Vibratory Roller	70	840
D6 Bulldozer	20	240
25t excavator	20	240

23. For the purposes of the assessment, it was assumed that plant and equipment operated using gas oil as fuel, which has an emission factor of 0.2565kg CO_2e/kWh (DESNZ, 2023). All plant were assumed to operate at an average load factor of 0.75.

1.3 The Offshore Project (In-combination)

24. As stated in **Chapter 23: Climate Change**, the Offshore Project application was prepared separately and has been submitted. At the time of preparing the Offshore Project application some components of the Onshore Project had yet to be finalised. Therefore, there are differences between GHG emissions presented in the Offshore Project and Onshore Project applications, as aspects of the Onshore Project presents refined information compared with the Offshore Project. An overview of the Offshore

Project and the onshore infrastructure is set out within **Chapter 5: Project Description**.

25. It is not anticipated that these differences will change the significance of effect concluded in this chapter.

1.3.1 Embodied emission in the Offshore Project

26. The same methodology and assumptions outlined in **Section 1.2.1** of this Appendix were used to calculate embodied emissions within offshore construction materials.

27. GHG emissions were derived from quantities or volumes of known materials (at this stage of the application) that will be used in construction. The key components of the Offshore Project considered in the embodied emission comprise:

- Wind Turbine Generators (WTG) (i.e. tower, nacelle, blades) and mooring system
- Offshore substation platform (OSP) and (sub-)structure
- Scour protection (i.e. rock)
- Offshore export and inter-array cables.

28. The emission factors used in the GHG assessment for embodied emissions in offshore construction materials have been presented in **Table 1.1**.

1.3.2 Marine vessels

29. Marine vessels will be used to bring materials and components to the wind farm site, install infrastructure (WTGs, offshore substation platforms, substructure and cables), provide crew accommodation and support during construction, commissioning and for operation and maintenance activities.

Indicative vessel logistics during construction, operation and maintenance

30. The current working assumptions for offshore vessel logistics during construction and operation and maintenance phases have been supplied by the Projects design team. These are outlined for construction transit and activities on site in **Table 1.7** and **Table 1.8** respectively. Operation and maintenance vessel activity is provided in **Table 1.9**. The Applicant will strive to choose vessels with clean and efficient propulsion systems where possible.

Table 1.7 Anticipated vessel transit activity during construction of the Project

Component	Total vessel movements	Vessel type	Assumed total movements per vessel type	Notes/ comments/ assumptions
Floating wind turbine	37	Barge	12	Four barge deliveries, with up to three barges on site
		Small tug	16	Two per WTG

Component	Total vessel movements	Vessel type	Assumed total movements per vessel type	Notes/ comments/ assumptions
generators scope		Anchor handling tug (AHT)	8	One per WTG
		Service operations vessel (SOV)	1	During commissioning of WTGs
Mooring scope	44	AHT (pre-lay)	4	N/A
		Barge for mooring chains (chain supply)	8	One per WTG
		AHT (hook up)	16	Two per WTG
		Small tug (hook up)	8	One per WTG
		Offshore support vessel (hook up)	8	One per WTG
Inter-array cable (IAC) scope	20	Offshore support vessel	2	N/A
		Cable lay vessel	2	N/A
		Cable lay vessel	8	N/A
		SOV	8	N/A

Table 1.8 Anticipated vessel activity on site during construction of the Project

Component	Activity	Vessel type	No. of days active	Total no. vessels (each with one day activity)
WTG	Barge in UK waters and unloading at H&W	Barge	18 days	32
	Tow to integrated site	Small tug	7 days	14
	Tow to site	AHT	21 days	24
		Small tug	21 days	42
Mooring	Mooring pre-lay	AHT	21 days	21
	Mooring chain supply	Barge for mooring chains	21 days	21
	Mooring hook up	AHT	14 days	14
		Small tug	14 days	28
		Offshore support vessel	14 days	14
Cables	Pre- and post-lay surveys	Offshore support vessel	7 days	7
	IAC pre-lay	Cable lay vessel	14 days	14
	IAC hook up	Cable lay vessel	14 days	14

Component	Activity	Vessel type	No. of days active	Total no. vessels (each with one day activity)
		SOV	14 days	14
WTG	WTG commissioning	SOV	14 days	14

Table 1.9 Anticipated vessel activities during operation and maintenance of the Offshore Project

Component	Assumed vessel type	Additional information	Duration on site	No. of vessel movements
WTG maintenance	SOV	Years 1 to 5	2 days per year per WTG	One return journey per year per WTG
		Years 5 to 10	3 days per year per WTG	
		Years 10 to 15	4 days per year per WTG	
		Years 16 or more	5 days per year per WTG	
OSP jacket and other infrastructure inspection	Offshore support vessel	N/A	1 week every 3 to 4 years	One return journey per visit
Inter-array cable (buried)	Offshore support vessel	N/A	3 weeks every 3 to 4 years	One return journey per visit
Subsea Offshore export cable survey	Offshore support vessel	N/A	5 days every 2 years	One return journey per visit
Substructure Underwater Inspection in Lieu of Dry-Docking/ external hull General Visual Inspection and mooring General Visual Inspection	Offshore support vessel	N/A	7 days every 5 years	One return journey per visit per WTG
Substructure internal close visual inspections and Non-Destructive Testing for Design Fatigue Factor <3	Offshore support vessel	N/A	5 days per structure every 5 years	One return journey per visit per substructure
Offshore export cable non-intrusive	N/A	N/A	N/A	N/A

Component	Assumed vessel type	Additional information	Duration on site	No. of vessel movements
Offshore export cable intrusive	Offshore support vessel	N/A	2 days every 3 years	One return journey per visit per WTG
Lifting Operations and Lifting Equipment Regulations cranes and lifting (pad eyes, etc.)	SOV	N/A	1 day every 6 months per WTG	One return journey per visit per WTG

31. The origin port of some of the marine vessels was not known at the time of the assessment, which affects how far the vessels have to travel to the site, and subsequently the quantity of emissions released. The majority of emissions will be released from vessels whilst at the site during construction, therefore changes to the transit time for marine vessels will have a limited effect in terms of the overall GHG footprint. The current construction/assembly ports under consideration are H&W Belfast, Port Talbot, Hunterston, Falmouth and Bristol Port. Therefore, as a worst case, Hunterston port (a return journey of approximately 550 nautical miles (nm)) was used to calculate GHG emissions during vessel transit for the vessels presented in **Table 1.7.** For transit related GHG emissions during operation and maintenance, it is likely that a closer port (i.e. Port Talbot, Falmouth or Bristol Port) will be used; therefore, to provide a worst case, Falmouth Port was used (a return journey of approximately 230nm).

32. Marine vessels will also be used to transport scour protection material (i.e. quarried rock); however, GHG emissions associated with these deliveries were not quantified as the level of information regarding rock deliveries is not known at this stage of the Application.

33. GHG emissions from vessel activity on site during the construction of the Project for the vessels presented in **Table 1.8** were calculated assuming that they were in operation for 24 hours a day to present a conservative scenario. Emissions from dredging activities during the construction of the Project have not been included in the assessment, as a breakdown of information regarding dredging activities is not known at this stage of the Application.

Emission calculations

34. Indicative vessel types that will be used during construction, and operation and maintenance activities were provided by the project team. Representative vessel

specifications for these vessels were obtained from other offshore wind farms of a similar nature to the Project. Fuel consumption figures were calculated by multiplying the engine size of the vessels by activity hours in transit or active on site (accounting for average engine load factors). Emission factors for marine gas oil (MGO), in kg CO_2e/kWh were obtained from DESNZ (DESNZ, 2023).

35. The shipping sector is expected to decarbonise over the lifespan of the Project, and projections for the speed and the extent that this will take place are difficult to predict. It was therefore assumed that marine vessels continued to use MGO during the construction, and operation and maintenance phases of the Project. This approach is considered to be conservative and may result in an overestimation of emissions, particularly with respect to the operation and maintenance phase.

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

1.4 References

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